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Farmers mobile application for ordering inputs and marketing produce

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FARMERS MOBILE APPLICATION FOR ORDERING INPUTS AND MARKETING PRODUCE.

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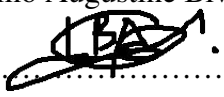
DECLARATION

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the dissertation contains no material previously published or written by another person except where due reference is made in the dissertation itself.

Limo Augustine Biwott



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ABSTRACT

Farming operations experience long agricultural supply chain every day. These long chains include, but not limited to very long processes of getting desired farm inputs and reaching the actual market for produce leading to excessive price abuse. In a small-scale farming setup, a farmer cannot access direct input and even sell their produce to the right market other than to depend on middle-men, brokers, who do not give them fair dues and thus the overall value of the farming becomes un-profitable.

The current small-holder farming setup do not explicitly consider commercial farming and majorly concentrate on subsistence farming yet there is enough potential to go commercial. This dissertation investigated the agricultural supply chain process. It was done by considering the challenges faced by farmers, especially small holder during start of farming, nurturing and selling produce. Further the current solutions used to get inputs and sale of produce were considered and a suitable solution designed, developed, tested and validated to ensure that it solved these challenges.

Data was collected from existing records of farmers input per season, produce gathered and sold. The data collected was used as input to an Android mobile application for farmers to order inputs and sell produce. Scrum Agile Development methodology was adopted as the software methodology for developing the solution. A proof of concept mobile application was adopted to make farm input orders and sell produce. Testing was conducted by the several farmers who were registered in the platform and a setup place in Eldoret town.

Keywords: Farmer input supply, farmer produce sell, application.

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ABBREVIATIONS

BAU- Business As Usual

CKW - Grameen Foundations Community Knowledge Worker

CNFA - Cultivating New Frontiers in Agriculture

EKL - Elgon Kenya Limited

GDP - Gross Domestic Product

GIS - Geographical information system

GPS - Geographical Positioning systems

IPM - E-Pest Management Systems

KARLO - Kenya Agricultural and Livestock Research Organisation

KOFAr - Kenya Organic Finest Aromas Ltd

MAAIF - Ministry of Agriculture Animal Industry and Fisheries

NARI - National Agriculture Research Institute

SCA - Supply Chain Analysis

VCA - Value Chain Analysis

VRT - Variable Rate Technologies

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DEDICATION

I dedicate this dissertation to my Loving wife, Joan Tirop, to my loving parents Wilson Terer and Leah Terer, to my siblings and to my Sons Nathaniel Kibet Murgor Japheth Kigen Murgor.

CHAPTER ONE: INTRODUCTION

1.1 Preamble

There are many terms and terminologies used in the agricultural sector that were of interest in this dissertation. Some of these were frequently used in this research and therefore it was good to define them. Agricultural supply chain normally refers to the whole range of goods and services necessary for an agricultural product to move from the farm to the final customer or consumer (Friedrich, 1992). A season is defined as the time from the period either short rains starts to the end or long rains from start to the end. Farmer is anyone who practices animal or crop production, both for food and/or commercial (John, 1980).

When a farmer starts a season, they either order inputs for animal or crops. Either feeds or fertilisers, or even pesticides or fungicides. A produce is the product of the animal or crop that can be consumed or sold (Norman, 1980). Farms are systems with inputs which can be money, labour, soil, climate, drainage, fertiliser and fuel. Processes include such activities as planting, ploughing, spraying, harvesting, shearing and milking. Further produce can be milk, cereals, eggs, wool, meat, hay and waste material (Friedrich, 1992).

Farming is classified according to what is grown and how it is grown: Arable being purely farming on crops, Pastoral farming on animals only, Mixed farming involving crops and animals, Subsistence farming is just done for the consumption by the farmer and his family, Commercial farming being to sell, Intensive farming includes high inputs of labour or capital usually on a small-scale farm (Fresco & Westphal, 1988).

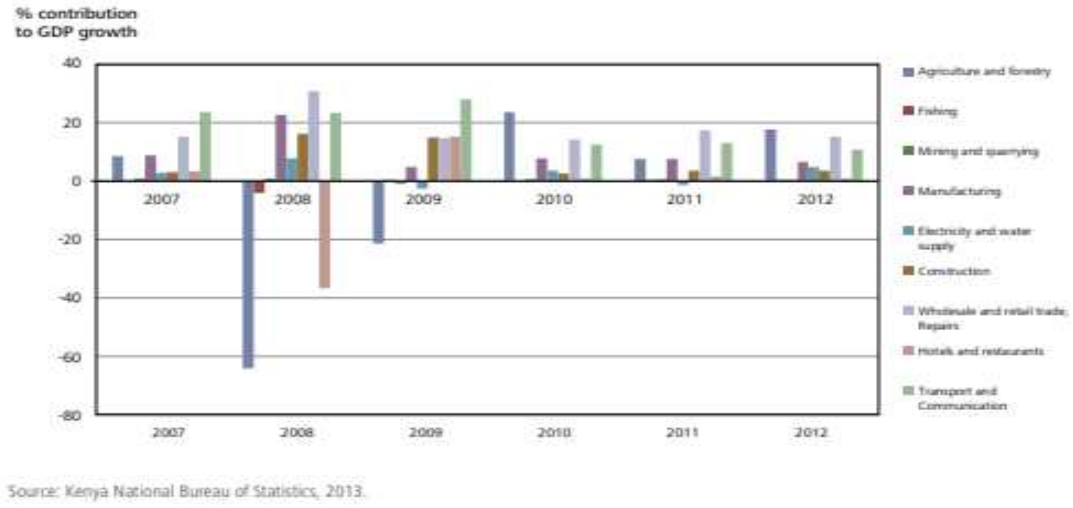
Most small holder farmers utilise the small acreage of land to either do mixed farming mainly subsistence. Subsistence farming is purely for consumption and not commercial (Ruthenberg, 1976). Small holder farming is characterised by starvation despite having own land, many crop diseases, animal diseases, and large dependence on natural environment just to mention but a few.

There are brokers who make marketing worst causing a myriad of problems, buying the farmers produce at almost half the market price, while supplying the said inputs at triple market price. Furthermore, traditional farming takes place in these farms, use of harvests as seeds and natural soil as nutrients to animals. In the life of a small-scale farmer lack of access to proper affordable inputs and good produce market affects their farming activity and sufficiency so much (Spedding,1979).

1.2 Background of the Study

Agriculture accounts for about one quarter of Kenya's GDP, and an estimated 64 per cent of households are engaged in farming activities, while 84 per cent of rural households keep livestock. Given the vital role of natural capital in the Kenyan economy, smart investment in agriculture can boost productivity and protect scarce natural resources. Average agricultural yield under the green economy investment scenario would exceed that of the business as usual (BAU) investment scenario by about 15 per cent by 2030 Green Environment Assessment (GEA) report (UNEP, 2014).

Agriculture remains the backbone of the Kenyan economy, contributing one-third of GDP. About 75% of Kenya's population of roughly 48.5 million work at least part-time in the agricultural sector, including livestock and pastoral activities. Over 75% of agricultural output is from small-scale, rain-fed farming or livestock production Kenya economy report (CIA, 2019). Figure 1.1 compares agriculture percentage contribution to GDP growth with other sectors in the Kenyan economy.



Source: Kenya National Bureau of Statistics, 2013.

Figure 1.1 Agriculture Percentage Contribution to GDP Growth Over the Years.

Agriculture was a source of living to 1/3 of the world's population (Clayton, 1983). However, it was faced with a myriad of problems, ranging from lack of labour, poor transport and communication , attack by diseases and pests, poor farming methods and natural calamities. For instance, when famine occurs, crops are lost, and livestock die just like recently in Baringo, Turkana and Tana River counties, animals died, people died, and maize flour prices became unaffordable. Lack of proper farming can lead to significant impact on the economy of the country and the population (Dillon, 1992).

Having been born in Uasin Gishu County, I experienced in the better part of my life the challenges of small-scale farming. Improper farming methods were evident. The re-use of produce as seeds, use of old traditional methods for livestock fertility and lack of better methods to manage diseases and pest attacks. The farms that small scale farmers had mainly used to do mixed farming, mainly for subsistence purposes. The whole farming produce was never enough to even feed the farmers till the next season and thus attracted very low to even zero commercial value in the end (Cederroth, 1995).

The farmers, who could get direct inputs other than from brokers who hiked prices beyond the reach, could really make a living out of it. To increase the value of farming, it cannot be complete if the farmer does not have a favourable market to sell their produce and make more meaning of the farming activities per season (Chambers & Ghildyal, 1985). Incentives by the government are not enough and more needs to be done both now and in the future.

Recently Kenya underwent a crisis of draught in several counties. Livestock were not spared, and maize flour prices went up. Lack of proper management, planning, modern farming, fair market prices and existence of big brokers caused the crisis . The end pain was the farmer who produced the commodities, sold at meagre prices and found them in shelves triple priced. With embraced technology, we can easily monitor the whole flow, from input supply, preparations, nurturing and to pre-harvesting and post-harvesting and thus add a great value in the agricultural supply chain and agriculture at large (Dillon, 1992).

Corruption in the agriculture sector was something that could not go unmentioned. It affected everyone, from farmer, to consumer, to the corrupt themselves and of course to the country at large. The country's population was dependent on food supply. There were many deaths due to lack of food, both to the animals and to human beings (Duckham & Masefield, 1970).

1.3 Problem Statement

Long supply chain in agriculture affects the farming activities greatly. Getting inputs is proving hard due to many intermediaries. The prices that farmers get the inputs are too high due to the long supply chains. The produce that farmers can gather at the end of the season does not get the value they deserve due to low prices that has engulfed the market because of lack of direct market access. The whole issue of high input and very low output prices is because of lack of direct linkage between a farmer and the market both for input access and produce market. The current system does not give a small-scale farmer a favourable environment for profitable farming.

1.4 Research Objectives

1. To identify the current methods and the challenges of ordering farm inputs and marketing farm produce.

2. To review the existing solutions for ordering farm inputs and marketing farm produce.

3. To design, develop and test a system for ordering farm inputs and marketing farm produce.

4. To validate the system.

1.5 Research Questions

1. What challenges are faced in the current methods of ordering farm inputs and marketing farm produce?

2. What are the existing solutions for ordering farm inputs and marketing farm produce.

3. How can a system for ordering farm inputs and marketing farm produce be designed, developed and tested?

4. Does the system solve the problem of ordering of farm inputs and marketing farm produce?

1.6 Research Justification

Farming needs proper planning from land preparation, proper inputs, nurturing, harvesting and selling of farm produce. With proper farm inputs and well-organized farm produce market, farming activity will be profitable hence boosting the economy of the country, improving livelihoods and enough food supply. In most cases no one bothers with the way farmers access farm inputs and market their farm produce. Therefore, it is common for farmers to be significantly affected by any long supply chain in the agricultural sector with price manipulation and quality of products being the major crisis. A proper way to get farm inputs and sell farm produce therefore should be arrived at.

1.7 Scope and Limitations

This research was carried out within Uasin Gishu county. This was due to the availability of many farmers and willingness to provide data necessary for this research. The major focus was on the current farm input orders and delivery as well as the farm produce markets and accessibility in Uasin Gishu. The implementation of the final product was done on an Android platform and a backend web platform. This is because Android devices are many, affordable and user friendly. This research was carried out in Kabongwa and Burnt Forest village and Eldoret town market within Uasin Gishu County. Data was collected from already existing farmer groups in the two villages, Eldoret farm produce market and Maraba investment in Eldoret town.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter includes the review of literature consisting of studies conducted worldwide in the related areas. This study identified gaps in the research area and possible ways to make improvements in the present research investigation. It provided an overview of the causes of long farm input supply chain, ICT in farm input and produce supply chains, general farm input supply, the farm produce marketing possibilities, current solutions limitations and a summary.

2.2 Causes of Long Supply Chain

For agricultural produce there is a chain that is followed from the point of production to consumption. Every agricultural produce goes through a process from the farmers to the customers (Sheikh, 2012). If a farmer was to realise higher profits, consumers were to enjoy fair price, and the national food security was to be assured, the supply chain system had to be systematically made strong, efficient, healthy and dynamic. At the heart of the agricultural supply chain concept is the idea of actors connected along a supply chain producing and delivering goods to consumers (Ngambeki, 2010).

Therefore, understanding supply chains, its actors and implications were critical to agricultural production in the country. The success and profitability of supply chain depends on how strong the supply chain is, or how strong the individual actors in the supply chain are (Masefield, 1970). The impacts of the long supply chain affected the input and finance provision, extension support and the general enabling environment. The key actors therefore can be seed suppliers, farmers, transporters, sellers and consumers (Kast & Rosenzweig, 1974).

It was important to conduct a Supply Chain Analysis (SCA) so that actors could make informed choices, including those who wanted to support like the policy makers and donors. The economic value of agriculture produce was multiplied if the supply chain of the product was strong, efficient and sustainable. The longer the supply chain, the higher the prices and at some point, the poorer the quality of the products (Grigg, 1974). However, these articles left out on the solution, a one solution that would enable a farmer to do the farm input ordering and farm produce marketing

2.3 ICTs In Supply Chains

In Kenya, Information and Communications Technologies, or ICTs have become an important tool in promoting agricultural supply chain efficiency. Applications can support farmers directly through SMS. Examples include iCOW, developed in Kenya, which provides information on the gestation period, on artificial information of the cows and on how to look after them. Applications such as M-PESA can support access to mobile payment services for a large percentage of those without banks, thereby facilitating transactions in the farm input and farm produce supply chain. The Grameen Foundations Community Knowledge Worker (CKW) is an example of ICT being used to strengthen the capacity of extension officers with timely and accurate information and at the same time, capture data from the field (Eric, 2007). Systems such as FARA's eRAILS are supporting agricultural researchers through data collection, analysis and access to up-to-date research publications.

Key ICT and mobile revolution benefits in a nutshell include access to inputs and product markets, market information systems and transaction costs (Maumbe, 2012). ICT advances in developed nations include but are not limited to electronic auctions for livestock, cotton and others, market maker for local food markets, agri-webinars where dissemination of farm business management practices is done, e-trading characterizing electronic markets, for example, e-Bay online trading, e-retailing just like Amazon online retailing, precision agriculture where variable rate technologies (VRT) is used, yield monitoring, field monitoring, soil sampling and others. Geographical information system (GIS) and Geographical Positioning Systems (GPS) and many others likes E-Pest Management Systems- IPM Systems (Thomas, 2015).

Therefore, ICT uses in agribusiness supply chains for market linkages and e-services was proved to be something to go by. Especially with a new focus on one application by a famer to do several things at a go. Already existing applications in agribusiness included: agri-tourism which allowed social media promotion and marketing, agri-banking which enabled mobile banking and remittances, agri-hubs had e-services for farmer groups, food banks and others and the online farmers markets where e-ordering and delivery was done (Maumbe, 2012).

The impact of ICT in agriculture were diverse and ranged from resolving market failure like access to food, agriculture commercialisation including new creative enterprises, climate change management by detecting new early warning signs, food security improvements like income growth and food access, development of skills in the society hence closing talent gap, rural poverty alleviation with ICT-based solutions, nutrition and supply chain performance with regional global market integration (Maumbe, 2012).

2.4 General Input Supply

Input supply is an essential condition for agricultural production. Inputs are either produced on the farm, such as farm produced seeds, manure and compost, farm tools or are purchased, such as fertilisers, pesticides, new seeds, irrigation water, mechanical power, animal feeds, breeding stock and visionary services. The process of agricultural development, in every part of the world has been associated with increasing dependence on such purchased inputs. The scope of expanding the area under cultivation is limited and output growth must come from increases in intensity which necessitates utilisation of more purchased inputs (Kalonge, 1994).

Improved access to agricultural inputs and services is one of the most important ways to boost yields and help smallholders move from subsistence to more market-oriented farming. These improvements in turn yield higher profits and improve livelihoods for smallholder farmers and their families (Amir & Knipscheer, 1989).

While the input and farm services sectors are unique from country to country, what holds true in all countries is that improving local retail access to inputs and services has the potential to empower rural entrepreneurs to reach thousands of farmers (Tollens, 2007). The large increase in crop production during the "Green Revolution" in Asia resulted from the introduction and delivery of a complete complimentary inputs including new seeds, fertiliser irrigation and pesticides.

Traditional farmers or subsistence farmers at times referred to as peasants, are usually integrated into markets that tend to function with high degree of imperfection. Peasant farmers are more characterised by their varying rather than total commitment to the market. The markets confronting peasants may be imperfect for reasons of low and uneven development of the economic infrastructure. This may be spatial fragmentation due to poor transport communications. Input supply remains an important constraint in the produce market supply (Ellis, 1988).

In Kenya, several companies are seeking to address food insecurity and poverty among small scale farmers by providing them with certified organic farm inputs, training in organic farming techniques and market-related service to increase their profit margins and market access. For instance, Kenya Organic Finest Aromas Ltd (KOFAr) and Elgon Kenya Limited (EKL) which endeavors in agri-input supplies majorly to the horticultural and floricultural industries in the East and Central regions of Africa. It is the largest agri-input supply company in Kenya who can meet almost 90% of farm agri-input especially into floriculture sector (Thomas, 2015).

Having considered these existing literature review on current farm input companies and importance of input purchases in agriculture, it was prudent that an easier efficient and an easily accessible system be developed as none is able to fulfill the farmers' needs.

2.5 Farm Produce Market

The basic economic forces which operate in markets are demand and supply (Dana & Melissa, 2011). Produce markets provide an outlet for agricultural producers. For agricultural products, supply varies because of seasonal variations induced by climate and growing season and cyclical variations because of the time lag involved in the reaction of supply to changed market conditions. The price can be either a real incentive to produce or can be disincentive, inducing the farmers to reduce the amount of produce they bring to market. Peasants cease to be peasants when they become wholly committed to production in a good incentive market (Ellis, 1988).

Farming, for so many years, had become family enterprises producing for the market and enabling families to derive their income and livelihood through the market (Checkland, 1981). Some companies are playing an important role in developing marketing opportunities for smallholder farmers (Eric, 2007). For example, Unilever has made a public commitment to source more raw materials from smallholder farmers, helping to improve agricultural practices and thus enabling them to supply global markets. Nestle, a major global food manufacturer, aims to create value for their shareholders and develop direct relationships between farmers and cooperatives through their Farmer Connect Programme (FCP).

In the current markets, middlemen have taken over fresh produce markets determining prices, who to sell to and who to access the facilities in a system that is fleecing farmers to the bone (Obi, 2016). You must go through the brokers, who also determine the prices, sell on your behalf, deduct their charges of sometimes up to KES 300 per crate and give you the rest. Brokers have taken advantage of the farmers to help organise produce marketing through aggregation, transportation and storage.

Use of technology, including online marketplaces can suction farmers against the ravenous brokers (Thistlethwaite, 2012). Seeds of Gold found out that the brokers system at Wakulima (Marikiti) is replicated in every fresh produce wholesale market in Nairobi, including Gikomba, Muthurwa and City Park and in major towns across the country. These brokers are a mini-government. They dictate the cost of every commodity, when to sell, who to buy from and most importantly, they 'own' the customers. In Nairobi, the county officials have learned to co-exist with them. Every farmer or supplier must surrender their produce to them and wait for whatever they will be given. They claim that a farmer cannot come from the farm with their produce and sell to the customers direct as they would not earn anything for their living (Obi, 2016).

Sometimes, farm produce must be transferred to a vehicle 'known' by the brokers to get access into the market. If a broker sells the onions, they earn at least KES 40 per net, and KES 40 must be paid to the county government for every net sold, plus the offloading fee. Therefore from 200 nets of onions, which is the capacity of a medium-sized truck, a farmer pays KES16,000, half which goes to the county government and the rest to the broker (Obi, 2016).

Whereas there are government policies aimed at protecting farmers in the market against opportunistic brokers, there are weak enforcement mechanisms that have given middlemen a leeway to operate freely. The county governments have little experience in running private sector businesses and are political entities focused on provision of public goods (Obi, 2016).

2.6 Current Solutions in Agricultural Supply

The current solutions in this review were many and diverse and all gave a solution to one part of agricultural supply chain.

iCOW

iCOW mobile application provided information on gestation period by allowing farmers to log individual animals on a database to receive individual text messages about the animal's reproduction cycle on their mobile phones (Gathigi & Waititu, 2012). iCOW therefore address only the gestation period problem and not the ordering of farm input and selling of farm produce.

Mobile Money

Mobile money technology like M-PESA, Airtel-Money, T-Kash, Eazzy Banking, Mobikash and other M-banking applications are greatly helping farmers in making timely payments and reducing farmers travel costs between input dealers (Deloitte, 2012). The mobile money also assists farmers access money incase banks are not within their reach. It forms an important part of the solution as we will use to make payments for both farm input orders and for farm produce.

M-Farm

Mobile phone SMS and voice messages were commonly used for accessing timely market prices, reaching clients, sharing accurate production information and money transactions. M-Farm, which provides up-to-date market information, and links farmers to buyers through their marketplace and current agri-trends (Macharia, 2013). M-Farm is a software solution and agribusiness company. Their main product M-Farm, is a transparency tool for Kenyan farmers where they simply SMS the number 20255 (Safaricom Users) to get information about the retail price of their products. However, this did not address the problem of getting farm input orders and selling farm produce.

Mkulima Young

Mkulima Young aimed at encouraging youth to engage in agricultural issues.

Mkulima Young aimed to draw more young people into farming, help them learn from each other, trade and overcome the challenges of agriculture together. It connected young farmers and those aspiring them with each other in a virtual space (Muiruri, 2013). It also educated the young to change their attitude towards agriculture from viewing it as an activity for the old, to a profession where they can accrue millions of shillings

Regional Agricultural Information and Learning Systems

Forum for Agricultural Research in Africa's (FARA) has a Regional Agricultural Information and Learning Systems (RAILS), hereafter called eRAILS which supports agricultural researchers through data collection, analysis and access to up-to-date research publications. eRAILS are managed and are ensured to have the most appropriate and relevant tools to facilitate knowledge sharing (Wopereis-Pura, 2009). FARA's eRAILS does not offer a solution to farmers input ordering and sell of farm.

Variable Rate application Technology

Variable Rate application Technology (VRT) does yield monitoring, field monitoring and soil sampling. It has potential to improve input efficiency, field profitability, and environmental stewardship (Sawyer, 1994). The problem farmers face however in ordering farm inputs and selling farm produce is not addressed by this.

Pest Management Systems

E-Pest Management Systems- Integrated Pest Management (IPM) Systems uses a systems approach to reduce pest damage and to tolerable levels through a variety of techniques, including natural predators, pathogens, parasites, genetically resistant hosts, environmental modifications, and, when necessary, chemical pesticides (Bottrell & Smith, 1982).

Agri-hubs

There exists Agri-hubs which has several e-services for farmer groups, a model that was developed to provide a conduit through which extension services can be provided for small-scale farmers. This is delivered e-services in the sense that farmers get information and knowledge electronically (Gilmore & Chasomeris, 2015). It did not fulfill the problem getting farm inputs and sell of farm produce by farmers.

2.7 Gaps and Limitations in Current Solutions

This far, only agri-hubs where e-services are done came close to solving farmers input accessing and farm produce marketing problems but its only deployed in the web interface.

The same solutions again are not easily accessed by farmers and the deployment user interfaces need refining to allow seamless farm activities especially on the agri-hub platform. In this literature review, there was lack of a one stop solution that a farmer could do both ordering of inputs at the comfort of their farms and sell their produce.

2.8 Summary

The current methods therefore did not fully support ordering of farm inputs and marketing of farm produce and they were either partial, unreliable, deployed in inaccessible interfaces and expensive. The dissertation therefore came up with an Android application which allows both farm input orders and farm produce sell on the mobile phone. It was justified given the expensive and undependable techniques that are used currently as highlighted in this literature review. A system that considers farmers during decision making for farm input orders and farm produce sales was therefore developed to restore farming activity benefits and lead to significant increase in agricultural revenues and food supply.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter discusses the research methodology to be used in line with the research questions. It is organised into the following major sections: software development methodology, system analysis, system design, system implementation, system testing and evaluation.

3.2 Research Design

In this research, objective one stated in chapter one has been addressed in the literature review done in chapter two whereby current methods of ordering farm inputs and marketing farm produce and the challenges have been identified. Objective two has been partially achieved in the literature review by researching on the existing solutions for ordering farm inputs and marketing farm produce. To address the remaining part of objective two, qualitative techniques, like a questionnaire, was used to get the list of the current systems, their limitations and users' expectations of the new system and to see the number of people who would like to use the new system or think it was a good idea.

The findings of this exercise guided in achieving objective three which was the design, development, deployment and testing of a model to help in the process of farm input ordering and sell of farm produce. A proof of concept for the android application was conducted to address objective four on validation of the system proposed.

3.3 Scrum Agile Software Development Methodology

The system required several iterations to achieve a refined and tested product. Therefore, Agile methods which comprise of a subsection of evolutionary and iterative methods and are grounded on repetitive improvement and adaptable development practices was used (Larman, 2004). Every iteration became a mini-project which was self-contained with activities that cover requirements analysis, planning, design and development, testing and retrospection (Boehm, 2007).

The rationale of adapting short iterations to make it possible for new information and response from iterations N and earlier result to the enhancement of iteration N + 1. The end users will adaptively specify their requirements for subsequent releases based on their observation of the growing product, instead of assumptions at the beginning of the project. Iteration length is filled by choosing scope for every iteration. Instead of increasing the iteration length to fit the selected scope, the scope is condensed to fit the iteration length (Boehm, 2007). Agile methodology was used in this research because of the following reasons (Sultanía, 2015):

i. Focus on customer as a priority.
ii. Requirement change adaptation at any stage.
iii. Frequent delivery of working software.
iv. Business and developing team members work together.
v. Work is defined for the specified time.

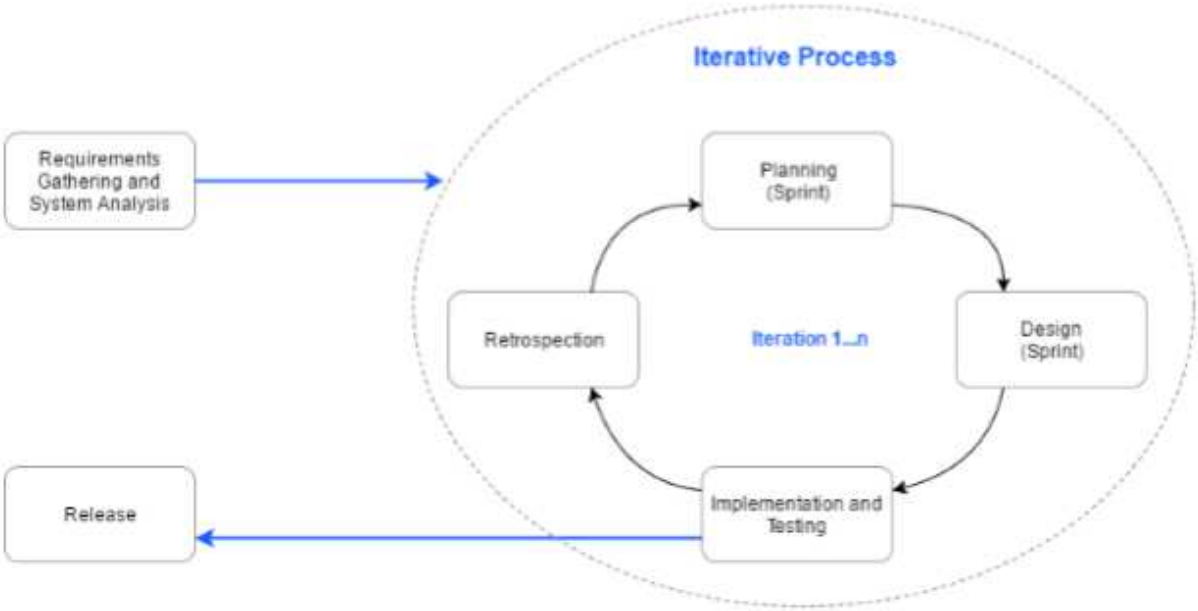


Figure 3.1 Agile Software Development Methodology with Scrum (Boehm, 2007)

As shown in figure 3.1, Agile projects proceed in an iterative fashion where new features are integrated to extend the capabilities of the software. That is, each sprint delivers user-desired, working, and tested features. Each iteration generally consists of four distinct phases: planning, design, implementation and testing, and retrospection.

3.3.1 Requirements Gathering and System Analysis

Data on farm input purchases and farm produce marketing was collected from existing records through document reviews. Questionnaires with sections of currently existing methods for making farm input orders and selling farm produce and the issues affecting the same to guide on what needs to be done and specifically the requirements. Simple random sampling was used to gather the details from different respondents within the two villages.

High-level requirements were gathered as well as the scope of the project. This was to allow researcher to quickly begin coding and to find out what worked even quicker (Boehm, 2007). This phase was used to gather information about the decision variables, constraints and information necessary to build an effective model for farmers to place farm input orders and sell farm produce as well as do reports.

i. Location of the Study

This study was carried out in Uasin Gishu County, focusing mainly on farm inputs supply and delivery including market for farm produce. To come up with efficient ways of farm input ordering and delivery, Maraba Investment was made a target in Eldoret as they currently deal with all types of agri-inputs. Farmers in the Kabongwa and Burnt Forest villages helped with information on what the farmers need as far as farm input ordering and sell of farm produce is concern. Eldoret city market also became the basis of farm produce marketing data collection.

ii. Target Population

The target population is the group of elements to which the researcher wants to make inference (Fricker, 2013). The target population formed two functions. First, it provided data and secondly tested the model using the final proof of concept (POC). The target population comprised of 2 team leads from Kabongwa and Burnt Forest,3 sales representatives of Maraba Investment, 10 retailers from Eldoret City market and 15 farmers. This made to a target of 30 respondents.

In addition, the total number of input suppliers in Eldoret town within Uasin Gishu was considered, trend of farmers visiting per day per season was evaluated too. This was done by opening a center in City Plaza in Eldoret whereby assessment of the neighbouring suppliers and agrovets were checked and requested to provide their statistics.

3.3.2 Planning

This is the first phase of the iterative process and its core purpose is to decide and document which new features are to be added to the software, or what changes to existing features need to be made (Boehm, 2007).

We agreed with all stakeholders on the features to be implemented within a given time and resource constraints. Thereafter we identified the milestones to be done and assigned the roles of the managing stakeholders to spearhead. This phase came to an end when all stakeholders agree upon the features to be implemented within the given time and resource constraints.

3.3.3 Design

Objective three was partially be addressed by this phase. The main activities included modelling and development of one or more features agreed upon between the various stakeholders during the planning phase (Boehm, 2007). In this design, Unified Modelling Language (UML) was used as the modelling language to model design diagrams and to offer clarifications on user requirements and interactions. The tools for modelling included use case diagram, sequence diagram, context diagram and entity relationship diagram (Dennis, Wixom, & Tegarden, 2012).

Use case diagram and its corresponding use case descriptions were used to model the system functionality. The system functionality was identified and partitioned using the use cases and that made it easy to separate the system into actors and use cases (Dennis, 2012). The use cases were represented as a text that described the action the user is doing on the system

Sequence diagrams were used to show information passing between the main entities of the system to model the system flow according to (Dennis, 2012). It depicted how objects interact with each other sequentially.

A Context diagram was used to define the boundary of the system and its interactions with the critical elements in its environment. It gave a single diagram that had the system of interest at the centre, with no details of its interior structure or function, surrounded by those elements in its environment with which it interacts (Le & Donald, 2000).

Entity relationship diagram (ERD) showing the tables, their attributes and their relationships was used to model the database (Dennis, Wixom, & Tegarden, 2012). This enabled the researcher to create different objects with actual real-life relationships. A database schema

showing the fields, data types and their descriptions was used to model the tables, triggers and views.

3.3.4 Implementation and Testing

Implementation

This was the actual development of the system based on the design produced in the design subsection and geared towards addressing the partial part of objective three as stated in chapter one. The system consisted of a mobile application based on Android programming. Data was stored in a central MySQL database and accessed via a web platform.

Android Application

The Android application was developed as a proof of concept to test the farm input, produce and marketing model. It was developed using the Android Studio and hosted on an online domain server.

Database

MySQL relational database management system was used to design the database. This is because it is open source, secure and has a huge online development support community (Ramakrishnan, 2000).

RabbitMQ

The Python library for RabbitMQ open source message broker software was used to queue input data files using the Advanced Message Queuing Protocol (AMQP) that RabbitMQ implements (Videla & Williams, 2012).

3.3.5 Testing

In this phase, the testing team decided if the software is correct and complete (Boehm, 2007). Completed features were removed from the list of features needing another planning sprint, and incomplete features were again candidates for future iterations. The system went through the following types of testing:

Compatibility Testing

This was done to test the compatibility of the Android application on different devices, Nokia, Infinix, Samsung, Techno, Sony, Itel and Huawei. This was done by the fifteen farmers led by the two team leads in Kabongwa and Burnt Forest villages who acted as immediate respondents.

Load Testing

This was done to measure the amount of time the model takes to process multiple requests simultaneously and produce feasible solutions. Load testing was done through the fifteen farmers led by the two team leads in Kabongwa and Burnt Forest villages

Integration Testing

This was conducted to ensure that the various system modules work as expected after their integration. This was through developer mode experiments.

User Acceptance Testing (UAT)

User acceptance testing to measure user satisfaction and feedback was done to help in validating the system. UAT was conducted by the fifteen farmers led by the two team leads in Kabongwa and Burnt Forest villages, the three Maraba sales representatives and the ten traders within the Eldoret city farm produce market.

3.3.6 Retrospection

In this phase, the development team meets to reflect on the last iteration and discuss those tasks, techniques, and team interactions that worked and those that need improvement (Boehm, 2007). The final system was evaluated by the target population and new users, to establish whether it is valid and if the research objectives stated in chapter one was met. This was essential as it indicated if the system helped the farmers in ordering farm inputs and selling farm produce.

3.3.7 Validation

Objective four as stated in chapter one was addressed in this phase. The product developed was cross-checked for functionality and performance to see if it was implemented correctly and whether it served the purpose that was outlined at the planning stage. Its features, compatibility, accessibility and workability were passed through several validation exercises to confirm the product was valid and met the requirements.

3.4 Summary

This chapter has described the methods and processes that were used to collect data and the methodologies that were used to answer the research questions. It also helped to decide on the target population where data was collected from and to test the final Android application and validate it.

CHAPTER 4: PLANNING AND REQUIREMENTS ANALYSIS

4.1 Introduction

This chapter discusses the planning phase and the requirement analysis. The researcher explains the results of the findings of the research carried out. This involves the analysis of the results obtained from the questionnaires. The analysis was done using Google forms analysis tools. The responses from the users were represented using graphs and charts to offer clear visualisations of the responses and to enhance a deeper understanding of the results. The results obtained were used to answer some of the research questions in section 1.4. The responses were also used to come up with the system design for the application. The questionnaires are attached in Appendix C.

The sample size was 30 respondents from Kabongwa and Burnt Forest villages, Eldoret City Market, Maraba investment and team leads within Uasin Gishu. The number of respondents who participated in the survey is 30 while the number of respondents who completed the survey was 27 hence the response rate was 90.0%.

4.2 Planning Phase

The planning phase was done by identifying all the activities that were necessary for the completion of the study and the time required for each activity. The study used a Gantt chart to achieve a well visualised planning. Appendix B shows the Gantt chart.

4.3 Respondents from Uasin Gishu Villages

The respondents were from Kabongwa and Burnt Forest villages in Uasin Gishu. They indicated if they do farm input ordering and farm produce sells. This was to ensure the respondents were taken from villages who do farming, buy farm inputs and even sell farm produce. 30% of the respondents majorly did orders for farm inputs, another 30% were majorly involved in selling farm produce while the other 40% did bought buying of farm inputs, selling farm produce and purchase of farm produce as shown in figure 4.1 below.

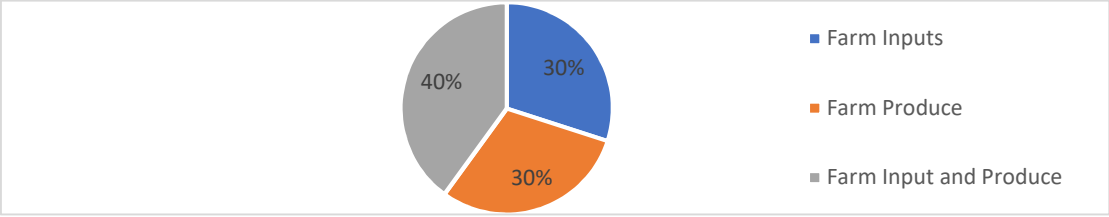


Figure 4.1 Respondents' Activity of Interest Distribution in The Selected Uasin Gishu Villages

4.4 Roles in the Farms

The researcher assumed that accurate information could only be obtained from respondents who are directly involved in farming, and more specifically in ordering of farm inputs and selling of farm produce. The respondents were asked to indicate whether part of their activities included making farm inputs orders and selling of farm produce. This was used to ensure that the respondents were actively involved in the process of making farm input orders and selling produce. 80% of the respondents indicated that their roles in the farms included ordering of farm produce and selling farm produce ash shown in figure 4.2 below.

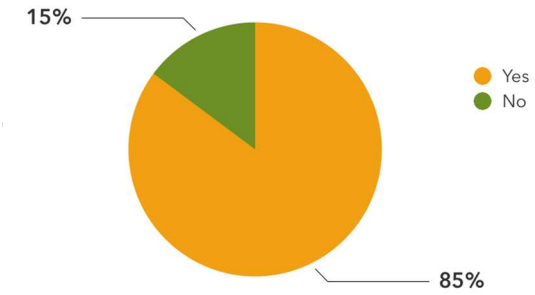


Figure 4.2 Roles of Farmers in the Farms

4.5 Number of Years Performing the Roles

The respondents were asked to give the approximate number of years they have been involved in making farm input orders and selling farm produce. This was used to gauge the quality of responses. As the ones who had been doing this for larger period understands the challenges and processes of making farm input orders and selling farm produce. 37% of the respondents had been this for over five years, 7% for between three to five years, 19% for between one to three years while the remaining 37% had performed the task for a period one year and below. Figure 4.3 shows a summary of these results.

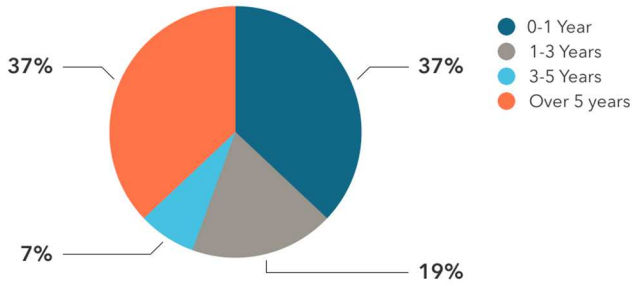


Figure 4.3 Years Respondents Have Been Making Orders for Farm Inputs and Selling of Farm Produce

4.6 Techniques for Making Farm Inputs and Selling Farm Produce

The respondents were asked to indicate the technique they use in making orders for farm produce and selling farm produce. This helped to know the most common methods that are used for getting farm produce and selling farm produce. 56% of the respondents indicated that they travel to Eldoret to purchase farm inputs , 19% of the respondents indicated that they sell their produce in either shop, neighbours or to brokers, 11% of the respondents were found to buy farm inputs from local shops and don't sell farm produce, 7% of the respondents showed that they re-use the farm produce as farm inputs for subsequent years. 7% of the input suppliers uses television communication in disseminating information.

4.7 Process of Placing of Farm Inputs and Farm Produce Orders

The farmers were interviewed on how they get the inputs and in case they place orders for the farm inputs. The most common method was farmers going to the shops in Eldoret town for their farm inputs and their own means of transport. Some who sell their produce to NCPB take their inputs in exchange of their produce at their own transport costs. There was not a single farmer who placed their input orders from their mobile phone's applications or through agents.

4.8 Time Taken for Ordering and Delivery of Farm Inputs and Farm Produce

Respondents were asked to indicate the time it takes them to distribute the farm inputs to the farmers. It takes a minimum of 12 hours and a maximum of 48 hours for the farm inputs to move from Eldoret town to the two villages in Uasin Gishu.

For the farm produce, the farmers took weeks to manage to reach to the Eldoret city market and sell the produce. Very few farms produce make to the market within the same day of produce while some were taken by buyers direct from the farms.

4.9 Cost Incurred in Ordering of Farm Inputs and Selling Farm Produce

The respondents were asked to indicate the cost that is incurred for the distribution of farm inputs and farm produce. The highest cost incurred during search for farm input and delivery to the farms was identified to be the travel, the purchase and again transport costs which ranges between ten thousand Kenya shillings and one million Kenya shillings. The highest cost for the farm produce to reach to the markets depended on the bulkiness of the produce and the means, with hired lorries being very expensive.

4.10 Challenges Experienced in Making of Farm Inputs Orders and Farm Produce Sales

The respondents were asked to describe some of the challenges that they face in the process of getting farm inputs and farm produce using the current methods.

All the farmers indicated that the use of current process takes a long time. It is expensive to travel to Eldoret and look for the right inputs for the farm. The transportations menace is another headache with those brokers willing to deliver produce to their doorsteps charging exorbitant prices

To get to the market for farm produce, one must look for the market first, which is not a guarantee. The farm produce can remain in stores for several months while favourable prices are being awaited. The transport costs too are enormous, and the roads are not passable during the rainy season. Other main problem is the low prices that mid-men offer to purchase the farm products. Lack of enough and suitable storage for farm produce causes major losses after harvesting has been done.

4.11 Mobile Phone Ownership

Because the proposed solution is a mobile application, the respondents who are the potential users of the application, were asked to indicate whether they owned a mobile phone. All the respondents owned a smart phone. Figure 4.4 shows the respondents that owned a smart phone.

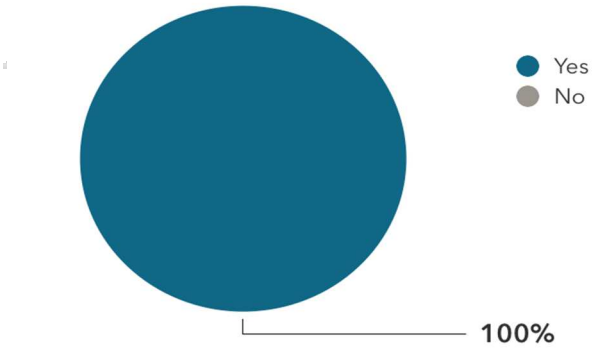


Figure 4.4 Respondent's Smart Phone Ownership

4.12 Mobile Device Operating System

The Respondents indicated the operating system on their mobile phones, which helped to determine the operating system the proposed solution should be based on. 85% of the respondents were using Android phones, 7% were using iPhone while the remaining 8% were having Windows phone and Blackberry each 4% respectively as shown in figure 4.5 below.

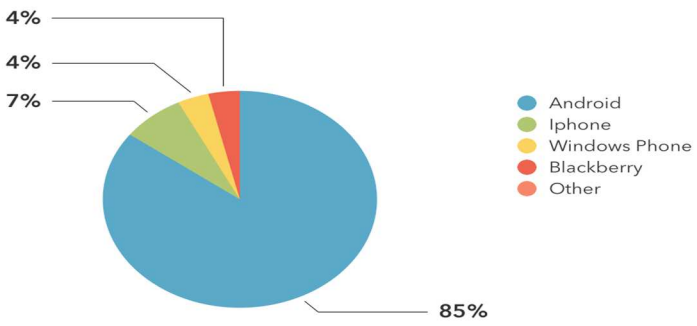


Figure 4.5 Respondents' Smart Phone's Operating System

4.13 Use of Mobile Applications

Respondents were asked to indicate whether they use other mobile applications apart from calling and messaging applications and they were also to name three applications that they mostly used. 63% of the respondents indicated that they use other mobile applications in addition to calling and messaging. Some of applications that were named to be mostly used by respondents included email, Google search, WhatsApp, Skype and Facebook. Figure 4.6 shows the respondents' use of other mobile applications.

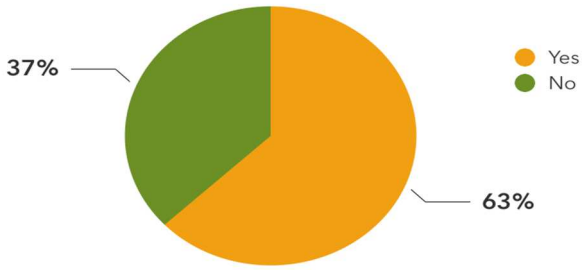


Figure 4.6 Respondents' Use of Other Mobile Applications

4.14 Suitability of A Mobile Application for Making Farm Input Orders and Selling of Farm Produce

Respondents were asked to indicate whether they thought a mobile application would be suitable to be used to be used to make farm input orders and sell fam produce and whether the use of a mobile application in the process of making farm inputs and selling farm produce would solve some of the challenges faced while using the current processes for making farm produce orders and selling farm produce. 80% of the respondents indicated their confidence on the suitability to use a mobile application to address the challenges faced in the ordering of farm inputs and selling farm produce. Figure 4.7 shows the respondents' response on the suitability of a mobile application in making farm inputs orders and selling farm produce

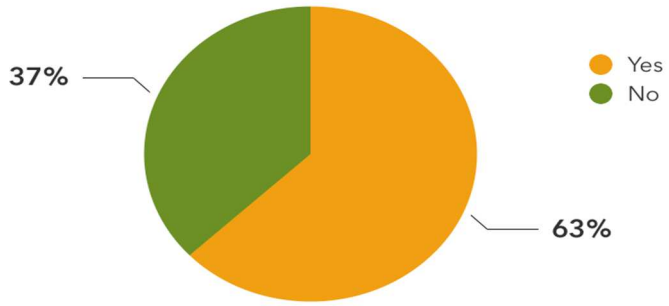


Figure 4.7 Suitability of the Mobile Application

4.15 Proposed Features for System for Making Farm Input Orders and Selling Farm Produce

The respondents who believed that a mobile application would be suitable to be used in making farm input orders and selling farm produce proposed features of the application. These features were used to come up with the system requirements and functionality. Below is a summary of the proposed features.

i. The application should have user management and information should be accessed based on user levels and roles.
ii. The application should offer a single platform for making farm input orders and selling farm produce

4.16 Analysis

Analysis of all the response got from the interviewed respondents were done and the below functional and non-functional requirements reached to.

4.17 Functional Requirements

Functional requirements defined the capabilities and functions that the implemented application and its components must perform successfully.

i. Create account

All users must create an account, set username and password to access the system

ii. Login

All users must login into their accounts using their username and password for them to access the system.

iii. View information

All users should be able to access the Home page displaying the farm input shop, profile, farm produce shop and account.

iv. Logout

All users should be able to logout of their accounts.

v. View Notifications

All users should be able to access the current notifications as per any new product added in the shops.

vi. Add products

Administrators should be able to add new products into the system

vii. Update orders

Administrators should be able to update the orders as to whether its delivered, canceled or pending.

viii. Delete orders /products

Administrators should be able to delete orders and products.

4.18 Non-Functional Requirements

These requirements that do not affect the way the application works or its core business, the application can still work without it but, are part of the system. They include:

i. Security – The system should allow access to only authorised users.

ii. Usability – The system should have an interface that is easy to use.

iii. Reliability and availability - The system should be reliable and always available to perform user tasks.

iv. Scalability – it should be easy to add additional functionalities into the system.

v. Performance – The system should have an acceptable response time while performing its functions.

vi. Integrity – the system should ensure that data stored is not altered or corrupted.

vii. Search – a user should be able to search any product in the system.

4.19 Conclusions

Based on the analysis of data provided by the respondents, the results were used to come up with the following conclusions:

i. The application should offer comprehensive shop for farm inputs and farm produce.
ii. Android is the preferred platform for development of the proposed solution.

CHAPTER 5: SYSTEM DESIGN

5.1 Introduction

This section of the dissertation provides a detailed explanation of the design and architecture of the proposed solution. Design diagrams showing the detailed design and architecture for both the Android mobile application and the website were drawn using the Unified Modelling Language (UML). The design diagrams include use case diagram with detailed follow-up use case descriptions, system sequence diagram, partial domain diagram, an entity relationship diagram.

5.2 System Architecture

The architecture adopted for the development of the application was the Client Server Architecture. Client server architecture is a model that acts as distributed application that partitions tasks or workloads between the providers of a resource or service, called servers, and service requesters, called clients.

The client side is made up of the Android mobile application and the web application. The mobile application contains six tabs for my account, shop, sell farm produce, make reports, notifications, suggest product and contacts. The web application is used for administration purposes to manage users, products and the push notifications disseminated. Both the mobile and web application are connected to an online server through the internet. The server is then connected to an online database where the users, product alerts, orders management and farmers information. Figure 5.1 illustrates the client server architecture.

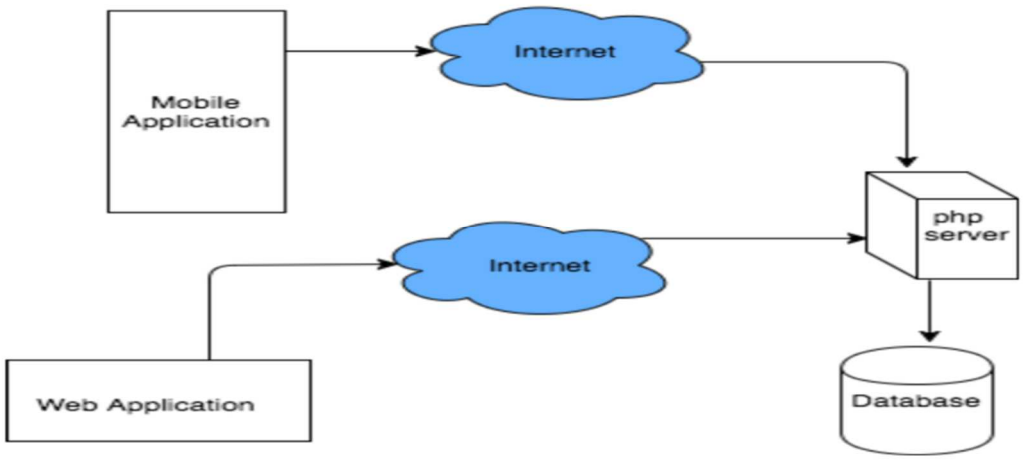


Figure 5.1 System Architecture for the Proposed Application.

5.3 Design

The user requirements collected from potential users of the system were combined with the developer's ideas to develop a system design that fulfils the functional, non-functional requirements and the research objectives. It consisted of the following components:

i. Use Case Diagrams and Descriptions
ii. Sequence Diagrams
iii. Partial Domain Diagrams
iv. Context Diagram
v. Entity Relationship Diagram
vi. Database Schema
vii. User Interface Flow Diagram

5.3.1 Use Case Diagram and Description

Use Case diagram is a behavioural diagram that shows the functionalities of a system in terms of actors and their goals as represented by use cases and any dependencies on those use cases. The following are a list of actors who interact with the system:

Administrator- This is the individual in charge of creating and managing users, update products and process orders and manage push notifications.

User- This is the person who uses the mobile application for making farm input orders or selling farm produce or checking the notifications on alerts of new products and do farmers registrations. Figure 5.2 below illustrates.

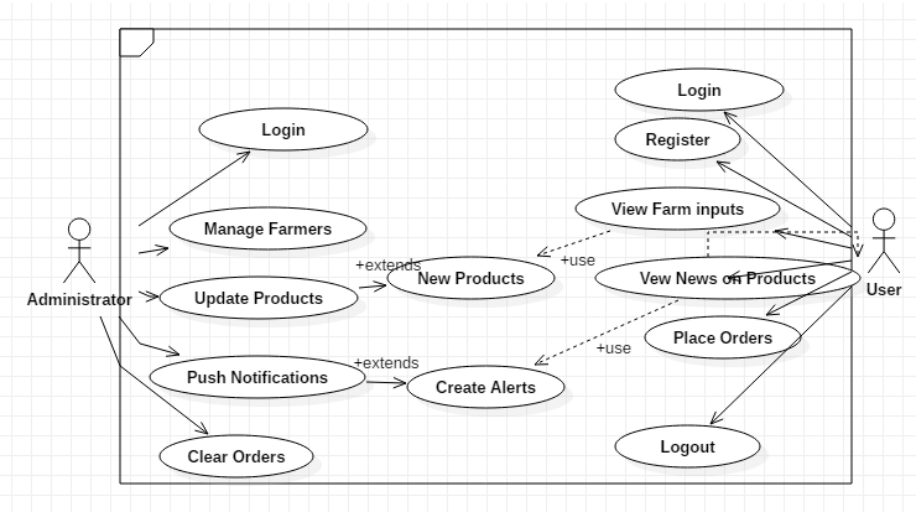


Figure 5.2 Use Case Diagram and Description.

Discussed below are the use case descriptions for the major use cases.

Table 5.1 Login/Logout Use Case Description

Use case 1: Login/Logout Use case Description: This use case describes the steps taken by the user to log in and out of the system	
Primary Actors: Administrator, user	
Precondition: The user must be registered to use the web application	
Post condition: The user gains access to the system	
Typical case of events	
Actor Response 1.Administrator and users enters username/email and password or logs out 3. User gains access to the system	System Response 2. System verifies login credentials and grants access to the web application or logs out the user
Alternative flow The user provides wrong username and password combination a) Access to the system is denied	

Table 5.2 Manage User Use Case Description

Use case 2: Manage User	
Use case Description: This use case describes the steps taken to manage a user	
Primary Actors: Administrator	
Precondition: The administrator must be logged in to the system. The user details must be saved into the database	
Post condition: The modified user details are stored into the database	
Typical case of events	
Actor Response 1. Select the edit user button 3.Enter and save changes user details	System Response 2. Display edit user form 4. Store modified user details
Alternative flow The modified user details are not saved	

Table 5.3 View Farm Input Products Use Case Description

Use case 3: Farm input products	
Use case Description: This use case describes the steps taken to view farm input products	
Primary Actors: User	
Precondition: The user must have the mobile application.	
Post condition: Farm input products and categories are displayed	
Typical case of events	
Actor Response 1.Select a product 3. Selects category	System Response 2.Display farm input product details and price 4.Display farm input products list according to selected category
Alternative flow Go back to farm inputs products	

Table 5.4 View product Alerts Use Case Description

Use case 4: View notifications of products	
Use case Description: This use case describes the steps taken to view farm product alerts	
Primary Actors: User	
Precondition: The user must have the mobile application.	
Post condition: Product alerts and push notifications are displayed	
Typical case of events	
Actor Response 1.Select a notification alert	System Response 2.Display product and price details of the selected push notification
Alternative flow Go back to notifications	

5.3.2 System Sequence Diagram

The system sequence diagram shows how users interact and receive feedback and messages to and from the system. It also shows how other activities in the system communicate, for

instance, from the applications interface and the database where information is added and retrieved. The diagram also shows how users receive feedback messages from the system. Figure 5.3 Illustrates this.

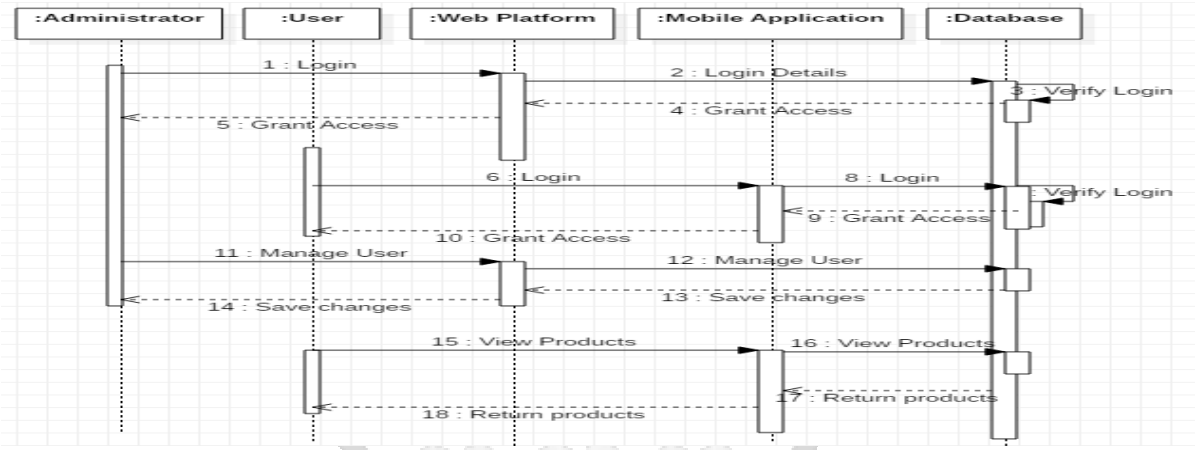


Figure 5.3 System Sequence Diagram.

5.3.3 Partial Domain Diagram

The partial domain diagram identifies relationships between entities of the application. A domain model is a visual representation of conceptual classes or real-situation objects in a domain (Larman, 2002). Figure 5.4 below illustrates.

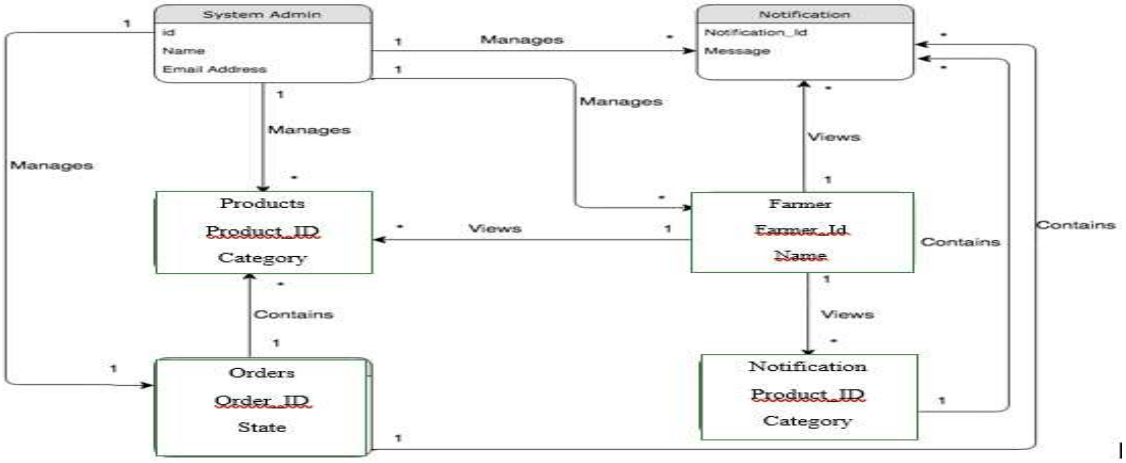


Figure 5.4 Partial Domain Diagram.

5.3.4 Context Diagram

A Context Diagram is a component of Functional Modelling that stands out on its own as a valuable tool. This allows to produce a high-level model of an existing or planned system defining the boundary of the system of interest and interactions with critical elements in its

surroundings (Burge, 2011). A context diagram was used to represent actors outside of the system that directly interacted with the mobile and web application. They consisted of entities and relationships. Entities represented the main system while multiple external entities represented external actors. Figure 5.5 shows entities of the application:

Users: these represented primary entities of the application

System Administrators: Manages users and data in the system.

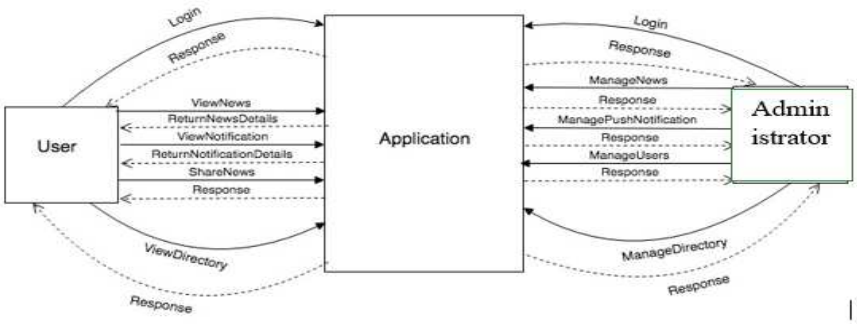


Figure 5.5 Context Diagram.

5.3.5 Database Schema

Entity Relationship Diagram

The entity relationship diagram shows the conceptual view of the database by illustrating the tables and their relationship to each other as shown in figure 5.6 below. Crow's foot representation was used to show the relationships between the tables, especially the one to one and one to many associations.

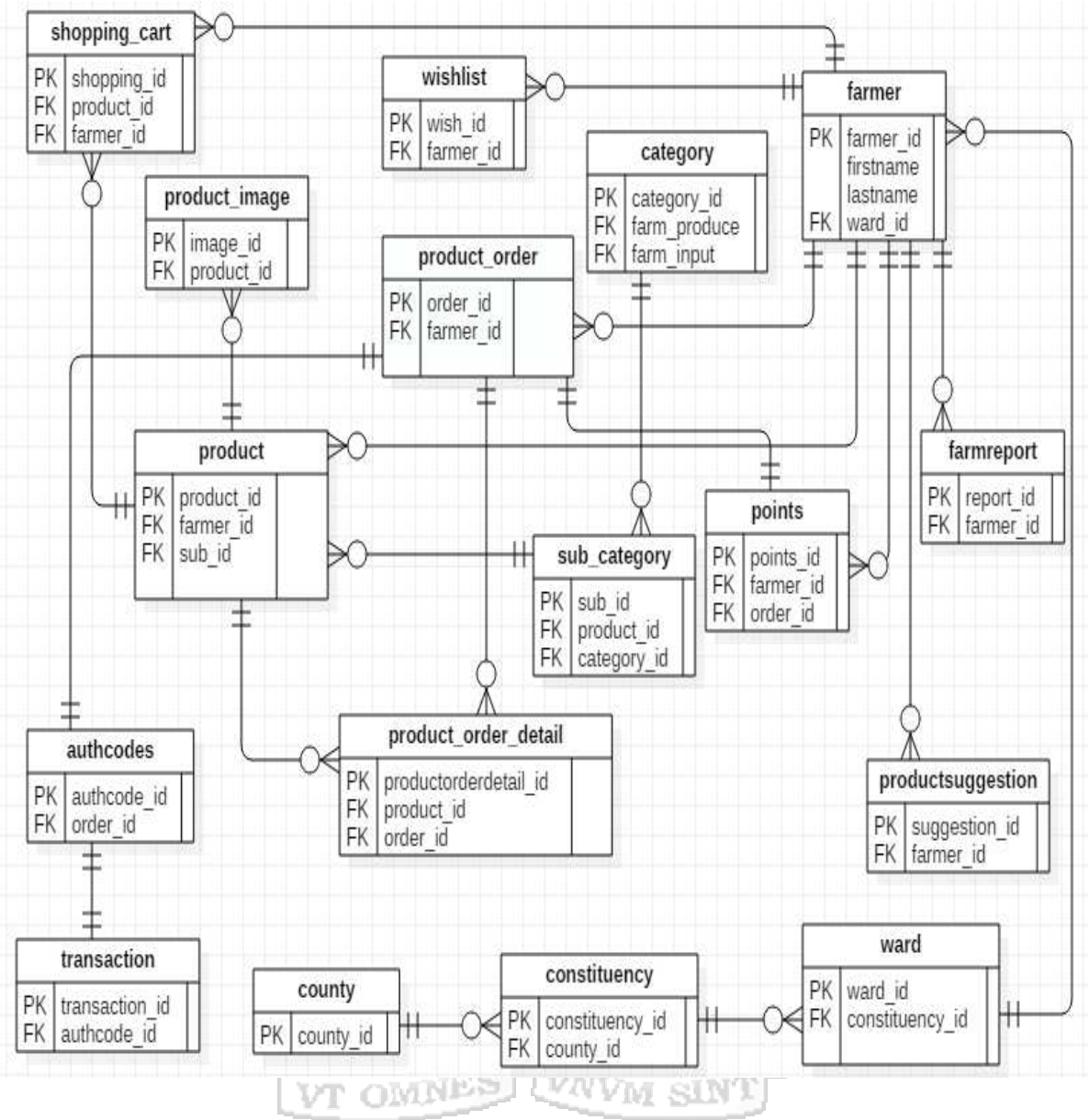


Figure 5.6 Entity Relationship Diagram

The database tables are explained in the following sections. The attributes, datatypes, indices and a short description are given.

Product

This table stores all products, both for farm produce and farm inputs in either the farm produce shop or the farm input shop. Table 5.5 below refers.

Table 5.5 Products Table

Column	Type	Null	Index	Default	Description
product_id	bigint(20)	No	Primary Key		Unique identifier
name	varchar(100)	No			Product name
image	text	No			Image of product
price	decimal(12,2)	No			Price of product
stock	int(10)	No			Whether in stock
draft	tinyint(1)	No			Not yet published
description	text	No			Details of product
status	varchar(50)	No			Active or Not
created_at	bigint(20)	No			Date of creation
last_update	bigint(20)	No			Last modified
active	int(1)	No		1	Can be ordered
farmer_id	bigint(10)	No	Foreign key	0	Farmer Key
Sub_id	Int(2)	No	Foreign Key	0	Sub_category key

Product_Image

Every product must have an image, table 5.6 below shows the attributes of the image and how it links with the product.

Table 5.6 Product_Image Table

Column	Type	Index	Description
image_id	bigint(20)	Primary Key	The unique identifier of the image
Product_id	bigint(20)	Foreign Key	Unique identifier of the product

Category

All the products are grouped into two main categories, the livestock and the crop products. Table 5.7 below shows the product category table.

Table 5.7 Product Category Table

Column	Type	Null	Index	Description
category_id	bigint(10)	No	Primary Key	Unique identifier
Farm_input	varchar(50)	No	Primary Key	Category of product
Farm_output	Varchar(50)	No	Primary Key	Category of product

Sub_Category

The subcategories of all the products are listed with properties shown below in table 5.8. The farmer finds it easy to navigate through the application.

Table 5.8 Sub Category Table.

Column	Type	Null	Index	Description
Sub_id	bigint(20)	No	Primary Key	Unique identifier of the product sub_category
name	varchar(50)	No		Name of subcategory
icon	varchar(100)	No		The image representation
draft	tinyint(1)	No		Sub_category under editing
brief	varchar(100)	No		A short description of the sub_category
colour	varchar(7)	No		Colour of the category
priority	int(11)	No		Order of listing
created_at	bigint(20)	No		Date of creation
last_update	bigint(20)	No		Date last updated

Product_Order

All the product orders will have the below attributes for easy tracking and reporting. Table 5.9 shows the attributes, the types and the default values.

Table 5.9 Product Orders Table

Column	Type	Null	Index	Description
Order_id	bigint(20)	No	Primary Key	Unique identifier
code	varchar(20)	No		Hash code
Farmer_id	varchar(50)	No	Foreign Key	Farmer_ID
address	varchar(300)	No		Farmers Address
email	varchar(50)	No		Farmers email
phone	varchar(50)	No		Phone number
comment	text	No		Brief description
status	varchar(50)	No		Status or order
total_fees	decimal(12,2)	No		Total price
tax	decimal(12,2)	No		V.A.T tax payable
created_at	bigint(20)	No		Date created
last_update	bigint(20)	No		Last updated date
payment	varchar(40)	No		Status of payment

Product_Order_Detail

Every order purchased will have a detail to make it easy to identify items per order. Table 5.10 shows the attributes.

Table 5.10 Product Orders Details Tables

Column	Type	Null	Index	Description
Productorderdetail_id	bigint(20)	No	Primary Key	Unique identifier
order_id	bigint(20)	No	Foreign Key	Unique key for order
product_id	bigint(20)	No	Foreign Key	Unique identifier for product
product_name	varchar(100)	No		Name of product
amount	int(11)	No		Total price
price_item	decimal(12,2)	No		Quantity of the product
created_at	bigint(20)	No		Date order was created
last_update	bigint(20)	No		Date last updated

Authcodes

All orders must be assigned a unique code for payment purposes. The authorisation code will be used during payment to confirm the payment status. Table 5.11 refers.

Table 5.11 Authorisation Codes Table.

Column	Type	Null	Index	Description
Authcode_id	bigint(10)	No	Primary Key	Unique code
Order_id	bigint(10)	No	Foreign Key	Order ID
code	int(6)	No		Hash code
status	int(1)	No		Code used or not.

Shopping Cart

The farmers have a shopping cart every time they are placing an order. All the products are placed in the cart and once on checkout they are converted to an order . Table 5.12 shows the attributes for this.

Table 5.12 Shopping Cart Table

Column	Type	Null	Index	Description
shopping_id	bigint(20)	No	Primary key	Unique identifier
Farmer_id	bigint(20)	No	Foreign key	Identity of the farmer
Product_id	varchar(100)	No	Foreign key	Identity of products
Amount	Bigint(20)	No		Total price

Wishlist

The details of all the products in the farmers Wishlist are stored here in the database in the user table as shown in table 5.13.

Table 5.13 Wishlist Table.

Column	Type	Null	Index	Description
wishlist_id	bigint(11)	No	Primary Key	Unique user ID
farmer_id	varchar(50)	No	Foreign Key	Farmers identity
products	varchar(20)	No		Login name

Farmer

All registered farmers are stored in table 5.14 below with the attributes show below.

Table 5.14 Farmers Table

Column	Type	Null	Index	Description
Farmer_id	bigint(10)	No	Primary Key	Unique identifier for farmer
firstname	varchar(40)	No		First name of farmer
lastname	varchar(40)	No		Last name of farmer
county	int(5)	No		County of farmer
constituency	bigint(5)	No		Constituency of farmer
ward	bigint(10)	No		Ward of farmer
village	varchar(100)	No		Village of farmer
latitude	double	No		Latitude of famer as at registration
longitude	double	No		Longitude of farmer as at registration
physical_address	text	No		Local area of farmer
phone	varchar(15)	No		Phone number of the farmer.
password	varchar(100)	No		Logon password
farm_type	bigint(10)	No		Type of farming
status	int(2)	No		Active or inactive farmer
date_created	timestamp	No		Date farmer registered
activation_code	text	No		O.T.P Code sent to mobile phone
image_url	text	No		Photo of farmer

Farm_report

Farmers will be able to make reports and submit. The reports will be stored in the format of table 5.15 below.

Table 5.15 Farmers Reports Table

Column	Type	Null	Index	Description
Report_id	bigint(10)	No	Primary Key	Unique report identifier
report_type	int(10)	No		Type of report whether expression of interest of active farm report
project_description	text	No		A short description
farming_category	int(10)	No		Category of farming
crop_option	int(10)	No		Type of crop
option_description	text	No		Description of the crop type
livestock_type	varchar(100)	No		Name of livestock category
livestock_number	int(11)	No		Quantity of livestock.
regular_activity	text	No		Daily activity done/weekly.
non_regular_activity	text	No		Non-routine activity
revenue	varchar(50)	No		Amount of profit
date_created	timestamp	No		Date or reporting
farmer_id	bigint(10)	No	Foreign key	Unique identifier of the farmer

Transaction

The payment details for all the orders shall be captured in a transaction as in table 5.16.

Table 5.16 Transactions Table

Column	Type	Null	Index	Description
transaction _id	bigint(10)	No	Primary Key	Unique identifier of transcation
memberid	bigint(50)	No		Identifier of payer
order_id	varchar(255)	No	Foreign key	Unique order identifier
authcode_id	varchar(50)	No	Foreign Key	Authcode ID
hash	varchar(255)	No		Separator symbol
amount	varchar(20)	No		Total price
transaction_type	varchar(10)	No		Type of transaction
status	int(1)	No		Failed or successful
date_created	timestamp	No		date of transaction
update_time	timestamp	No		Last time it was updated.
currency	varchar(10)	No		Currency code
phone	varchar(20)	No		Phone number of the farmer.
MerchantRequestID	varchar(100)	No		Unique key of M-pesa
CheckoutRequestID	varchar(255)	No		Code provided at checkout
ResponseCode	varchar(20)	No		Error or Success code at merchant
ResultCode	varchar(10)	No		Fail or success code at application.
ResultDesc	varchar(500)	No		Description of result code

Ward

All the wards within Kenya are stored in the table 5.17 below with attributes shown. This makes it easy for farmer do register and be located.

Table 5.17 Administrative Wards in Kenya

Column	Type	Null	Index	Description
Ward_id	int(10)	no	Primary key	Administrative Ward
constituency_id	int(4)	No	Foreign Ke y	Identifier for constituency
ward_code	int(4)	No		Ward Number.
ward_name	varchar(100)	No		Name of ward
created_at	timestamp	Yes	NULL	Date ward was registered.

Constituency

All the constituencies in Kenya will be stored in the table 5.18 below and shall help in locating farmers as well as making consistency -based decisions and easy registration.

Table 5.18 Constituencies in Kenya.

Column	Type	Null	Index	Description
Constituency_id	int(10)	no	Primary key	Unique identifier for constituency
county_ID	int(4)	No	Foreign key	County identifier
constituency_code	int(4)	No		Constituency number
constituency_name	varchar(100)	No		Name of constituency
created_at	timestamp	Yes	NULL	Date registered
updated_at	timestamp	Yes	NULL	Date updated.

County

All the counties in Kenya will be stored in the table 5.19 below and shall help in locating farmers as well as making county-based decisions as well as registration of farmers. For the rollout of the application, few counties will be enabled on the application and this will limit the total number of constituencies and wards and farmers in the end for easy management.

Table 5.19 Counties in Kenya.

Column	Type	Null	Index	Description.
County_id	int(10)	No	Primary key	County unique identifier
county_code	int(4)	No		Code for county
county_name	varchar(100)	No		County name
created_at	timestamp	Yes	NULL	Date county was registered.
updated_at	timestamp	Yes	NULL	Date modified.
status	int(1)	No	0	Valid or invalid county.

Points

Every farm who does a purchase on the mobile application shall be award 1 point for every KES 100 spent. Table 5.20 below shows the attributes stored per order.

Table 5.20 Awarded Points Table.

Column	Type	Null	index	Description
Points_id	bigint(10)	No	Primary key	Points identifier
order_id	varchar(50)	No	Foreign key	Order ID
farmer_id	bigint(10)	No	Foreign Key	Farmer ID
points	int(20)	No		Number of points
Date_created	Bigint(20)	No		Date of points award.

Product_Suggestion

Any user of the mobile application can suggest a product to be sold on the platform. The details of the suggested product are captured in table 5.21 below.

Table 5.21 Product Suggestion Table

Column	Type	Null	Index	Description
Suggestion_id	bigint(10)	No	Primary Key	Unique ID
farmer_id	bigint(10)	No	Foreign key	Farmer ID
points	int(20)	No		Awarded points
date_created	timestamp	No		Date of creation

5.3.6 User Interface Flow Diagram

This section deals with the flow of screen presentations when the user interacts with the application. When the application is first run, a splash screen appears followed by the home page.

Mobile Application Wireframes

These was used to prototype the system before actual implementations. The figures below show the wireframe designs of the screens for the mobile application.

Application Main Page

This is the home page, showing the latest products on a slider, my account, a shop where there is both farm input shop and farm produce shop, sell farm produce icon where farmers can upload their produce, notifications and suggest product as shown in figure 5.7 below.

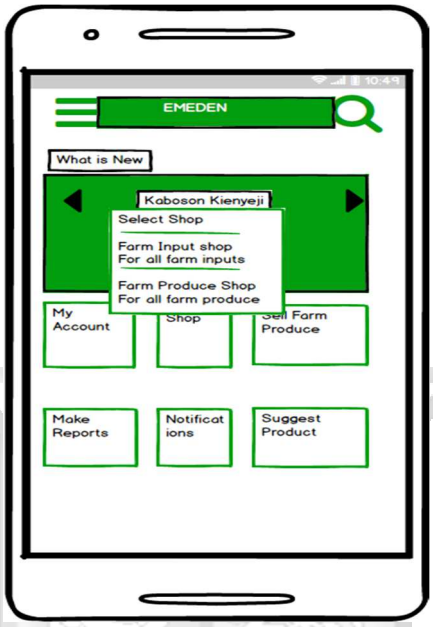


Figure 5.7 Application Main Page.

Farm Inputs Page

On selecting the farm input shop, page appears as shown in figure 5.8 below. The input products available are displayed, short description and sub-categories.

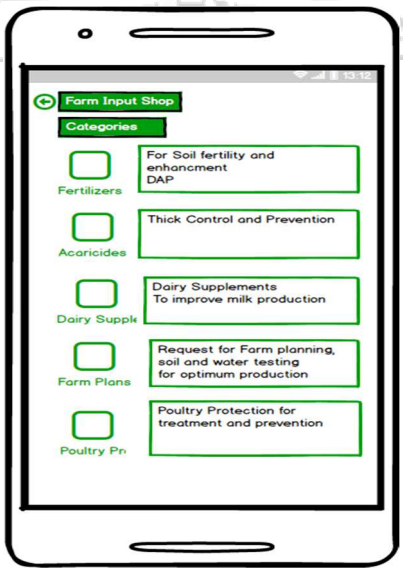


Figure 5.8 Farm Inputs Page.

Farm Produce Page

On selecting the farm produce shop, the screen below is displayed with farm produce products listed, short description and sub-categories as shown in figure 5.8 below.

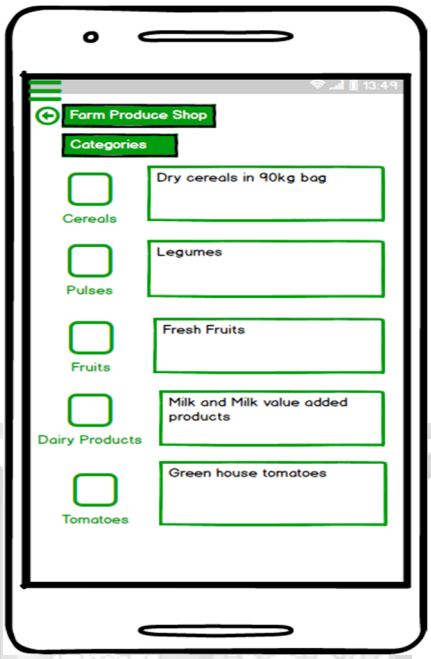


Figure 5.8 Farm Produce Page.

Shopping Cart

Upon selecting a product from the shop, the product image, price, details, quantity, stock status and a button to add to cart are displayed as shown in figure 5.9 below. The products chosen for purchasing are displayed with their amounts and totals and button to checkout.

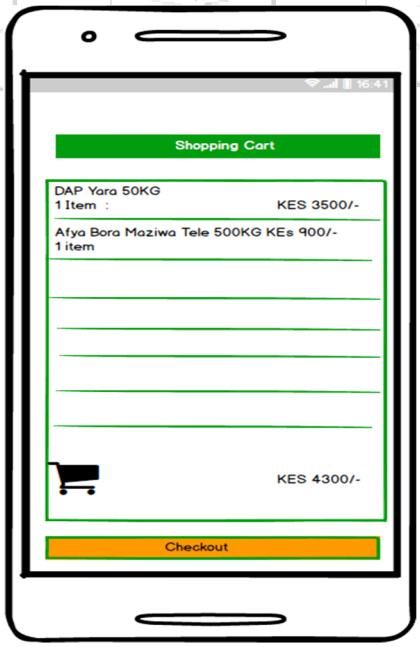


Figure 5.9 Shopping Cart Page.

Check Out Page

Once a farmer adds a product to cart and clicks in the shopping cart, the page shown in figure 5.10 below is displayed when checkout button is clicked. The farmer here chooses the payment option, pay now and proceeds to pay via M-PESA. The phone number entered will receive a notification to pay the total amount once the order is confirmed.

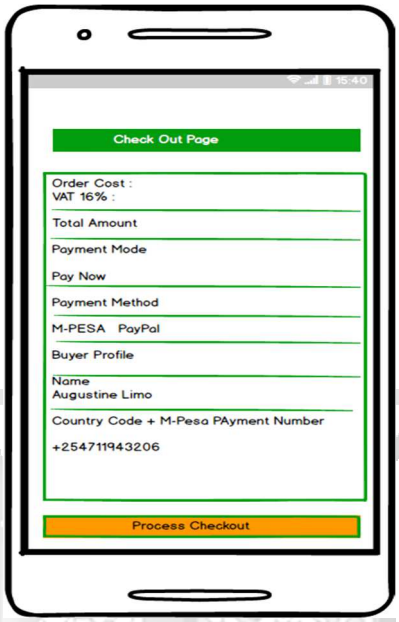


Figure 5.10 Check Out Page.

Order Confirmation Page

Figure 5.11 shows a page which gives farmers a confirmation that their order has been received and instructions on how to pay via M-pesa pop up on the phone.

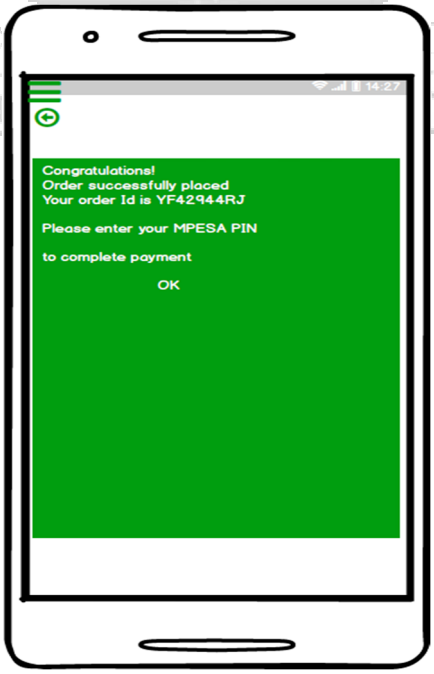


Figure 5.11 Order Confirmation Page.

My Account Page

My account page will display the list of the user profile as captures during registration. Total points earned for the orders placed too are displayed as shown in figure 5.12 below.

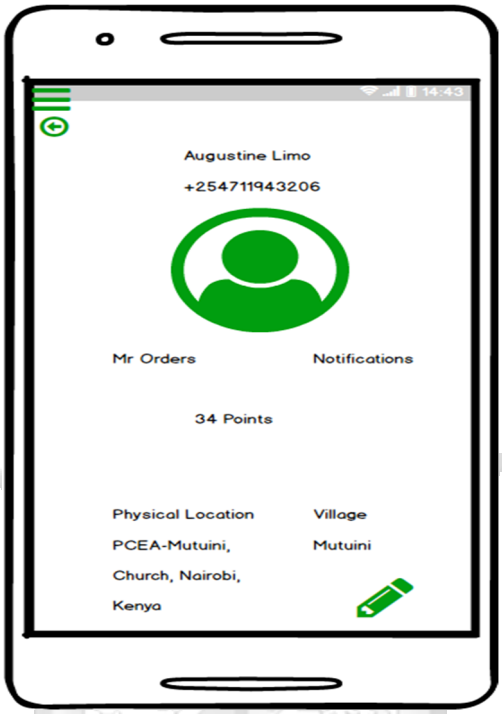


Figure 5.12 My Account Page

Make Reports

This feature will enable farmers to make reports on the mobile application as regards to the active farm activities and also allow investors to express interest in the farm inputs supply or farm produce purchases. Figure 5.13 shows the report template.

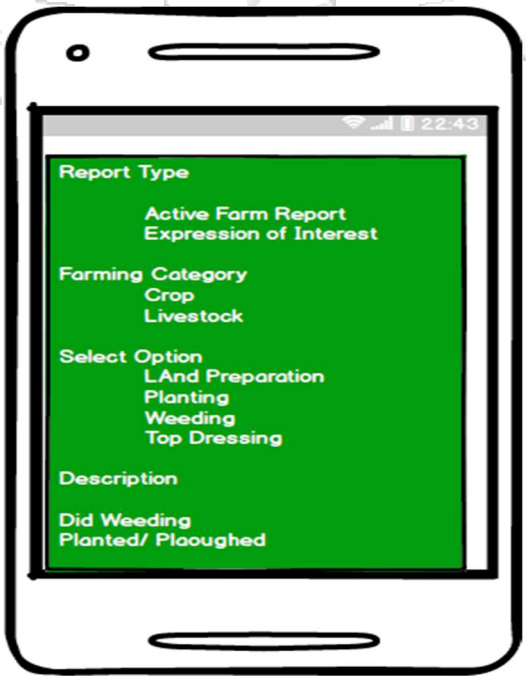


Figure 5.13 Make Reports Page

Notifications Page

All the product notifications triggered by the administrator from the web application backend to the farmers will appear on the notifications page as shown in figure 5.14 below.

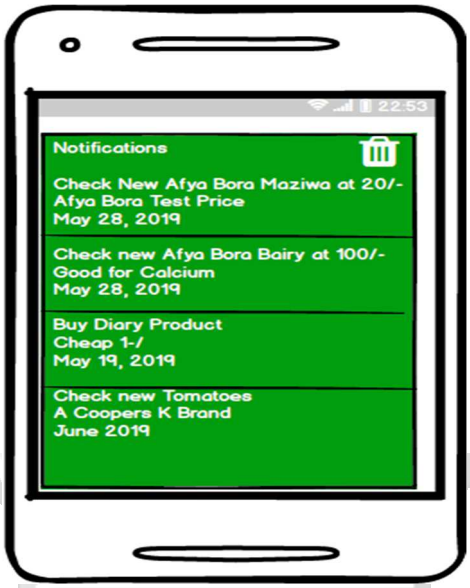


Figure 5.14 Notifications Page

Contacts Page

This page will provide the various options for reaching to the staff and administrators of both the web application and mobile application as shown in figure 5.15 below.

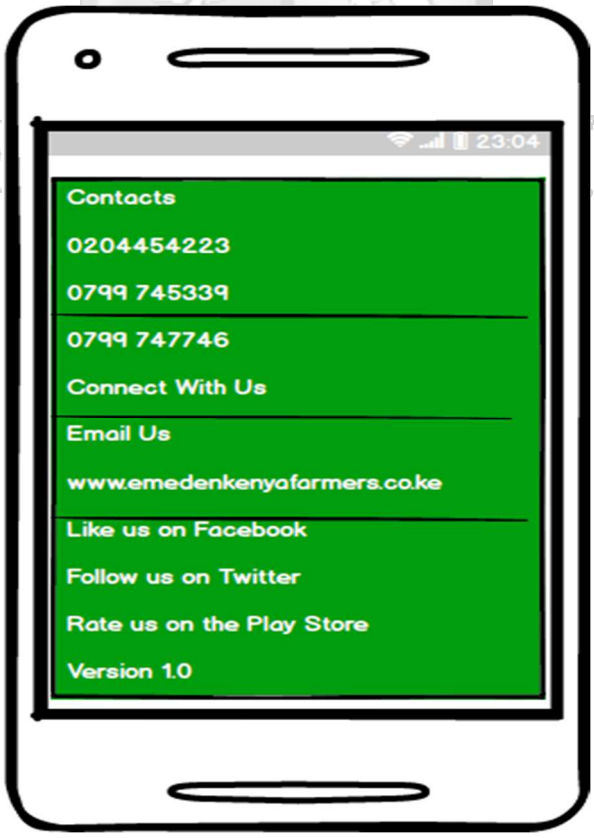


Figure 5.16 Contact Us Page

Navigation Page

This page will give the user shortcuts to personalised items as shown in figure 5.17 below. Shopping Cart page will appear as indicated in figure 5.9 above. Notification page is the same as figure 5.14 above.

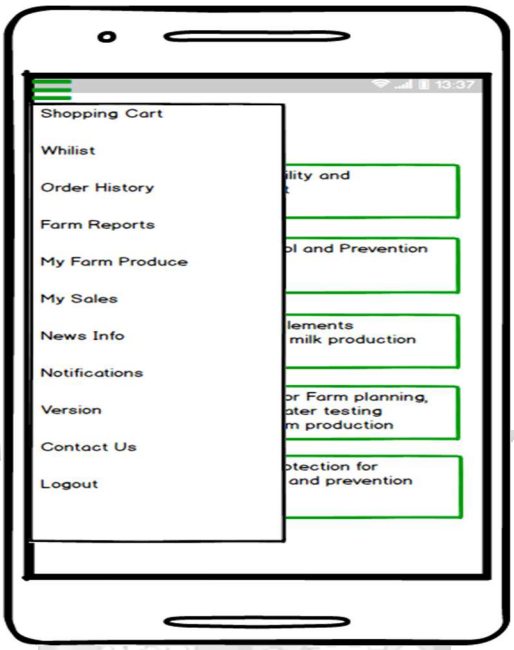


Figure 5.17 Navigation Page

Wishlist Page

Items on farmers wish list are displayed in the page as shown in figure 5.18 below. These are products that have been suggested by the farmer.

Figure 5.18 Wishlist Page

Order History

Total orders that a farmer makes will appear as shown in figure 5.19 below.

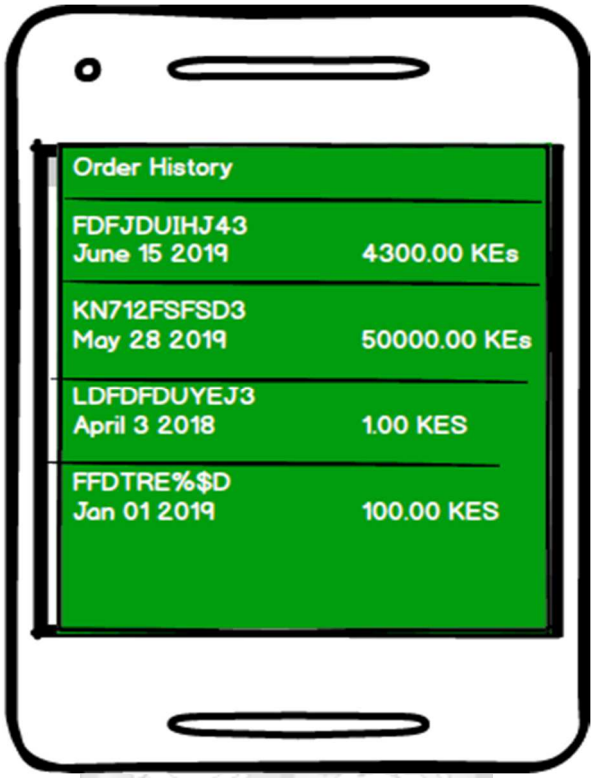


Figure 5.19 Order History Page

Farm Reports

Reports made and submitted by a farmer will appear as figure 5.20 below upon selecting the farm report option in the navigation pane.

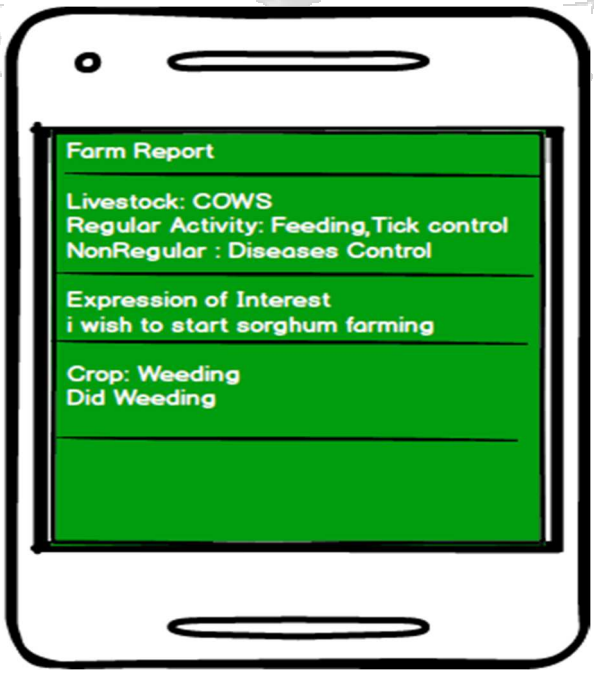


Figure 5.20 Farm Reports Page

My Farm Produce

This page displays the farm produce that have been uploaded for sell by the farmer as shown in figure 5.21 below.

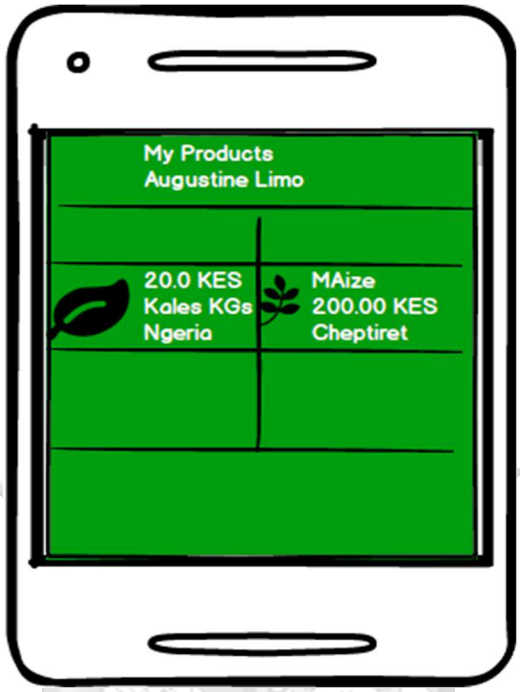


Figure 5.21 My Produce Page

My Sales Page

For the farm produce that were uploaded by the farmer, published by the administrator to the farm produce shop and are successfully ordered, the details will be shown in the page shown in figure 5.22 below with status of payment.

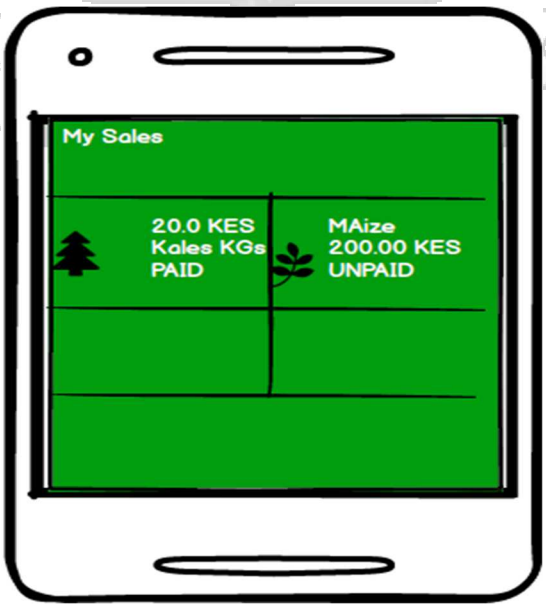


Figure 5.22 My Sales Page

News Info Page

This page will display the products that have been put on featured list as shown in figure 5.23 below.

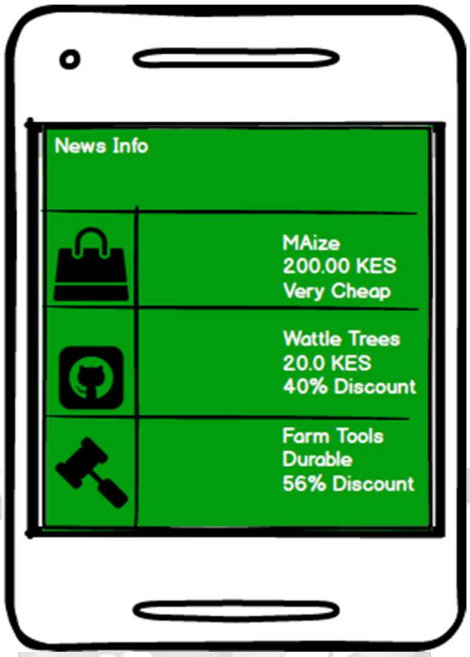


Figure 5.23 News Info Page

Web Application Wireframes

These was used to prototype the system before actual implementations. The figures below show the wireframe designs of the screens for the web application.

Dashboard

The web application dashboard will be the first page after login and it will give a summary of the orders, product information, news info, mobile application version and product categories as shown in figure 5.24 below.

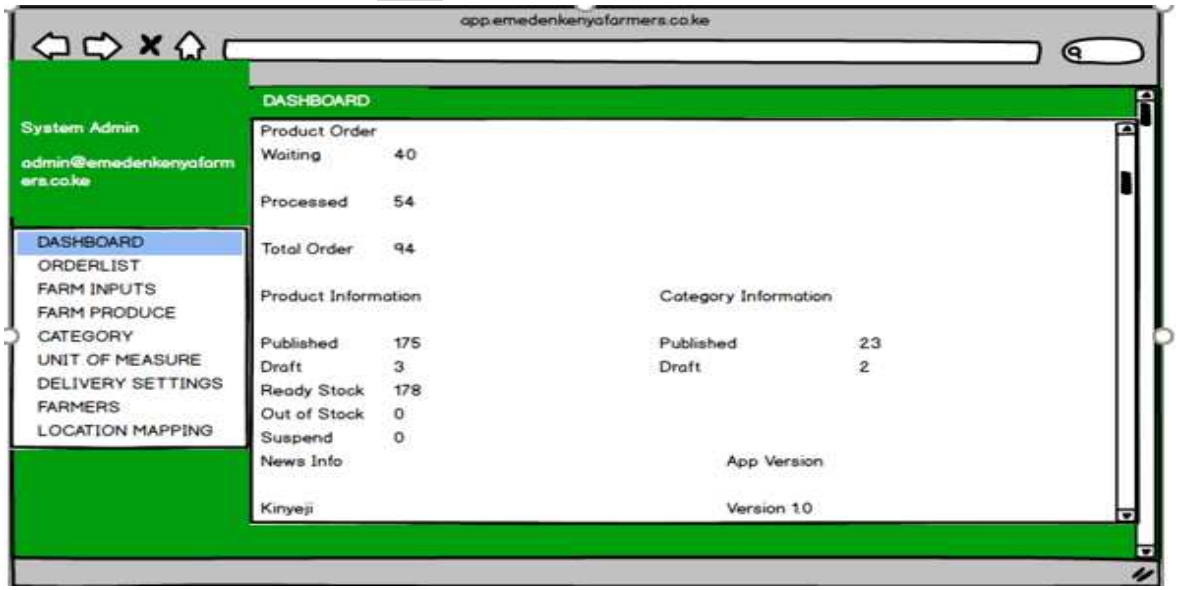


Figure 5.24 Web Application Dashboard.

Order List

This is where the administrator will view the orders that have been made, the buyer, the code of the order, amount, status of payment and date of the order as shown in figure 5.25 below.

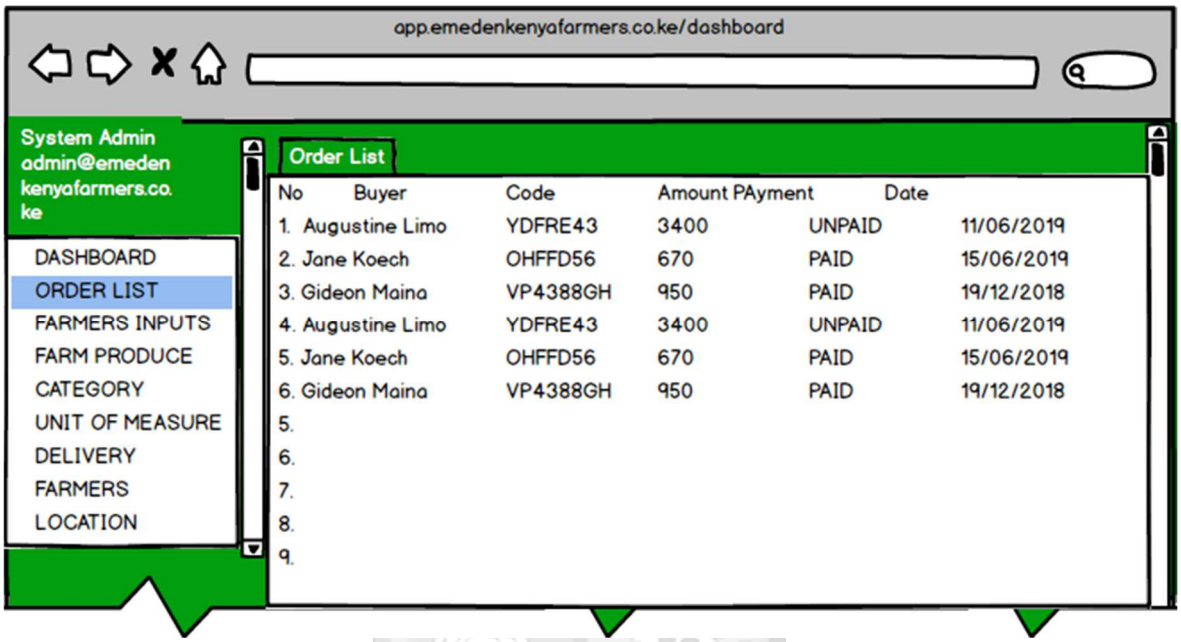


Figure 5.25 Order List Page.

Farm Inputs

The administrator will be able to view farm inputs here and can either add new products, delete the existing and edit prices as shown in the figure 5.26 below.

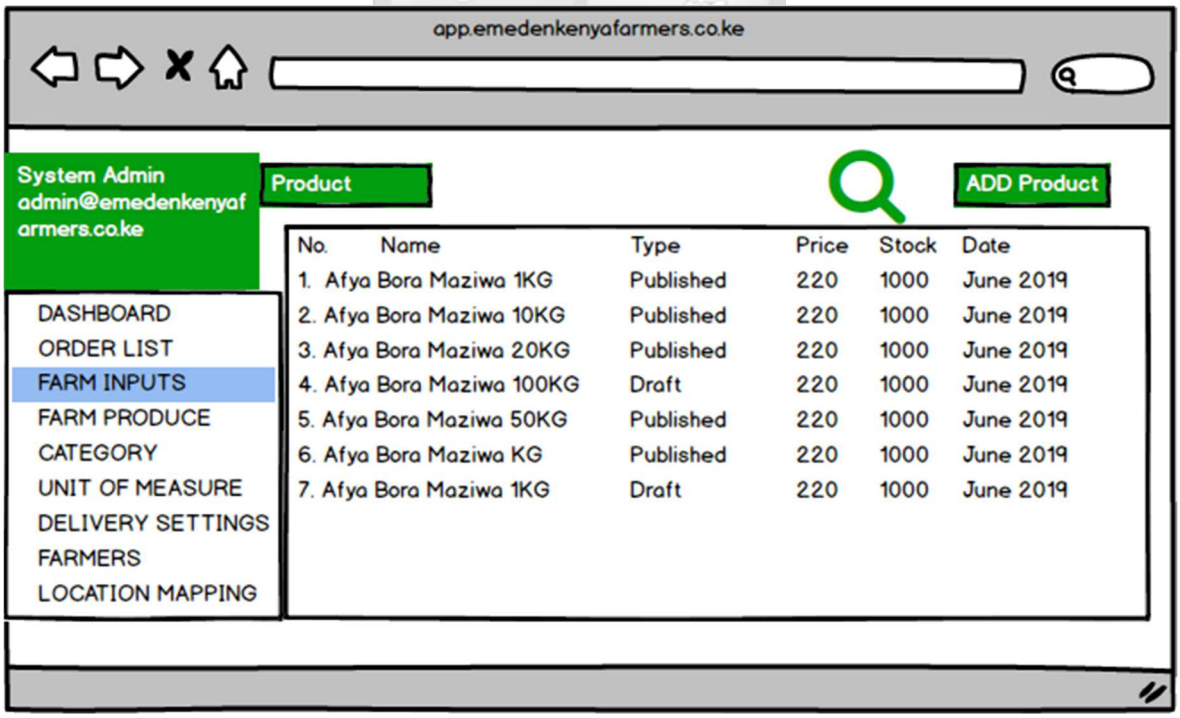


Figure 5.26 Farm Inputs Web Page.

Farm Produce

The administrator will be able to view and manage submitted farm products from farmers and publish them for visibility in the mobile application farm produce shop as shown below in figure 5.27.

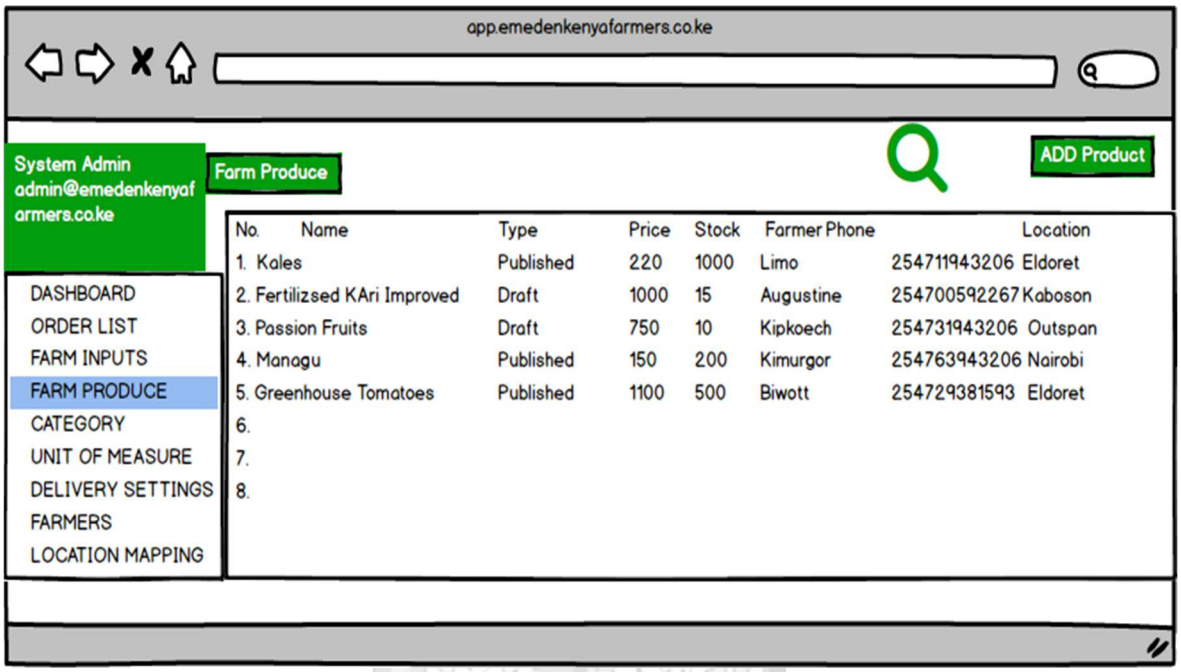


Figure 5.27 Farm Produce Web Page.

Category

This is the page where the administrator manages the categories of all the products, both farm produce and farm inputs as shown in figure 5.28 below. The admin can either delete, edit or publish the category accordingly.

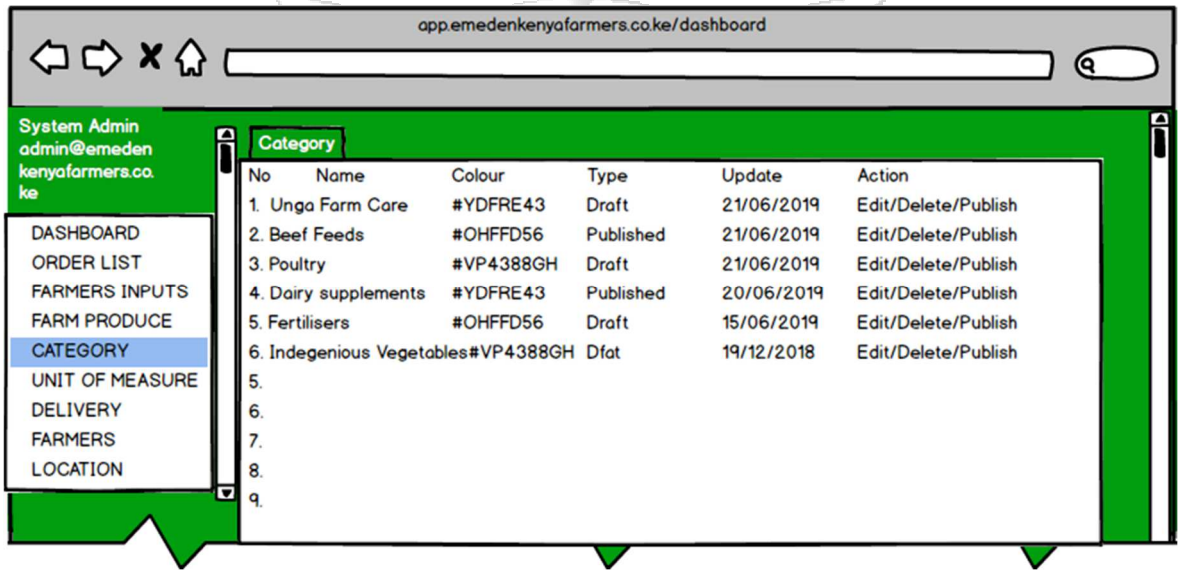


Figure 5.28 Products Category Page

Units of Measure

The various units used to measure and determine quantity of farm produce are listed in figure 5.29 below.

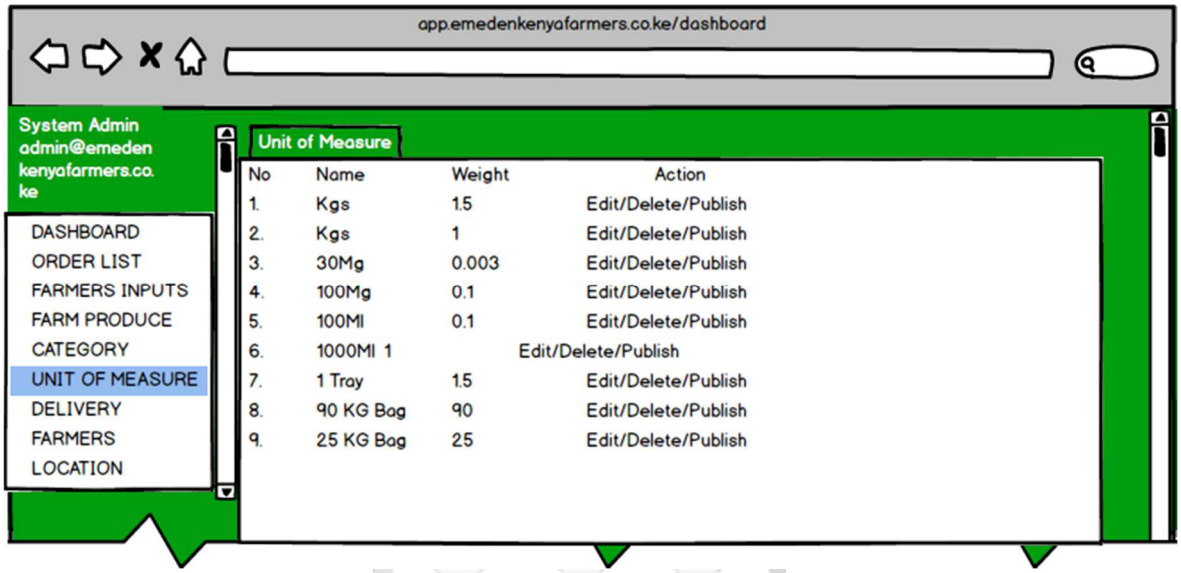


Figure 5.29 Units of Measure Page

Delivery Settings

For delivery costs and decision making, the below settings in figure 5.30 below

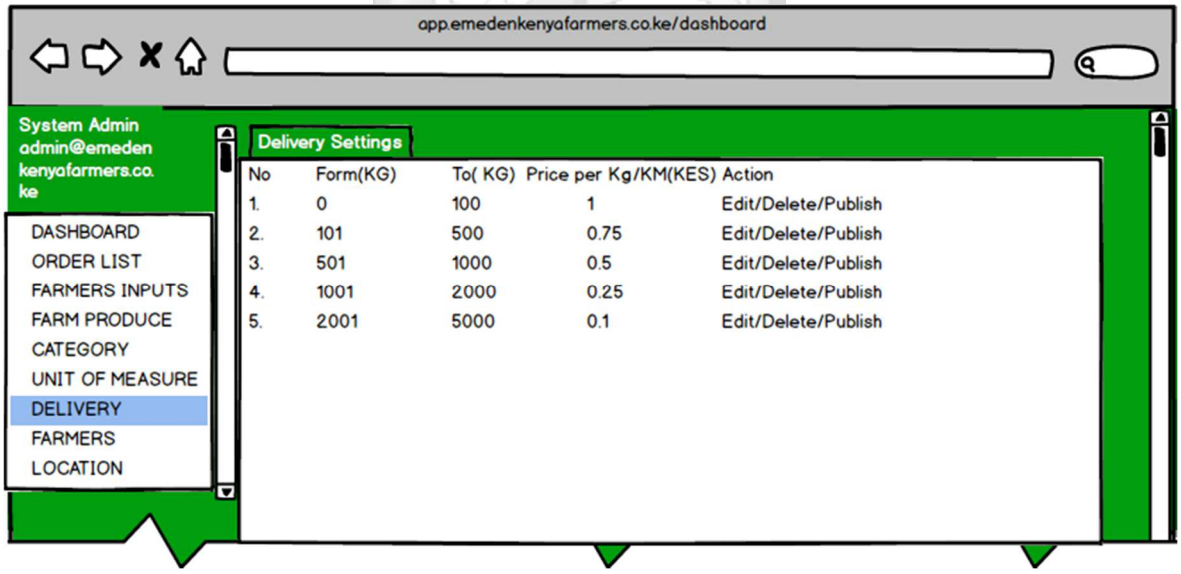


Figure 5.30 Delivery Settings Page

Farmers

This component will give a view of all the farmers registered in the mobile application, allowing the administrator to edit, add or remove as indicated in figure 5.31 below.

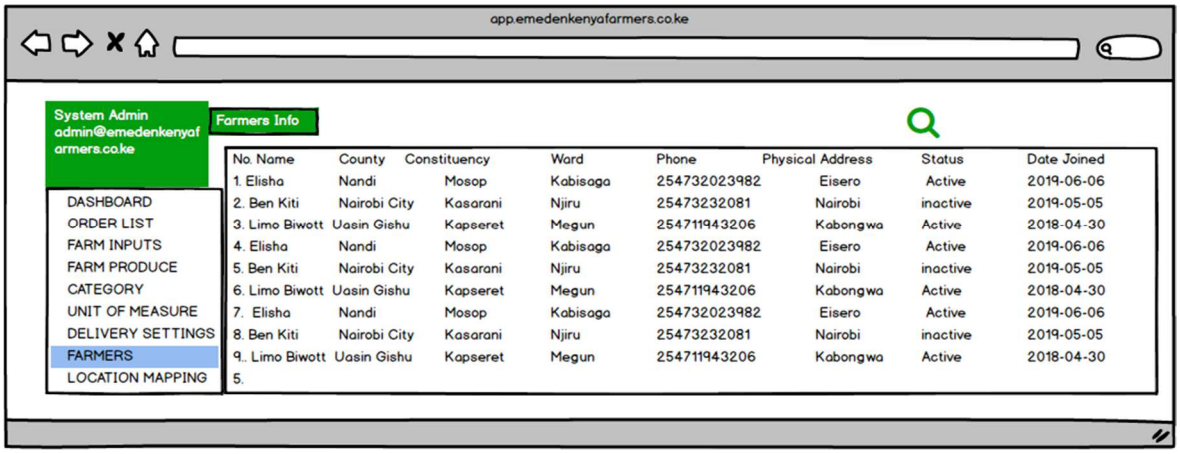


Figure 5.31 Farmers Information Page.

Location Mapping

This module will help control the number of counties to be focused on for mobile application roll out, survey and marketing. Figure 5.32 below shows county control.

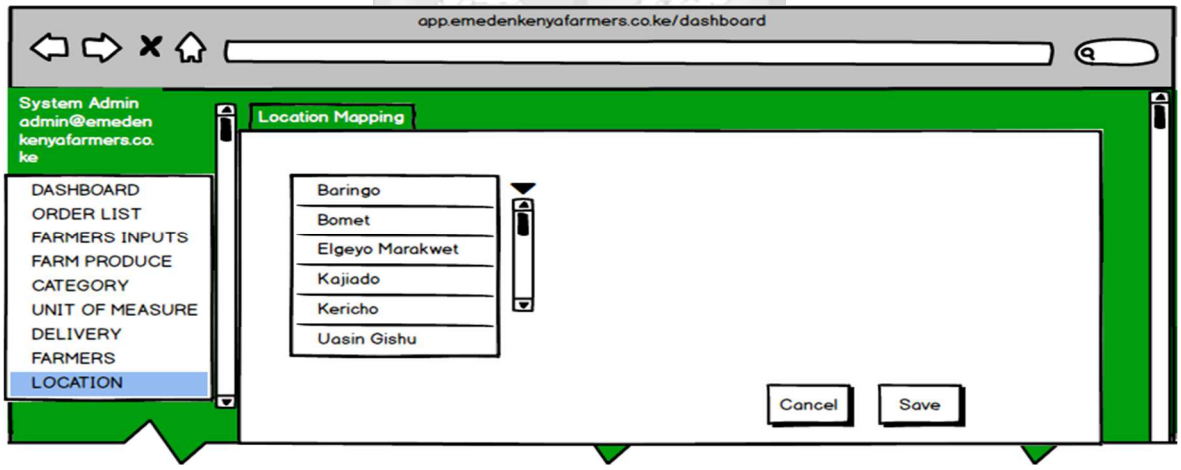


Figure 5.32 Location Mapping

Expression Reports

Farmers who choose the express interest option while making farm reports will be visible here in figure 5.33 below.

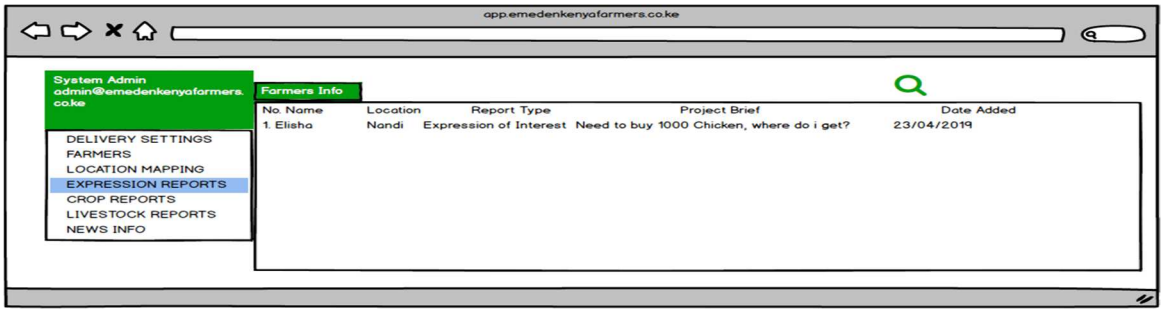


Figure 5.33 Expression of Interest Page

Crop Reports

The farm crop reports will be displayed on the page shown in figure 5.34 with farmers details.

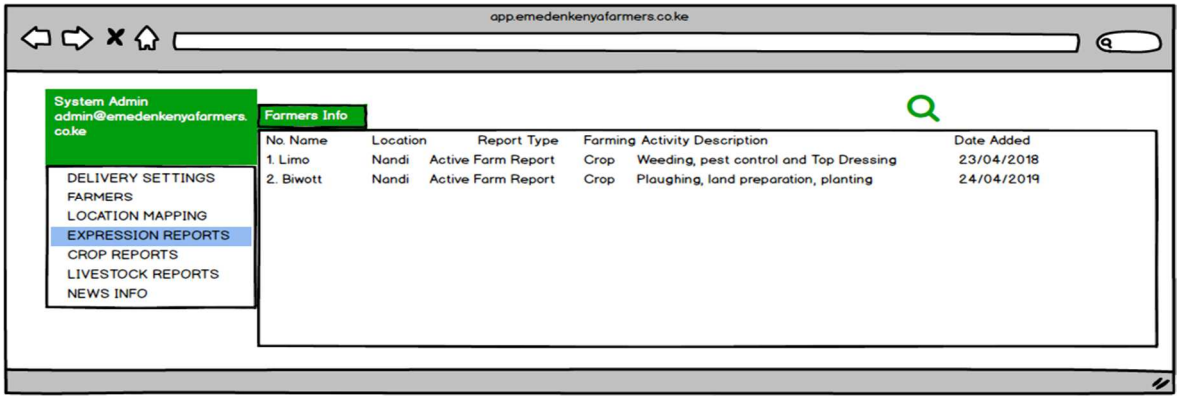


Figure 5.34 Crop Reports Page

Livestock Reports

The farm livestock reports will be displayed on the page shown in figure 5.35 with farmers details.

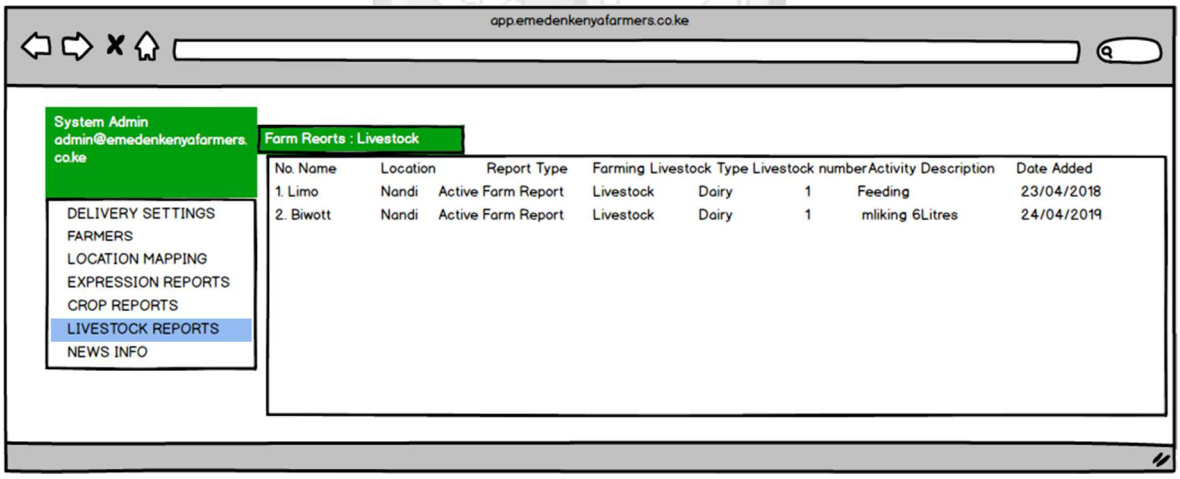


Figure 5.35 Livestock Reports Page

News Info

Featured products will be published on the news info page as shown in figure 5.36 below.

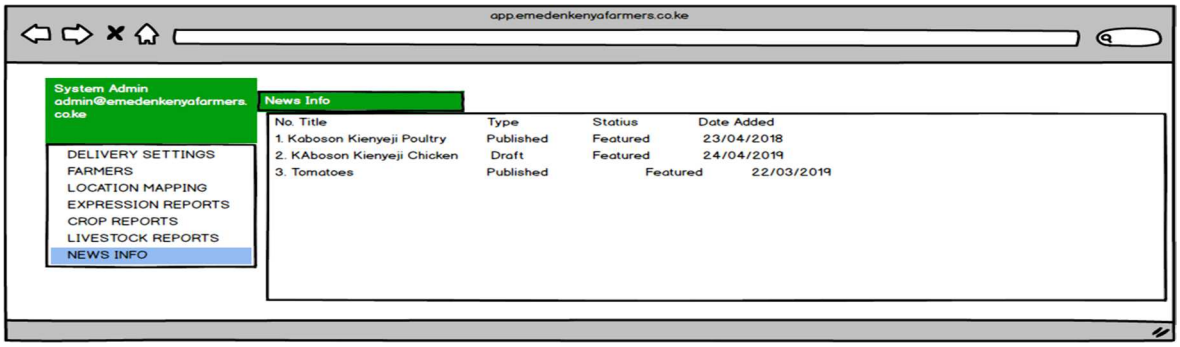


Figure 5.36 News Info Page

App

The version of the mobile application will be checked from the web application as shown in figure 5.37 below

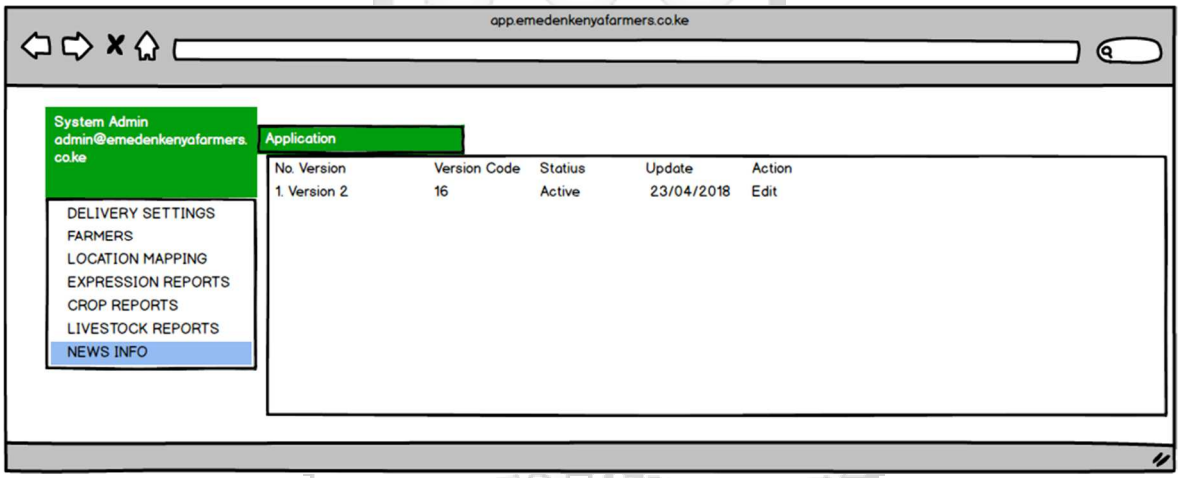


Figure 5.37 Application Page

5.4 Conclusions

System analysis and design helped in understanding system requirements. UML notation was used to construct diagrams that aided in understanding the system. These diagrams include; the use case diagram used to show the system requirements, sequence diagram used to illustrate the system process, partial domain diagram used to identify relationships between entities, context diagram used to represent actors outside of the system that directly interacted with the system, level 0 data flow diagram used to show the interaction between external entities and processes of the system and the ERD used to show the database design.

The proposed architecture is a client server architecture where the mobile and web applications are in the client side while the server and database in the sever side.

CHAPTER 6: PROTOTYPE BUILDING, EVALUATION AND TESTING

6.1 Introduction

This chapter explains how implementation and testing of the proposed applications were carried out. The major functionalities of the system were implemented, and tests carried on them. The system functional requirements were incorporated in the prototype functionalities and the system design strictly adhered to the plan presented in the system design.

6.2 Implementation Environment

6.2.2 Mobile Application

The Operating System for the mobile application implementation was Android. The source code was written in Java, utilising Android classes. The application was compiled and tested using the Android Software Development Kit (SDK) emulator and an Android device. The application is optimised for Android version 8.1.0 compatible with Android devices on minimum version 2.0 and maximum version 8.1.0. JSON was used as the web service that provides the interface between the Android application and the database. Reasons for choosing Android as the client application include: flexible SDK, availability of Android Development Tools (ADT) and availability of abundant support from online developer communities.

6.2.2 Web Application

The web application was developed using Hypertext Pre-processor (PHP). The website was hosted on an online Apache HTTP server. Reasons for using PHP were; it is an open source platform, it is platform independent; it supports all major web servers and databases; it has multiple layers of security to prevent threats and malicious attacks.

6.2.3 Database

The database was developed using the MySQL database. Reasons for using MySQL were; it is an open source platform; it is fully compatible with PHP and other platforms; it is secure in that all passwords are encrypted before storage restricting unauthorised access to the database.

6.3 Implementation Details

6.3.1 Mobile Application

The prototype is designed to run on an Android Operating System device compatible with Android devices with minimum version 2.0 and maximum version 8.1.0. The device running the application rely on an active internet connection, active sim card and an operational GPS.

System Components

The main system components of the application are:

Register and Login Pages

To gain access to the application, users have to login using a phone number or email address and a password. Creation and activation of accounts s done using the firebase cloud messaging and it ensures security and prevent unauthorised access.

Application Main Page

This Figure 6.1 shows the main page which provides a sliding image with recent farm products starting from the most immediate. The farmer selects the shop which is of their interest and continuous to check the details of the products. The farmer can also check their account details, suggest product or go to cart and sell farm produce.

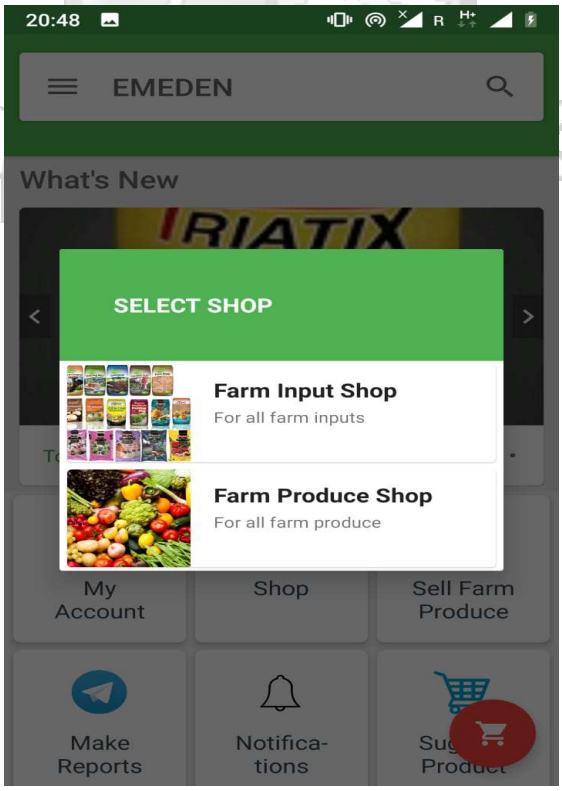


Figure 6.1 Application Main Page.

Farm Input Shop Page

Figure 6.2 shows farm input shop page which provides product categories and short description.

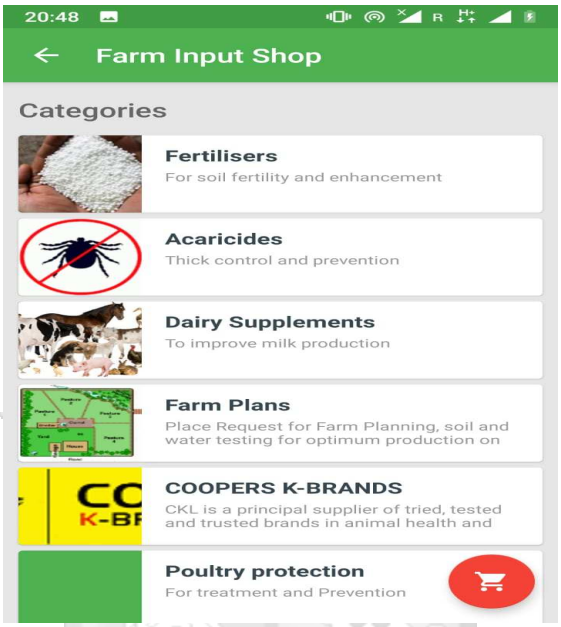


Figure 6.2 Farm Input Shop Page.

Farm Produce Shop Page

Figure 6.4 shows the farm produce page which provides categories of the published farm products from the sell farm produce function. A short description follows and upon clicking, more products per category and their prices are displayed.

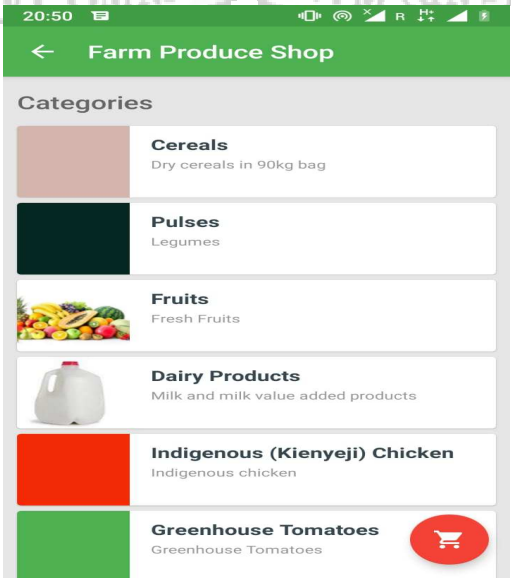


Figure 6.3 Farm Produce Shop Page.

Product Detail Page

Upon selecting a product from the shops, the farmer can view price and read the details of the product as shown in figure 6.3. The farmer can then add to cart and then check out.

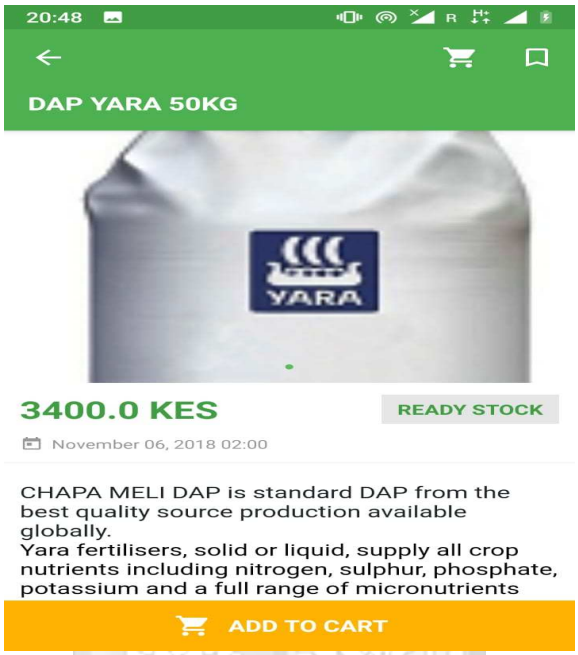


Figure 6.4 Product Details Page.

Shopping Cart Page

This page is displayed when one clicks on the cart and it shows products that have been added to the cart, their prices, quantity and total price as shown in figure 6.4 below. Farmer clicks checkout to proceed to checkout page.

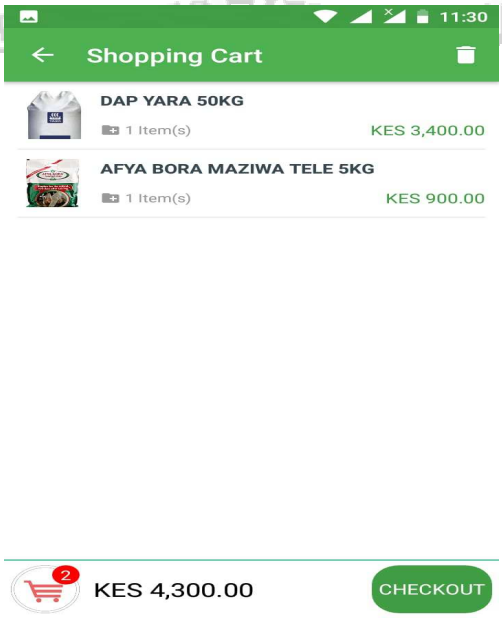


Figure 6.4 Shopping Cart Page.

Checkout Page

This page is shown in figure 6.5 below with order cost, price inclusive of Value Added Tax (VAT), option to pay now via M-Pesa and farmer details as captured during registration. The phone number entered will receive payment invoice notification.

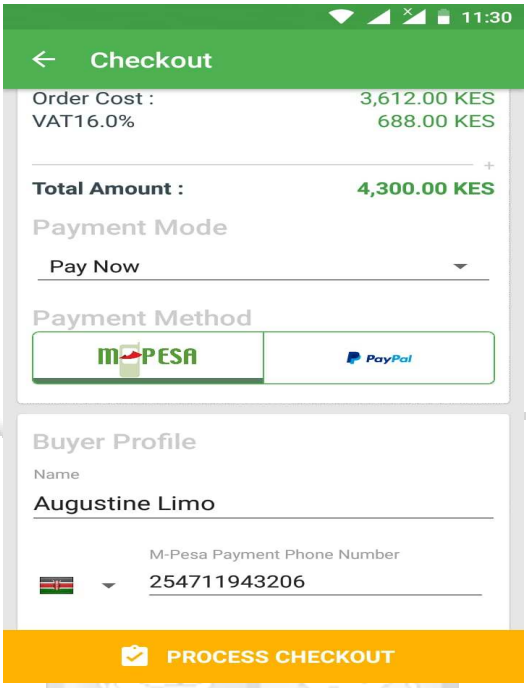


Figure 6.5 Checkout Page.

Order Confirmation Page

Once a farmer clicks on process checkout, below page appears to confirm that the order has been placed with information that payment has been sent to the entered phone number for M-Pesa payment as shown in figure 6.6 below.

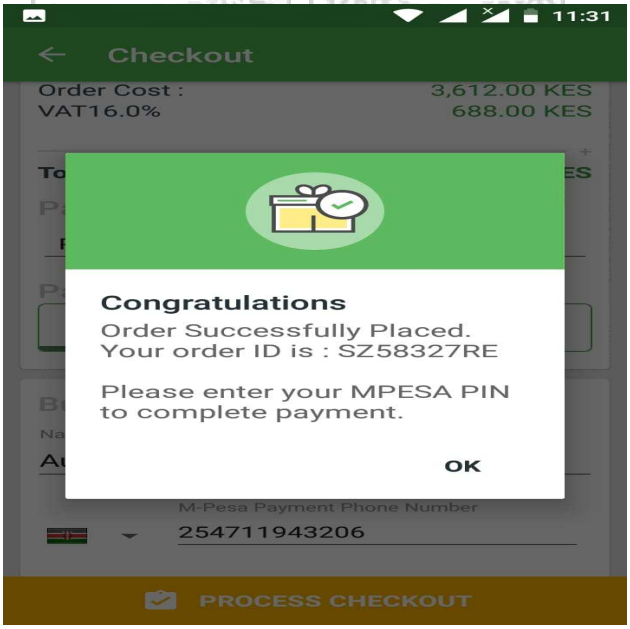


Figure 6.6 Order Confirmation Page.

Payment Page

Once the order has been made, the phone with the phone number that was provided during checkout receives the notification to enter the M-pesa PIN to pay for the order. The farmer will receive and SMS from EMEDEN confirming the order payment as shown in figure 6.7 below.

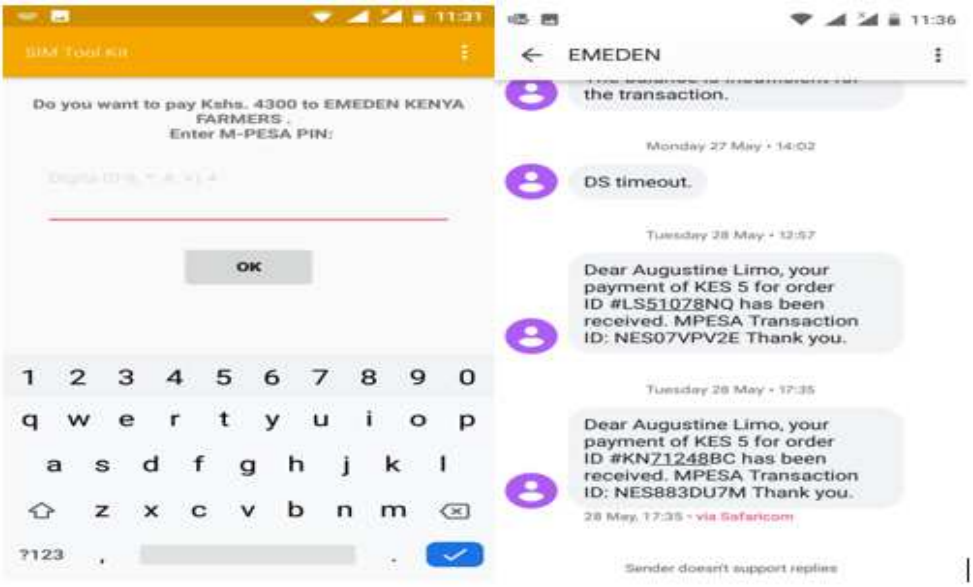


Figure 6.7 Payment Page.

Sell Produce Page

A farmer with produce to sell uses the sell farm produce functionality on the application. As shown in figure 6.8 below, the image of the produce, produce name, suggested price, unit of measure, quantity, category and product description are filled. Upon submitting, the administrator will validate the product and publish it and it will appear in the farm produce shop.

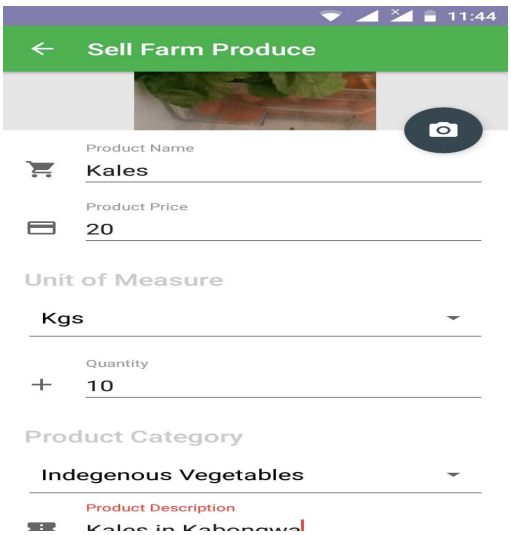


Figure 6.8 Sell Farm Produce Page.

Navigation Page

This page shows Wishlist, order history, farm reports, my farm produce, my sales, contact us, news info and notifications as shown in figure 6.9 below.

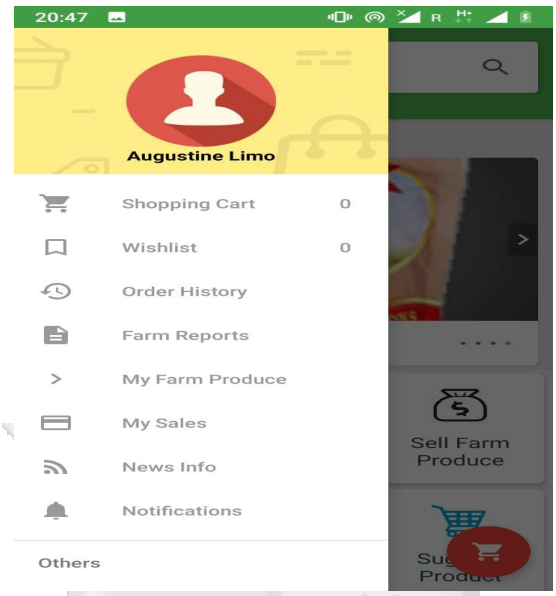


Figure 6.9 Navigation Page.

Wishlist Page

Items on farmers wish list are displayed in the page as shown in figure 6.10 below. These are products that have been suggested by the farmers on the suggest a product functionality.

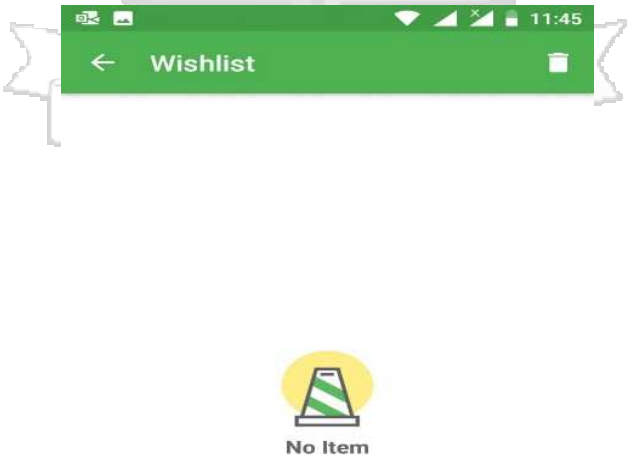


Figure 6.10 Wishlist Page.

Order History Page

Total orders that a farmer has made are displayed with their order codes, prices and the date of making the order as shown in figure 6.11 below

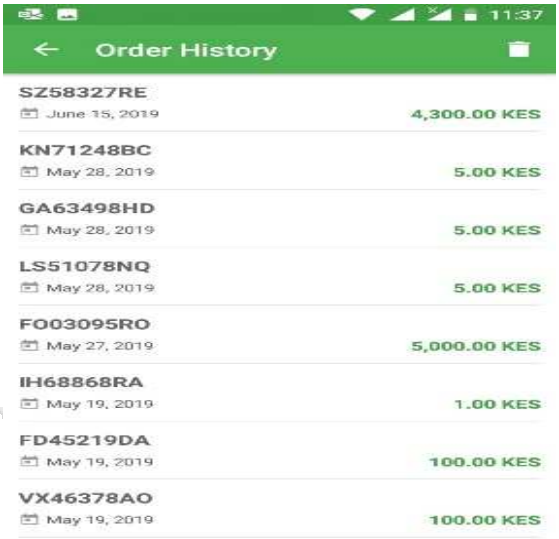


Figure 6.11 Order History Page.

Farm Report Page

For farmers who make reports using the make reports functionality on the application, the reports will be shown on the page below in figure 6.12

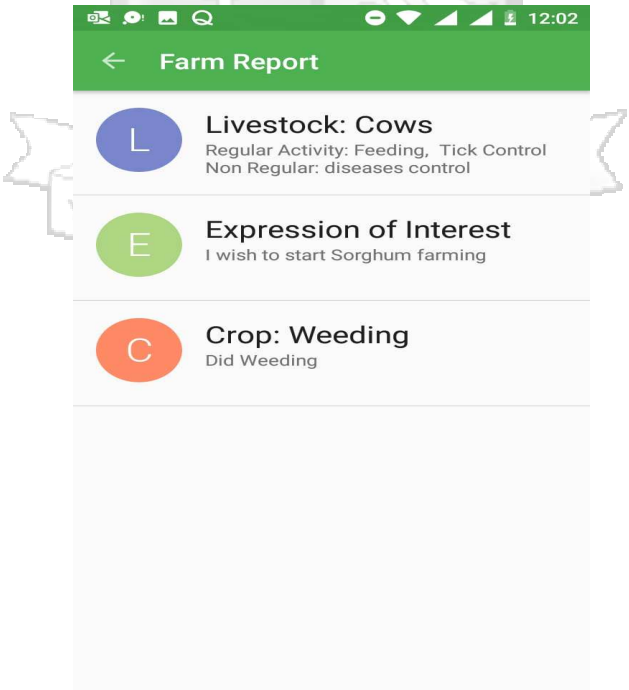


Figure 6.12 Farm Report Page.

My Farm Produce Page

This page displays the farm produce that have been uploaded for sell by the farmer as shown in figure 6.13 below. The produces are either waiting for administrator to publish them to the farm produce shop or are already published.

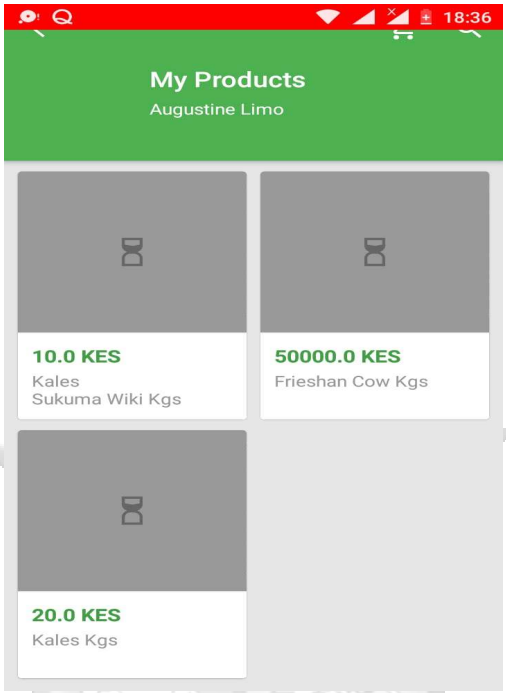


Figure 6.13 My Farm Produce Page.

My Sales Page

For the farm produce that were uploaded by the farmer, published by the administrator to the farm produce shop and are successfully sold, the details will appear in the page shown in figure 6.14 below.

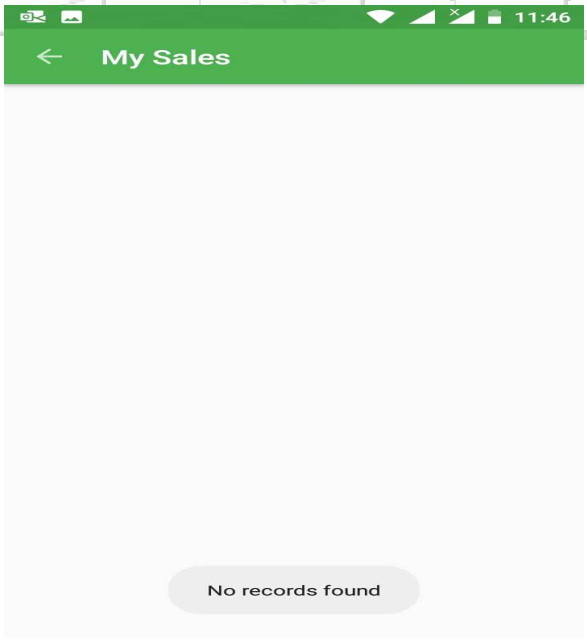


Figure 6.14 My Sales Page.

News Info Page

The products that are featured and placed on the slider of the home screen in the application are contained in the news info page with the details, images and date of featuring the products as shown in figure 6.15 below.

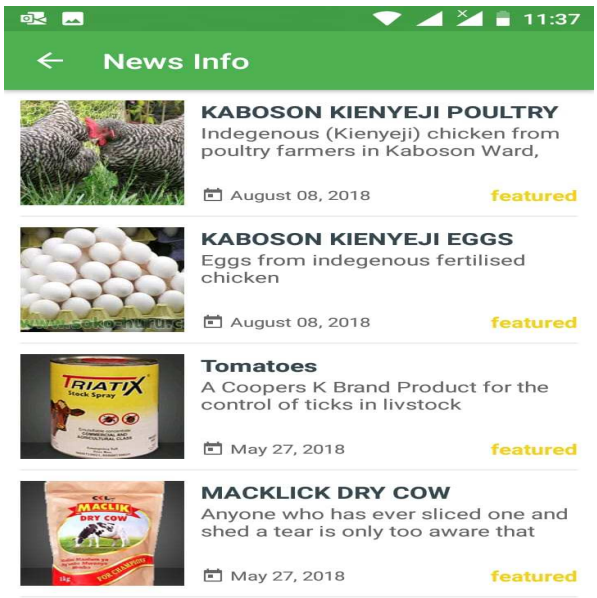


Figure 6.15 News Info Page.

Notifications Page

All the product notifications triggered by the administrator from the application backend to the farmers will appear on the notification page as shown in figure 6.16 below.

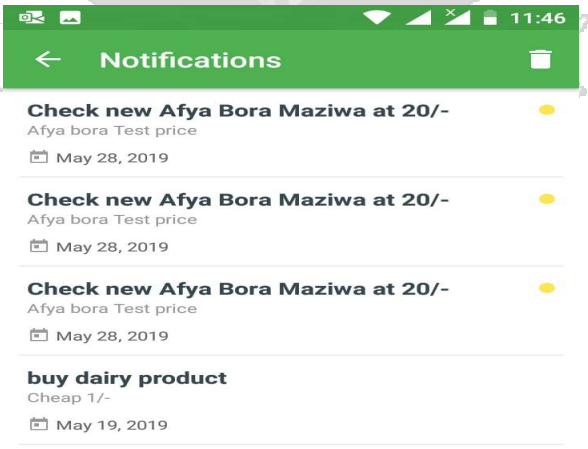


Figure 6.16 Notifications Page.

6.3.2 The Web Application

The web application's main function was to retrieve orders, upload and update products, control users, send new farm products notifications and send information to the developed mobile application and to the database. This application resides in the HTTP web server and is directly linked to the products database. The web application was designed for use by administration to manage users, manage products, manage orders manage, push notifications and the pull reports.

System Components

The main system components of the web application for the farmers mobile application for ordering inputs and marketing produce are :

Login Screen

To gain access to the web application users have to login using a username and password. The username and password are authenticated and verified then access is granted or denied. This prevents unauthorised access (Appendix I).

Dashboard

This gives a summary of the orders, product information, news info, mobile application version and their categories. On the navigation pane it gives all the components of the web application which include: order list, farm inputs, farm products, category, farmers, notification, news , location mapping, and other settings as shown in figure 6.17 below.

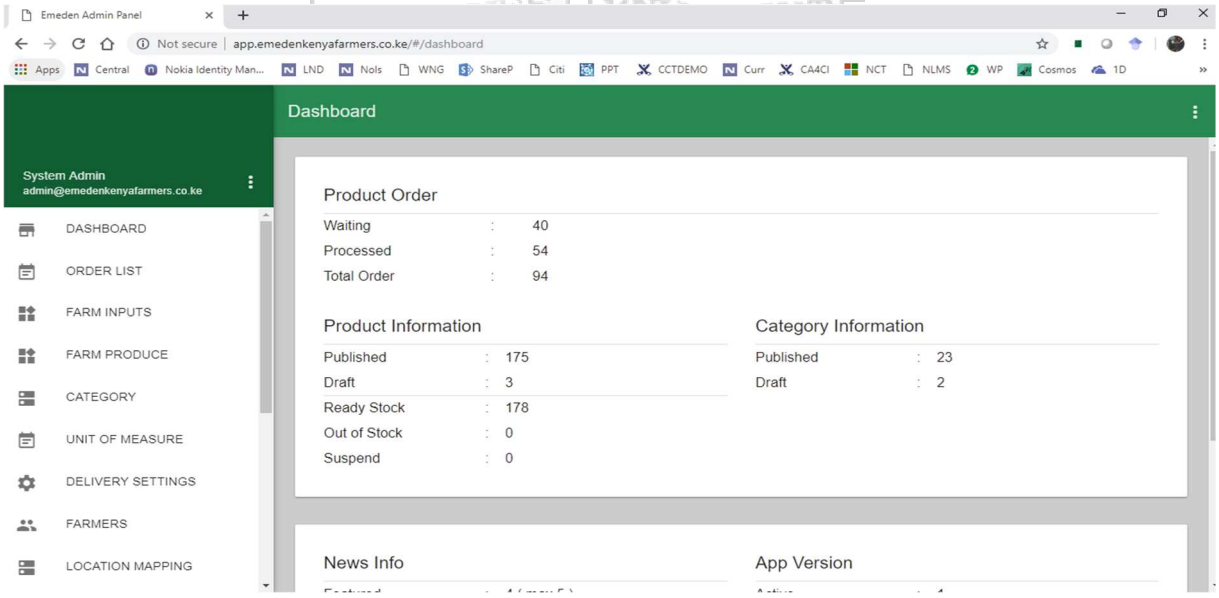


Figure 6.17 Web Application Dashboard Screen.

Order List

This is where the administrator manages the orders by viewing the status of payments, the buyer, details of order, either process, cancel or delete or edit as shown in figure 6.18 below.

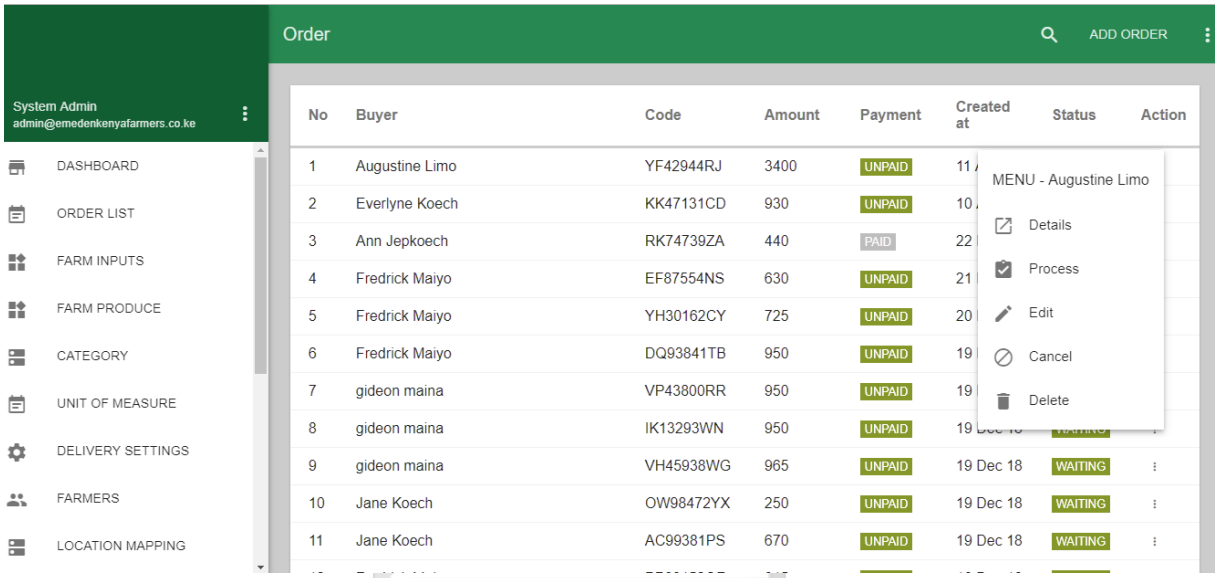


Figure 6.18 Orders Page.

Farm Inputs

This is where the administrator manages the farm input products by addig product, deleting, editing, pricing and publishing. The main view has the name of the product, the price , quantity in stock and date published as shown in figure 6.19 below. Any changes done here will reflect on the mobile application.

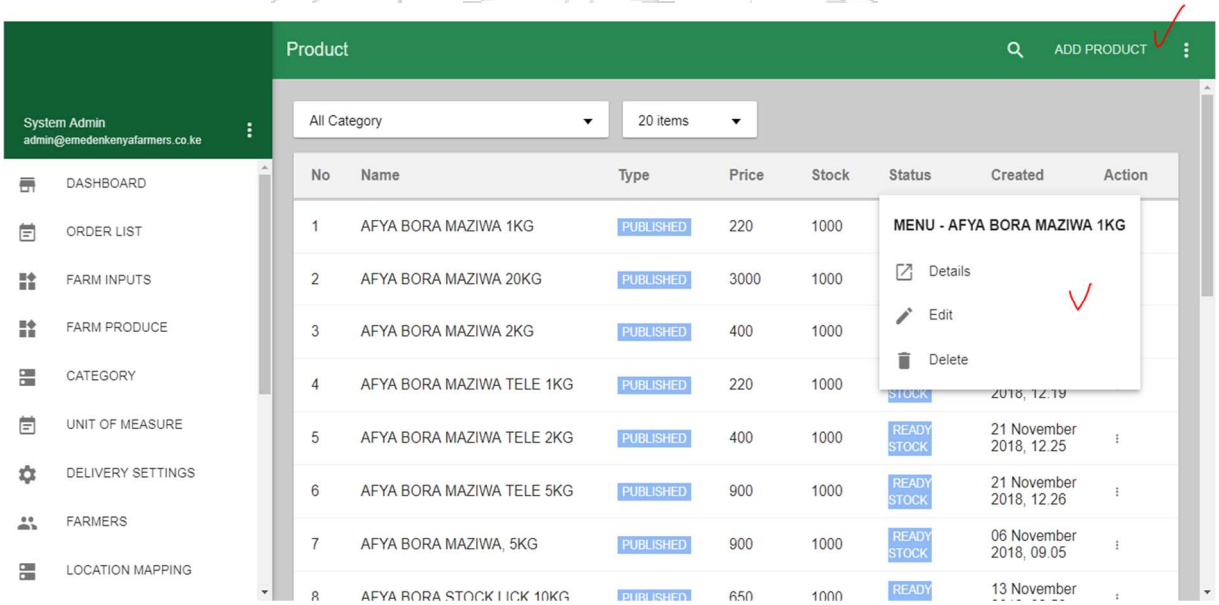


Figure 6.19 Farm Inputs Page.

Farm Produce

This is the page that administrator uses to verify the products that farmers have submitted using the sell farm produce module of the mobile application, either publish, edit or delete as shown in figure 6.20 below. The details on the screen are product name, type, price, status in stock, farmers name, phone number and location.

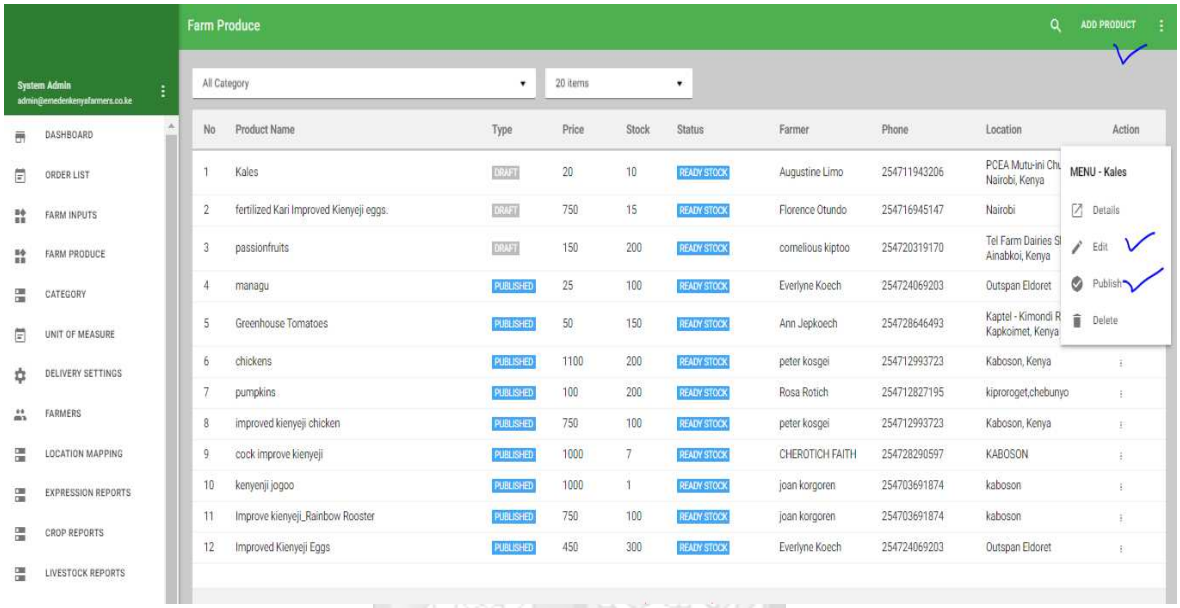


Figure 6.20 Farm Produce Page.

Category

This is the page that administrator uses to manage the categories of both farm produce and farm input products as shown in figure 6.21 below. There is category name, colour, type, date last updated and an option to edit.

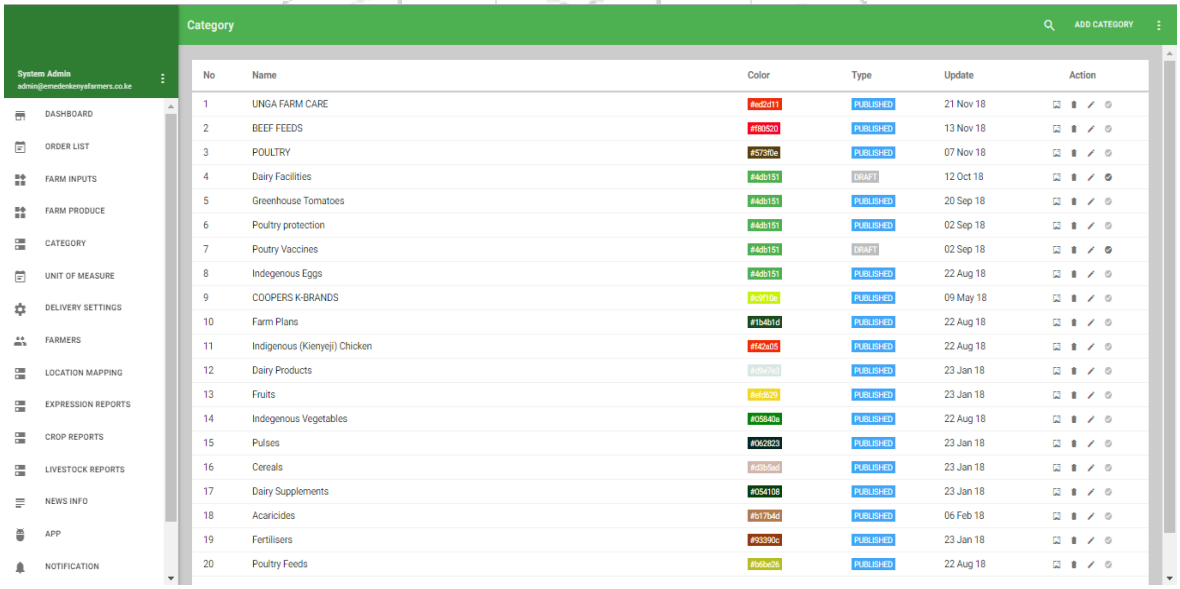


Figure 6.21 Category Page.

Units of Measure

The various units used to measure and determine quantity of farm produce are here for administrator manage by adding new or editing the existing. The unit name, weight and an option to edit or delete are there as shown in figure 6.22 below.

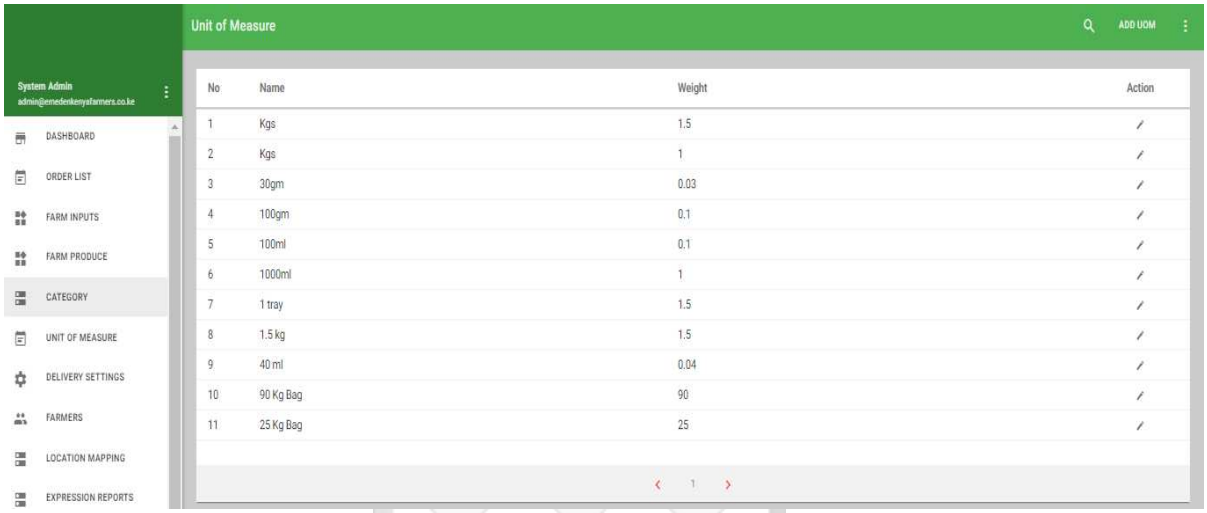


Figure 6.22 Units of Measure Page.

Delivery Settings

This is the page where in case delivery is to be done, the price for delivery and the truck to be used can be determined based on the number of Kilograms of the order and the price per Kilogram. There is also an action point for editing, deleting or adding new as shown in figure 6.33 below.

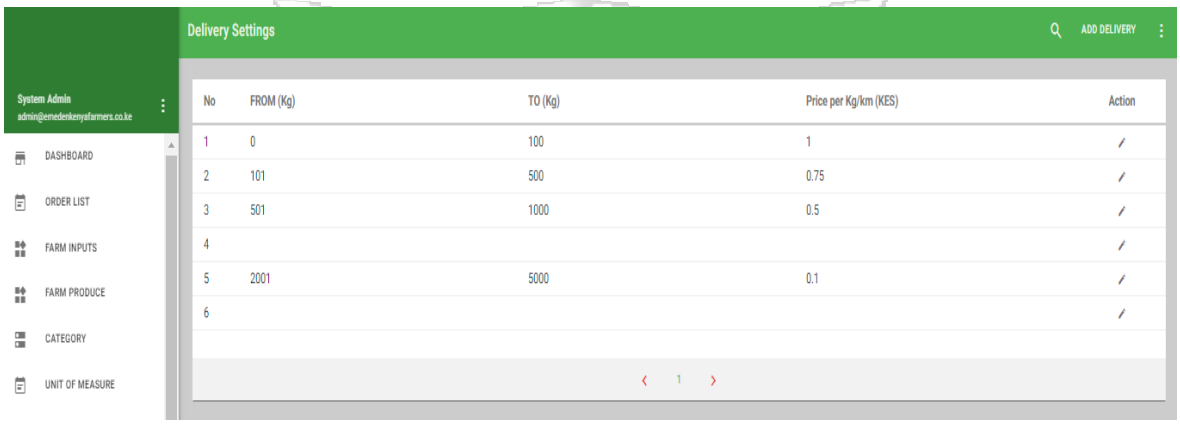


Figure 6.23 Delivery Settings.

Farmers

This component offers farmers management after they registered in the mobile application. It allows an administrator to view registered farmers' information, to edit, add and remove as indicated in figure 6.24 below. The name of the farmer, county, constituency, ward, phone number, physical address and status are shown.

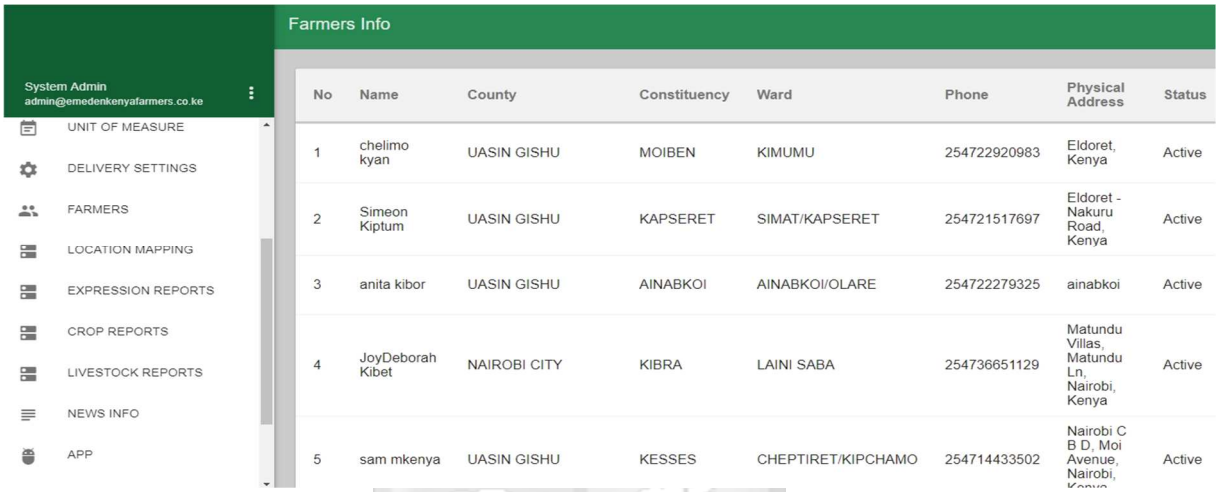


Figure 6.24 Registered Farmers Page.

Location Mapping

The administrator uses the page to determine the counties and location for focus in marketing and distribution of the mobile application as shown in figure 6.25 below. A few counties were selected for the research and sampling.

Figure 6.25 Location Mapping.

Expression Reports

This is the page where the reports of the farmers including farm input dealers who wish to express their interest using the make reports module in the mobile application. The administrator can view the reports as shown in figure 6.26 below.

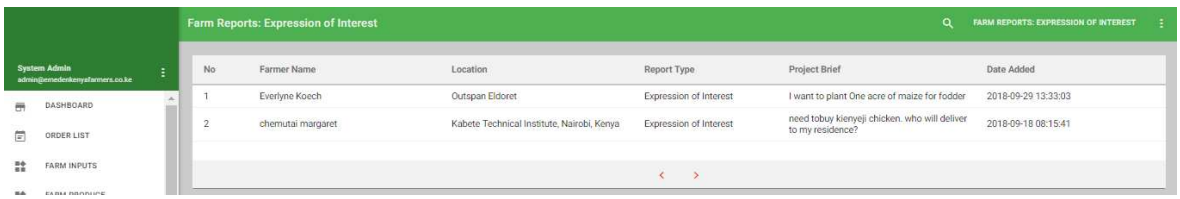


Figure 6.26 Farm Reports on Expression of Interest.

Crop Reports

The farm reports on crops will be displayed on the page shown in figure 6.27 below for administrator to manage and suggest related training or proper market preparation. The make reports module in the mobile application enables farmers to do this.

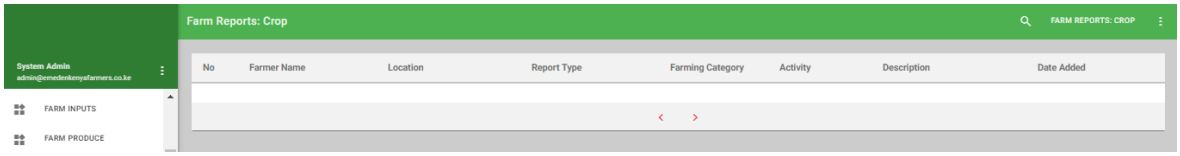


Figure 6.27 Crop Reports Page.

Livestock Reports

The farm reports on livestock will be displayed on the page shown in figure 6.28 below for administrator to manage and suggest related training or proper market preparation. The make reports module in the mobile application enables farmers to do this.

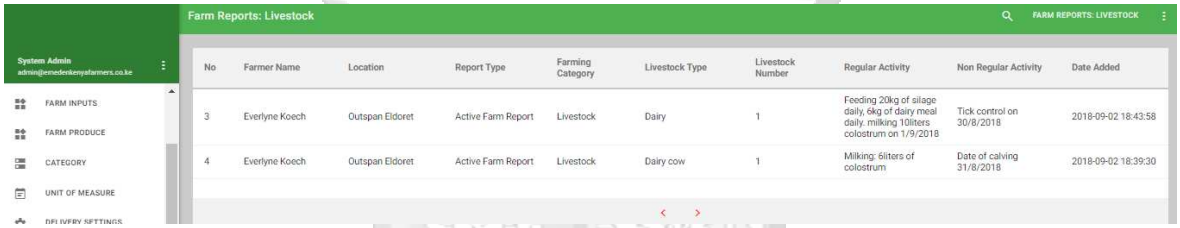


Figure 6.28 Livestock Reports Page.

News Info

The products that are to be featured and placed on the slider of the mobile application page are added in the page in figure 6.29 below by the administrator. The title of the product, type, status and date updated are clearly shown.

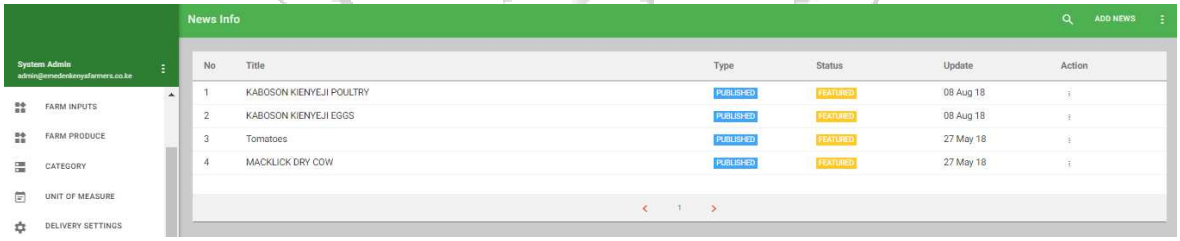


Figure 6.29 News Info Page.

App

The version of the mobile application can be checked from figure 6.30 below including the version name, the version code, status, date of the version and the action to add, delete or edit.

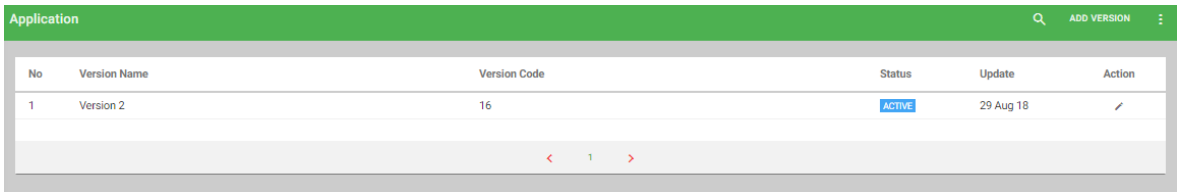


Figure 6.30 Mobile Application Information Page.

Notification

This page indicates the device name, the serial number, the operating system version, app version, last update and an action point for administrator to send specific notifications to the mobile application either individually or all as shown in figure 6.31 below. The notifications will appear as a push notification on the mobile application and will be saved in the notification module of the mobile application for reference.

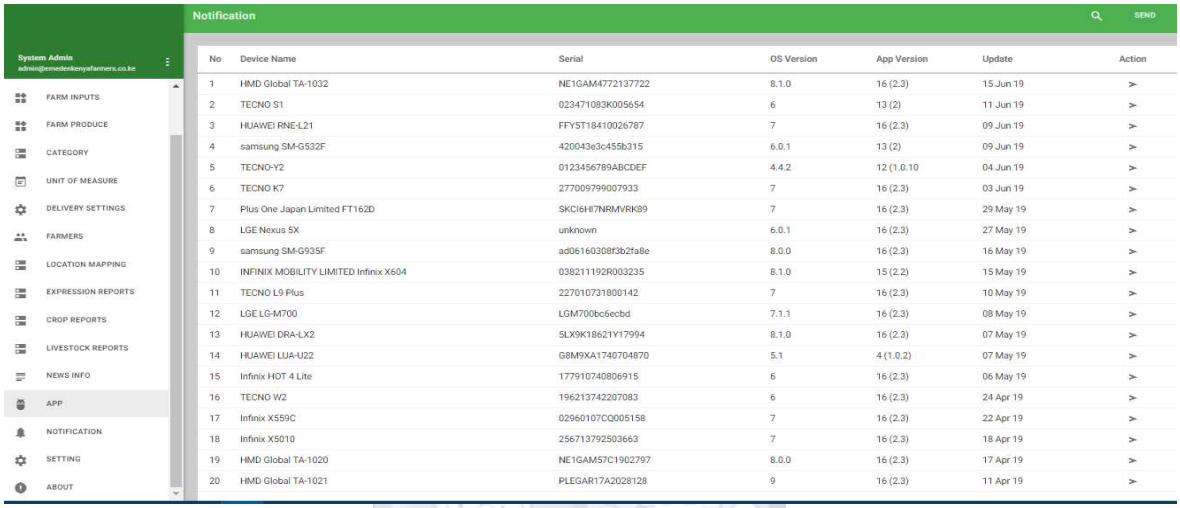


Figure 6.31 Notifications Page.

Setting

This page controls the administrator account, password and login information, and the default currency that the prices of the farm inputs and farm produce shall be displayed at. Also, the value added tax is controlled here as shown in figure 6.32 below.

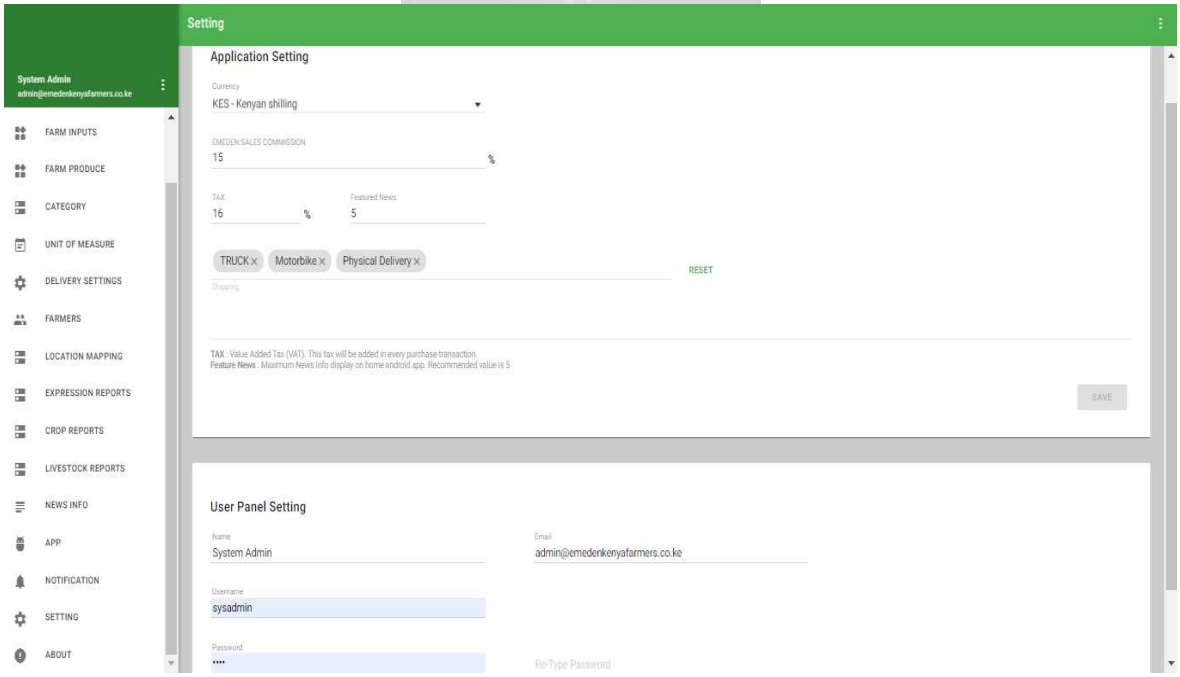


Figure 6.32 Setting Page.

6.4 System Testing

6.4.1 Introduction

This section describes tests performed on the mobile and web application. Tests were done against functional and non-functional requirements of the application. During testing the mobile and web applications were handled as one system because none of them work in isolation.

6.4.2 Usability Test

This was used to determine whether the application is user friendly. It was used to ascertain whether a new user can easily understand the application even before interacting with it so much. The major things checked were: the system flow from one window to another, whether the icons and words used were visible and easily understood by user.

6.4.3 Functional Test

Functional tests were done based on use cases to determine success or failure of the system implementation and design. For each use case testing measures were set with results being considered successful or unsuccessful. Below are tables showing some of the major use cases and their test results.

Table 6.1 Create User Account Test Case

Identifier	
Test Case	Creating user account
Description	Users create accounts using their mobile phone numbers
Utilised Use Case	Create Account
Results	Successful account creation, location and phone number are stored
Pass/Fail	Pass

Table 6.2 Login and Logout Test Case

Identifier	
Test Case	Logging in or out of the system
Description	Users perform login with a username and password pair then logout.
Utilised Use Case	Login and Logout
Results	Successful login and access granted or Successful logout
Pass/Fail	Pass

Table 6.3 View farm input products, farm produce and notifications Test Case

Identifier	
Test Case	View farm input products, farm produce and notifications
Description	Users select the shop, the farm product and the notifications they wished to view
Utilised Use Case	View farm input and farm produce items and notifications
Results	Farm input items, farm produce items and notifications are displayed successfully
Pass/Fail	Pass

Table 6.4 Manage Users Test Case

Identifier	
Test Case	Manage Users
Description	Administrators can add, update and delete user details
Utilised Use Case	Manage Users
Results	User details successfully added, updated and deleted from the database
Pass/Fail	Pass

6.4.4 Compatibility Test

Compatibility test was done to ensure that the mobile and web applications are compatible with the available platforms. The mobile application was tested against the available Android versions while the web application was tested against the available web browsers that are commonly used.

Android Platform Compatibility Testing

Compatibility test conducted for each of the available Android platforms is shown in Table 6.8 below.

Table 6.5 Android Platforms

Android Platform	Android Version Number	Compatible
Android 10 (Gingerbread)	2.3.3	Yes
Android 11 (Honeycomb)	3.0	Yes
Android 12 (Honeycomb)	3.1	Yes
Android 13 (Honeycomb)	3.2	Yes
Android 14 (IceCreamSandwich)	4.0	Yes
Android 15 (IceCreamSandwich)	4.0.3	Yes
Android 16 (Jelly bean)	4.1	Yes
Android 17 (Jelly bean)	4.2	Yes
Android 18 (Jelly bean)	4.3	Yes
Android 19 (KitKat)	4.4	Yes
Android 20 (KitKat Wear)	4.4W	Yes
Android 21 (Lollipop)	5.0	Yes
Android 22 (Lollipop)	5.1	Yes
Android 23 (Marshmallow)	6.0	Yes
Android 24 (Nougat)	7.0	Yes
Android 25 (Nougat)	7.1.1	Yes
Android 26 (Oreo)	8.0	Yes
Android 27 (Oreo)	8.1	Yes

Table 6.6 Browser Type

Browser Type	Compatible
INTERNET Explorer (versions 4 and above)	Yes
Firefox (version 8.0 and above)	Yes
Chrome (All versions)	Yes

6.4.5 Load Test

Load testing was done by running the mobile application on different devices such as smart phones and tablets with Android operating system to check the performance of the application, response time, resource utilisation rate and the application breaking point. This was used to determine how long the application takes to respond, how long it takes to give back result and under what circumstances does the application fail. The figure 6.33 below shows a loaded page of the farm inputs details

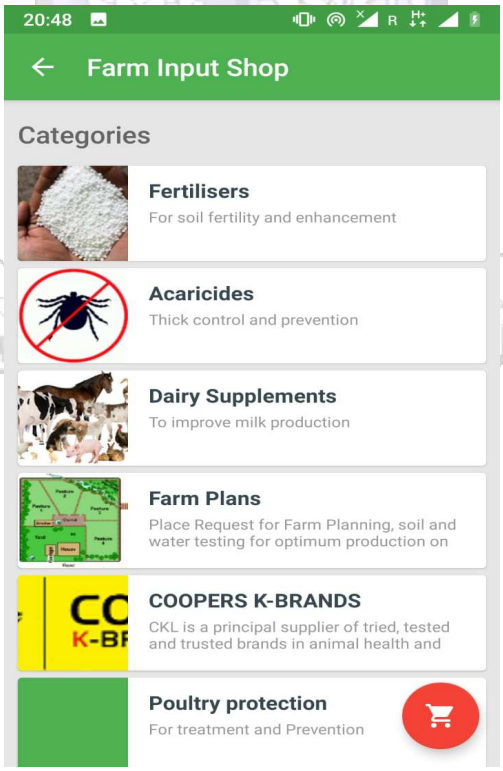


Figure 6.33 Farm inputs Shop Detail Loaded Page.

6.4.6 Integration Test

This was done by combining individual units of the application and then tested together. This type of testing was used to check how the entire application performed when all the units were integrated and working together.

6.5 User Testing

The end users of the application within the target population were directly involved in usability testing. A total of 18 respondents carried out the user testing and provided appropriate feedback which was used to refine the prototype until a satisfactory application was developed. 27 respondents participated in the user testing because they were the only ones who were available in the organisation while user testing was being carried out. User testing was done to achieve the following objectives:

- User friendliness
- Functionality
- Aesthetics
- Acceptance

  Appendix D provides the user-testing questionnaire. Charts were used to represent user responses.

6.5.1 User Interface Aesthetics

The application appearance including the look and feel was tested by the end users. 85% of the respondents indicated that the application was attractive, 11% indicated that the application was attractive while the remaining 4% of the respondents indicated that the application was not attractive at all. A summary is shown in Figure 6.34 below.

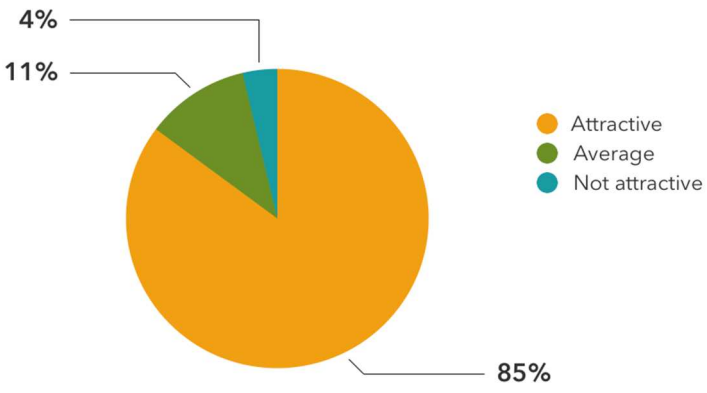


Figure 6.34 UI Aesthetic Feedback.

6.5.2 User Friendliness

The ease of learning and using the application was tested by potential users. 81% of the potential users indicated that the application was easy to learn and use, they managed to use the application without prior training. 15% indicated that the application was average meaning it was neither hard nor easy to learn or use, they needed the intervention of a trainer in some cases to confirm that what they were doing was right. The remaining 4% indicated that the application was difficult to use. Figure 6.35 shows a summary of the results.

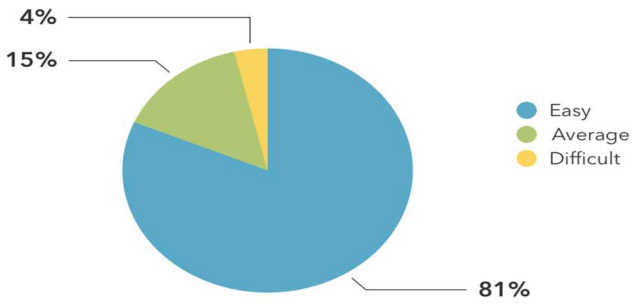


Figure 6.35 User Friendliness Feedback.

6.5.3 Functionality

The end users of the application tested the system functionality against the user specifications. 89% of them indicated was the application's functionality was good meaning that the developer achieved most of the user functionality and requirements specification, 7 % indicated that the application's functionality was fair meaning that some of the user specifications were not entirely meet, and the remaining 4% indicated that the application functionality did not meet the intended purpose of the application. This result was used to refine the prototype until an acceptable application was developed. A summary of the results is shown in Figure 6.36 below.

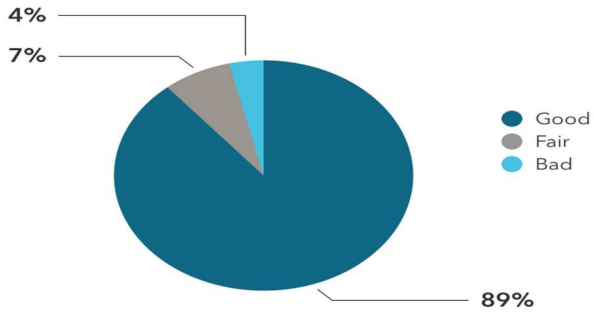


Figure 6.36 Test Results on Functionality of the Mobile Application.

6.5.4 Acceptability

To measure if the application was great success user acceptance was tested. 93% of the potential users readily accepted the application for use in dissemination of information by police while the remaining 7% were undecided. Since majority of the users readily accepted the application this test was a great success. Figure 6.37 provides a summary of these results.

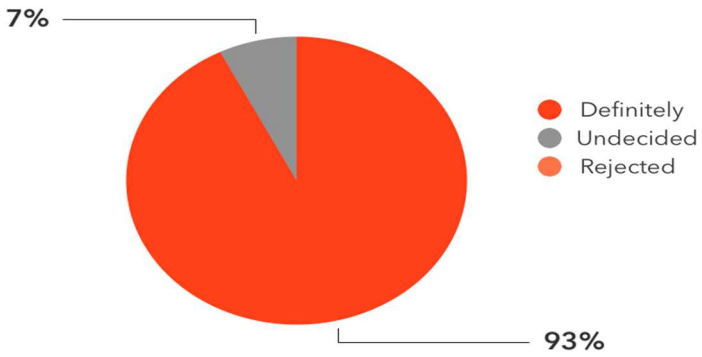


Figure 6.37 Acceptability Feedback.

6.5.5 Validation

Validation was done to ascertain whether the implementation addressed the challenges that were raised as far as ordering of farm inputs and selling of farm produce was concerned. An online questionnaire (Appendix A) was designed and sent to end users to test the applicability of the developed mobile application in ordering farm inputs and selling farm produce. 19% of the respondents were from Eldoret produce market, 37% were farmers from Kabongwa and Burnt Forest villages. Agrovets who use the application were 19% and the team leaders were 19% and the other 26% were staff and county government officials. This is shown in Figure 6.38 below.

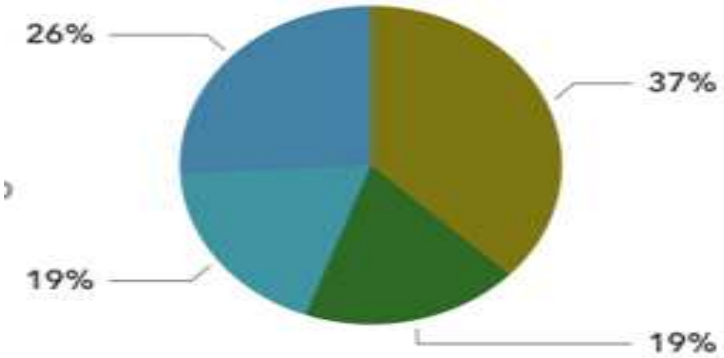


Figure 6.38 Applicability Test Respondents Categories.

All the respondents who participated in the validation testing also participated in survey to collect user requirements and the usability test of the mobile application as shown in Figure 6.39 below. The respondents were asked to state whether they participated in the above-mentioned survey and tests.

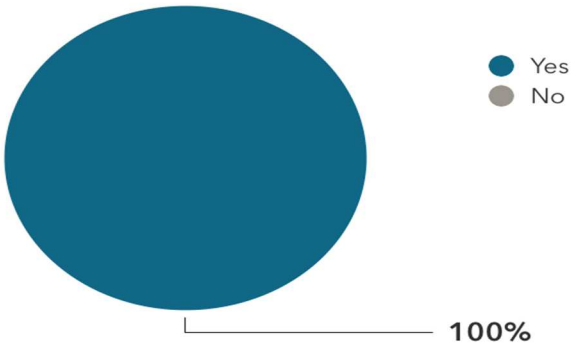


Figure 6.39 Participation in User Requirements Survey and Usability Testing.

The respondents were asked to indicate if the functionalities provided by the mobile application fully solves the problems posed by the current techniques ordering farm inputs and selling farm produce. 80% of the respondents indicated that the functionalities provided by the mobile application fully solves the problems that are currently posed by the process of ordering farm inputs and selling farm produce while the other 20% stated that it partially solves the challenges. This is shown in Figure 6.40 below.

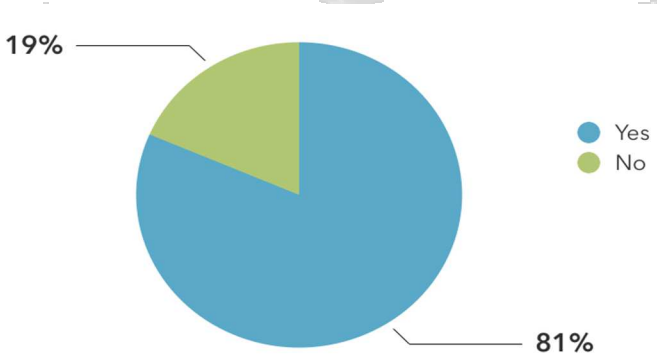


Figure 6.40 Does the Mobile Application Solve the Challenges.

The respondents who indicated that the functionalities provided by the mobile application fully solve the problems posed by the current techniques for ordering farm inputs and selling farm produce were further asked to state some of the key functionalities of the mobile

application that provides solution to the current problems in ordering farm inputs and selling farm produce.

Some of the functionalities that the respondents stated as very key in the mobile application as far as ordering farm inputs and selling farm produce is concerned included the functionality for the farmers to order farm inputs. The other functionality that the respondents stated was the functionality upload farm produce to the application whenever ready. This was very important to the respondents as it involved submitting the details of the orders of farm inputs and those of farm produce, which eventually would ensure excellent service delivery to the farmers.

They also stated that the application provides instant notification alerts on new products and therefore eliminates the time-consuming process of manual learning of new farm products in the market. Several farmers also indicated that the ability to place farm input orders from your farm using a mobile phone eliminates the tedious and tiresome process of travelling to towns to get the farm inputs and transport costs. In addition, the farmers indicated that the mobile application has also eliminated the high cost incurred in manual search for markets and even brokers by allowing farm products to be uploaded in the farm produce shop.

The respondents were also asked to indicate if they were satisfied with the solutions provided by the mobile application for solving problems ordering farm inputs and selling farm produce, and 67% of them expressed their satisfaction as indicated in figure 6.41 below.

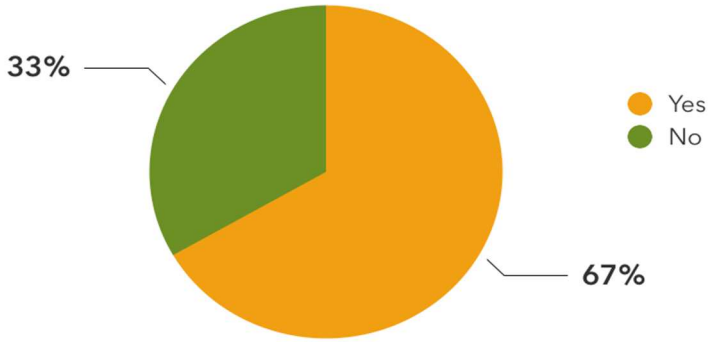


Figure 6.41 User Satisfaction on the Functionalities.

Finally, the respondents were asked if they would recommend the mobile application to be adopted especially by farmers as an application solution to current challenges encountered in ordering farm inputs and selling farm produce, and 85% of them indicated their confidence in the applicability of the mobile application in ordering farm inputs and selling farm produce and recommended that the application should be adopted by the farmers and consumers as a solution to solve the current problems faced by the current systems ordering farm inputs and selling farm produce. This is shown in figure 6.42 below.

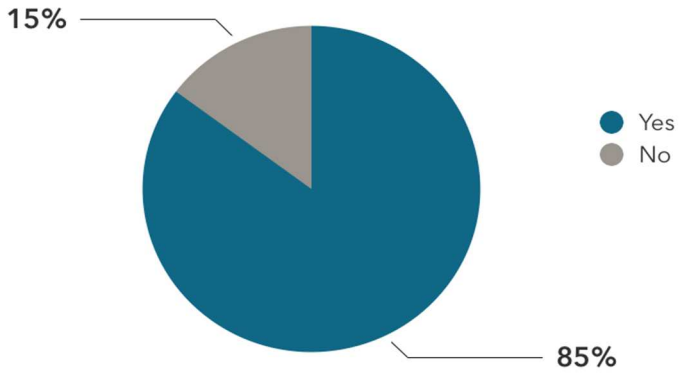


Figure 6.42 Recommendation on Adoption of the Mobile Application.

6.6 Conclusions

The system requirements formulated in the requirements gathering and analysis stage provided fundamental information that was used in system implementation. The system design provided details of how the system was implemented. The research objectives and questions were also put into consideration to ensure that the system was implemented to achieve user requirements provided by potential users. The overall development and implementation were done in adherence to the proposed objectives.

CHAPTER 7: DISCUSSION

7.1 Introduction

The objective of the research was to identify the current challenges facing the ordering of farm inputs and selling of farm produce, to investigate the current techniques used for the ordering of farm inputs and selling of farm produce, to design, develop and test a mobile application for the ordering of farm inputs and selling of farm produce and to validate that the mobile application for the ordering of farm inputs and selling of farm produce solves the challenges faced using the current techniques for the ordering of farm inputs and selling of farm produce.

This was to identify and develop a suitable technique that will be adopted to address the current challenges faced in the ordering of farm inputs and selling of farm produce. The research findings helped classify the appropriate method which was utilised and a mobile and a web application that solves the current challenges in the ordering of farm inputs and selling of farm produce were developed. By providing a mobile and web application for the ordering of farm inputs and selling of farm produce was made easier, accessible, affordable and efficient.

The mobile application was developed for use by the farmers who had access to a data enabled phone with a GPS, sim card and running an Android operating system with major focus in two villages in Uasin Gishu county. The web application was developed for management by system administrators and could be accessed using a standalone computer, laptop or mobile device. This chapter describes research findings and achievements, how research objectives were obtained, and it also provides a review of the application developed citing advantages and limitations of the developed application.

7.2 Findings

A study of the literature showed that the techniques used in the ordering of farm inputs and selling of farm produce include iCOW, M-Farm, Mkulima Young, M-PESA, Airtel-Money, T-Kash, Forum for Agricultural Research in Africa's (FARA) Regional Agricultural Information and Learning Systems e-RAILS, Variable Rate application Technology (VRT), E-Pest Management Systems- Integrated Pest Management (IPM) Systems and Agri-hubs. iCOW addresses only the gestation period problem and not the ordering of farm input and selling of farm produce. The mobile money: M-PESA, Airtel-Money, T-Kash also assists farmers access money incase banks are not within their reach.

Mobile money technology however does not resolve the problem of farm input supply and sell of farm produce. It however formed an important part of the solution as we will use to make payments for both farm input orders and for farm produce.

FARA's eRAILS does not offer a solution to farmers input ordering and sell of farm produce as it is more of a knowledge sharing and research across Africa.

Variable rate technology (VRT) has potential to improve input efficiency, field profitability, and environmental stewardship through soil monitoring and yield monitoring. The problem farmers face however in ordering farm inputs and selling farm produce is not addressed by this.

E-Pest Management Systems- Integrated Pest Management (IPM) Systems uses a systems approach to reduce pest damage and to tolerable levels through a variety of techniques, including natural predators, pathogens, parasites, genetically resistant hosts, environmental modifications, and, when necessary and appropriate, chemical pesticides. This does not address the problem farmers face in farm input ordering and sell of farm produce

Agri-hubs which has several e-services for farmer groups, a model that was developed to provide a conduit through which extension services can be provided for small-scale farmers, however, does not fulfill the making of farm input orders and sell of farm produce by farmers.

7.3 Achievements

The unified farm input shop and farm produce shop in the system is the most appropriate technique for the ordering of farm inputs and selling farm produce as it is accessible, affordable and efficient. However, at present, there is no one stop mobile application that a farmer can do both ordering of farm inputs and sell farm produce.

This research will, therefore, improve the techniques for making farm input orders and selling of farm produce by implementing a mobile application for ordering farm inputs and selling farm produce. Using a mobile application will maximise the advantages of mobile phones and bridge its gaps and limitations by providing an easy application for making farm input orders and selling farm produce. The respondents were drawn from Kabongwa and Burnt Forest Villages in Uasin Gishu county, farmers drawn from the Eldoret farm produce market, Maraba investment staff and team leads in the county.

37% were farmers from the two villages who do the farm input ordering and sell far produce every year, and 19% were sale representatives from Maraba, and 26% were farmers within the Eldoret farm produce market and 18 % were the team leads. A total of 60% of respondents had been ordering farm inputs and selling farm produce for over 3 years, indicating that the quality of respondents was good as most of them had participated in the process of ordering farm inputs and selling farm produce.

All the respondents owned smartphones, of which, 85% had Android operating system and the other 20% had a mixture of iPhone and Windows phones. Since most of the respondents had smartphones with the Android operating system, Android was the preferred platform for the implementation of the proposed solution.

There was no automated system and a one stop shop for making farm input orders and selling of farm produce and the existing methods, as drawn out from the review did not solve the challenges faced in making farm input orders and selling farm produce. Challenges faced in the current systems include: time wastage in the travel looking for inputs and markets, the cost incurred in both fare and transport, the cost increase due to brokers and the process is tiresome.

After providing a brief description of the mobile application, 80% of the respondents agreed that a mobile phone application would be the viable solution for the ordering of farm inputs and selling of farm produce and would solve most of the challenges experienced in the making of farm input orders and selling of farm produce.

Based on the above-mentioned findings, an application for ordering farm inputs and selling farm produce was designed and developed. It comprises an Android mobile application and a web application. The Android mobile application is used to place farm input orders and sell farm produce while the web application is used for farm input upload, orders administration, push notifications, publishing farm produce, and user management. Features of the application include account control, shops for both farm inputs and farm outputs, product details, checkout, product notifications and confirm order pages.

The application successfully passed the functional and user testing. In user testing a cumulative of 96% of the respondents stated that the application was attractive and useful and 81% of the respondents indicated that the application was easy to use. Also, 89% of the respondents showed that the applications' functionality was great and satisfactory, and the application was successfully accepted by 93% of the respondents.

7.4 Review of Research Objectives about the Mobile Application

This dissertation identifies the challenges faced in the ordering of farm inputs and selling of farm produce. A mobile and web application was designed and developed with a selected technique from the literature review and results from system analysis. The research objectives acted as a guideline to develop the mobile and web application.

The first objective was to identify the challenges faced in the ordering of farm inputs and selling of farm produce. This objective was achieved using an online questionnaire provided in Appendix B and Appendix C. Analysis of the responded feedback yielded to the following challenges: time wastage, non-quality inputs, expensive, and brokers hiked prices in both farm produce market and farm input supply. The mobile and web application was developed to address the mentioned challenges.

The second objective was to investigate the ordering of farm inputs and selling of farm produce This information was useful as it enabled the researcher to gain an understanding of the techniques used and identify the strengths and weaknesses of each technique hence choosing the best technique to be adopted. This objective was achieved by the review of literature based on the current techniques for ordering of farm inputs and selling of farm produce used globally. Available techniques include the use of iCOW, Mobile Money, M-Farm, Mkulima Young, variable rate technology, e-RAILS, E-Pest management, agri-hubs and Integrated pest management (IPM). Based on the information gathered and requirements provided by the respondents, a mobile application for the ordering of farm inputs and selling of farm produce emerged the best to address the current challenges.

The third objective was to design, develop and test a mobile-based solution for the ordering of farm inputs and selling farm produce. This objective was achieved through the design, implementation, and testing of the mobile and web application. The mobile application was developed for the Android platform while the web application was developed using the CodeIgniter 3.1.8 framework. The following tests were carried out; integration testing, load testing and functional testing where the system functionality was tested. Also, compatibility testing where the mobile application was tested against different Android versions and the web application was tested against different web browsers and finally user testing where the aesthetics, user-friendliness, application functionality and user acceptance were tested.

The fourth objective was to validate that the mobile application for ordering farm inputs and selling farm produce solves the challenges faced using the current techniques for ordering

farm inputs and selling farm produce. This objective was achieved using an online questionnaire (In Appendix E). The respondents were requested to state whether the functionalities provided in the mobile applications were providing solutions to the challenges currently faced in the ordering of farm inputs and selling of farm produce and if they were satisfied with the mobile applications as the solution in the ordering of farm inputs and selling of farm produce. Also, if they would recommend the mobile application to be adopted for the ordering of farm inputs and selling of farm produce in the farming sector. 80% of the respondents indicated that the features provided in the mobile application provide solutions to the challenges faced in ordering of farm inputs and selling of farm produce, 60% indicated that they were satisfied with the solution provided with mobile application to be used as a solution to ordering of farm inputs and selling of farm produce and 80% indicated that they would recommend the mobile application to be used for ordering of farm produce and selling of farm produce in the agricultural sector.

7.5 Review of the Application in Relation to the Current Methods

The proposed system is an Android application and web application for the ordering of farm inputs and selling of farm produce.

7.5.1 Advantages of the Application

i. The application is so simple to use and straightforward.
ii. The application can easily be adopted by users of all levels of education and technological backgrounds.
iii. This application is free; it makes it possible for anyone to use it at no cost provided they have internet.
iv. The application also incorporates a web application that makes it easier for the administrator and to store and manipulate data seen in the mobile application.

7.5.2 Limitations of the Application

i. The mobile application is only usable by smartphone owners with an Android operating system.
ii. Some information on the mobile application and the entire web application need the Internet for one to access them.

CHAPTER 8: CONCLUSIONS, RECOMMENDATIONS AND FUTURE WORK

8.1 Conclusions

Information about ordering of farm inputs and selling of farm produce was reviewed. From analysis carried out, the results pointed out that there are major problems in the ordering of farm inputs and selling of farm produce.

The result was the development of a mobile application and a web platform for ordering of farm inputs and selling of farm produce. The key features of the application include: making farm input orders, selling farm produce, checking out, confirming orders, suggesting products, editing user profile and receiving notifications about new products.

The application was aimed at fast and easy process of ordering farm inputs and selling farm produce, elimination of costs for many market players in the supply chain and receiving alerts and notifications of new farm produce and farm inputs in the market. System testing was performed, look and feel, ease of use, system functionality and acceptance was done.

8.2 Recommendations

A one stop shop mobile application for ordering of farm inputs and selling farm produce is very important since it saves the farmer financial losses that result from usage of expensive current techniques of ordering farm inputs including travel and transport costs whilst enabling direct market access for farm produce and getting quality farm inputs.

Therefore, my recommendations for the application to work better is, firstly, the farm input manufacturers subscribe and upload their products with their prices in to the mobile application, the farmers to adopt the application and get direct access to cheap quality farm inputs. Secondly, farmers to upload their farm produce on the application with their desired prices and administrator to verify the farm produce and publish for the market at the farm produce shop feature in the application.

Finally, the county government to adopt the same as it helps in knowing what the farmers will grow, their capacity and the market to facilitate improved food security in the both the county and the country at large.

8.3 Future Work

i. The weaknesses and limitations of the proposed solution in the research study have indicated the following areas as recommendations for further work.

ii. The application should add a model for farmers to create farm reports.

iii. The application should be developed for other mobile platforms to allow farmers and users with phones other than Android to access the application's functionality.

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APPENDICES

Appendix A: Supply of Farm Inputs and Farm Produce Questionnaire

Supply of Farm Inputs and Farm Produce Questionnaire

Part A: Agricultural Input Supply Chain Survey

You are invited to participate in a research study investigating the implementation of a prototype for making orders for farm inputs and outputs plus selling farm produce using Mobile Application Technology.

The information collected through your participation will be purely used for academic purposes.

1. What is your name? (Optional)

2. Which farming do you do?

o Crop farming o Livestock Farming o Mixed Farming o Other

If other, please specify

3. Do you make orders for farm inputs?

o Yes o No

4. Do you sell farm produce?

o Yes o No

If yes, where is your major market?

o Rural

o Urban

o Formal

o Informal

5. Which technique do you to order farm inputs?

o Agrovets o Suppliers o Re-cycle o Online shops

6. Describe the process for ordering farm inputs

……

……

7. How long does it take (in terms of number of hours) to get inputs using the current methods? …….

8. How much do you pay (in KES) to get farm inputs using the current methods?

…….

9. Have you ever had cases where farm inputs fail to arrive on time?

o Yes o No

If yes, how often do you experience this and why?

……

……

10. What are some of the challenges you experience with the current methods of selling farm produce?

……..

……

……

Part B: Agricultural Produce Supply Chain Survey

You are invited to participate in a research study investigating the implementation of a prototype for making orders for farm inputs and outputs plus selling farm produce using Mobile Application Technology.

The information collected through your participation will be purely used for academic purposes

1. What is your name? (Optional)

2. Which category best describes you? *

o Subsistent Farmer o Commercial Farmer

If other, please specify

3. Which technique do you use to receive information about new products in the market?

o Radio o Television o Newspapers and Magazines o Social Media o Others

4. What are some of the challenges you experience with the current methods of receiving information about new agricultural products? *

…….

…….

……

5. Do you own a smartphone? *

o Yes o No

6. If yes, which operating system does your phone have? *

o Android

o IOS

o Windows

o Blackberry

o Other

7. Do you use other mobile applications apart from calling and messaging? *

o Yes o No

If yes, name 3 applications that you use mostly *

…….

……

……

8. Do you think a mobile application will solve the mentioned challenges? *

o Yes o No

9. What features do you think the application should have?

……

……

……

Part C: User Testing Questionnaire for making farm input orders and selling farm produce

1. Did you manage to perform the following task? (Indicate Yes or No)

a) Create account o Yes o No

b) Publish and Delete orders (only for system administrators) o Yes o No

c) Update products details (only for system administrators) o Yes o No

d) Login and logout o Yes o No

e) View recent notifications about products? o Yes o No

f) Search specific products on the application? o Yes o No

g) Share the mobile application with your peers? o Yes o No

h) Edit your profile information? o Yes o No

2. How did you find the user interface of the mobile and web application based on its look and feel?

o Attractive

o Average

o Not attractive

3. Rate the mobile and web application based on whether the application was easy to learn as a first-time user and ease of using the application

o Easy o Average o Difficult

4. Rate the system functionality based on whether it met the user requirements (functionality) o Good o Fair o Bad

5. Would you accept the system for making input orders and selling farm produce?

o Definitely o Undecided o Rejected

Part D: Validation Questionnaire

Mobile Application for Making farm input orders and selling farm produce validation Test

1. Which category best describes you?

o Farmer o Consumer o Agricultural products Dealer

2. What is the name of your premises? (Optional)

.....

3. Did you take part in the user testing of the mobile application for making farm input orders and selling farm produce?

o Yes o No

4. If Yes, Does the functionalities provided by the mobile application solve the problems posed by the current systems for acquiring farm inputs and selling farm produce?

o Yes o No

5. What are some of the key functionalities of the mobile application that provides solution to the current problems acquiring farm inputs and selling farm produce?

……
…

……
…

……
…

6. Are you satisfied with the solutions provided by the mobile application as far as acquisition of farm inputs and selling of farm produce is concerned?

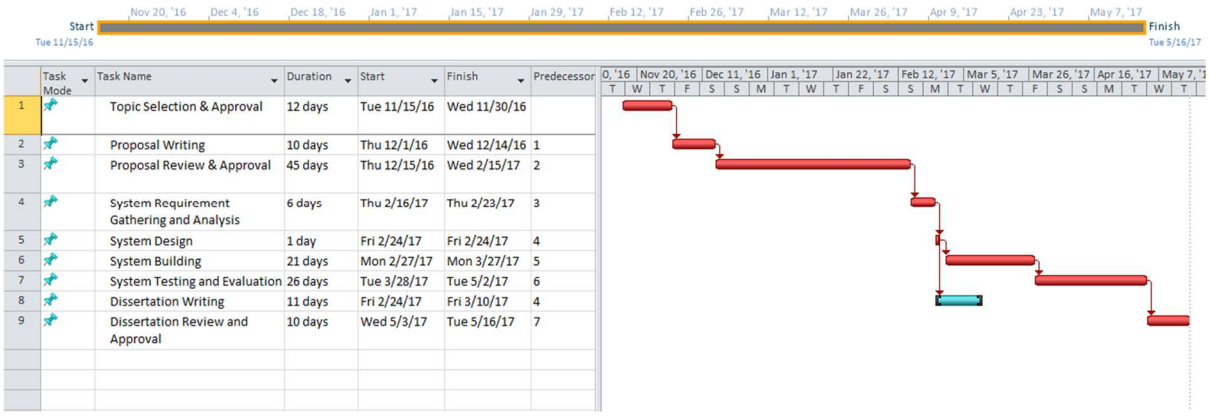
o Yes o No

7. Would you recommend that the mobile application be adopted by all farmers as a solution to the current challenges in acquiring farm inputs and selling farm produce?

o Yes o No

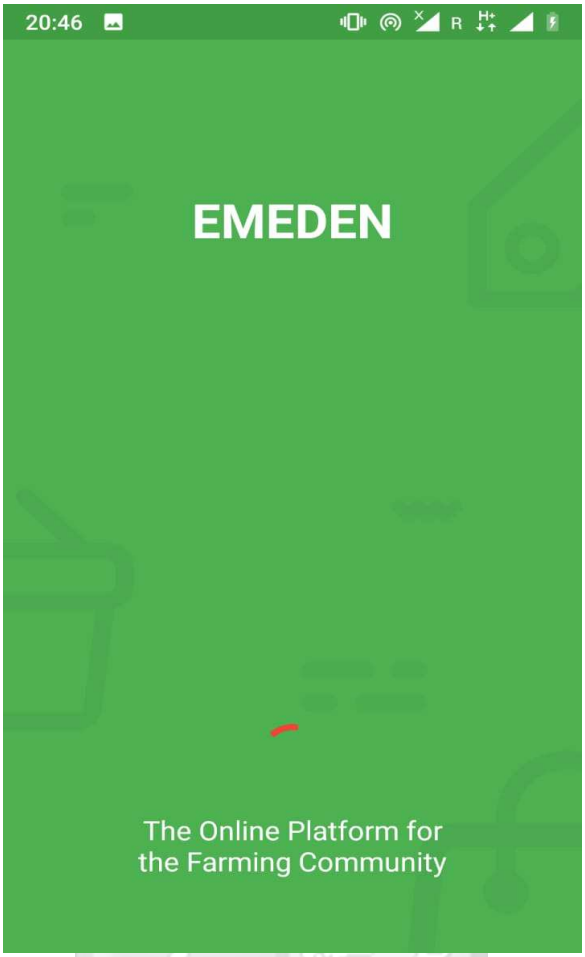
8. Is there any other functionality that you think will be useful in ordering farm inputs and selling farm produce?

Appendix B: Gantt Chart

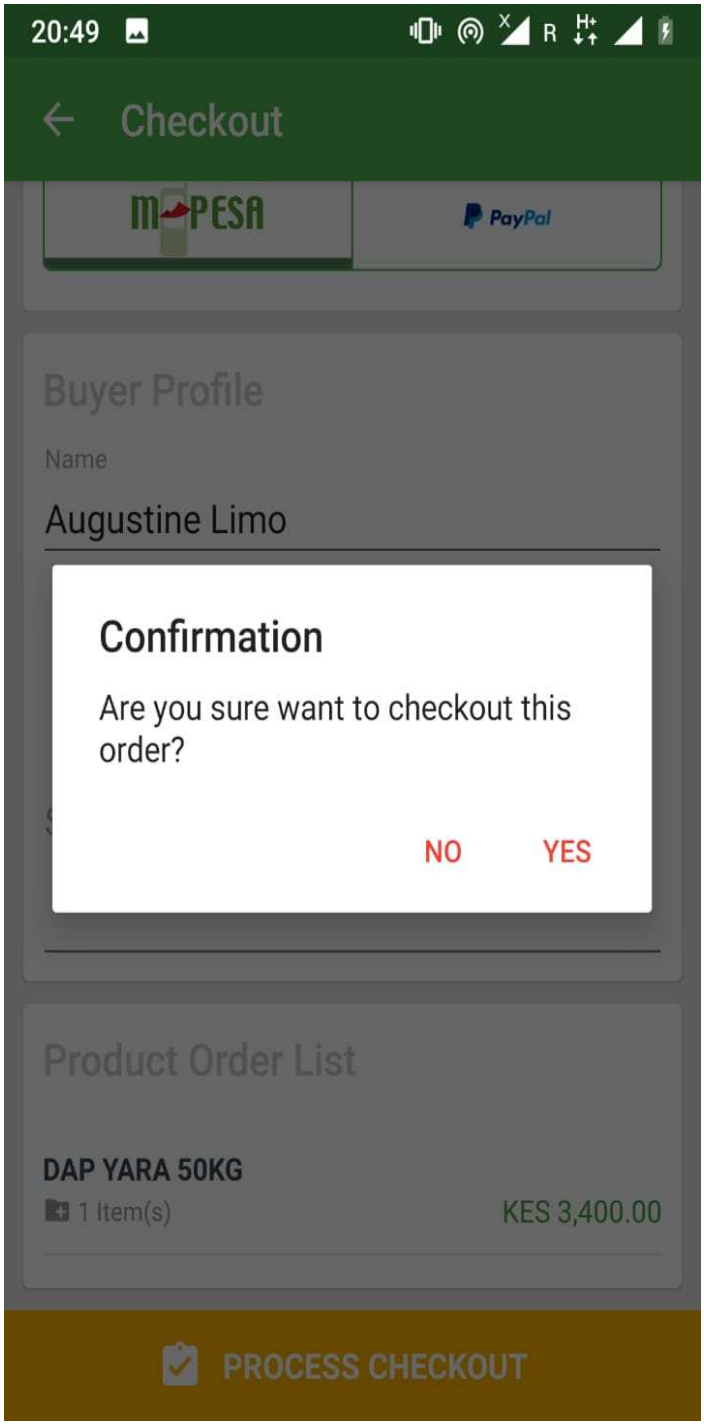


	Task Mode	Task Name	Duration	Start	Finish	Predecessor
1		Topic Selection & Approval	12 days	Tue 11/15/16	Wed 11/30/16	
2		Proposal Writing	10 days	Thu 12/1/16	Wed 12/14/16	1
3		Proposal Review & Approval	45 days	Thu 12/15/16	Wed 2/15/17	2
4		System Requirement Gathering and Analysis	6 days	Thu 2/16/17	Thu 2/23/17	3
5		System Design	1 day	Fri 2/24/17	Fri 2/24/17	4
6		System Building	21 days	Mon 2/27/17	Mon 3/27/17	5
7		System Testing and Evaluation	26 days	Tue 3/28/17	Tue 5/2/17	6
8		Dissertation Writing	11 days	Fri 2/24/17	Fri 3/10/17	4
9		Dissertation Review and Approval	10 days	Wed 5/3/17	Tue 5/16/17	7

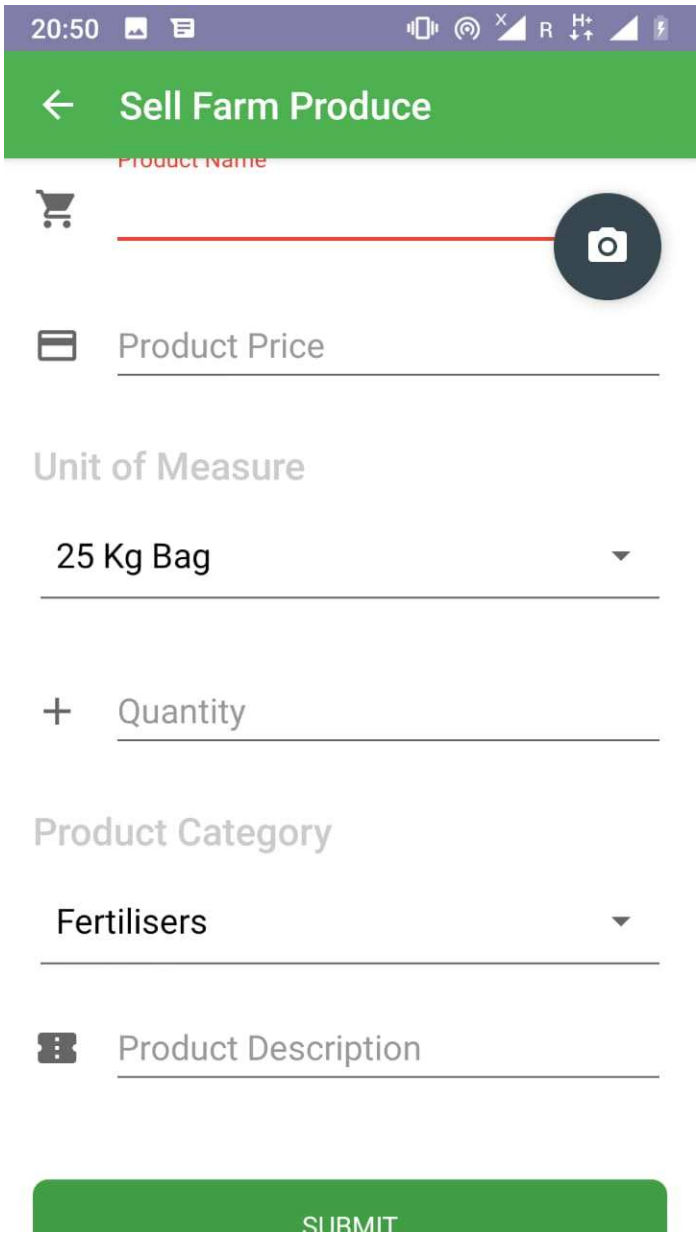
Appendix C: Opening Mobile Application



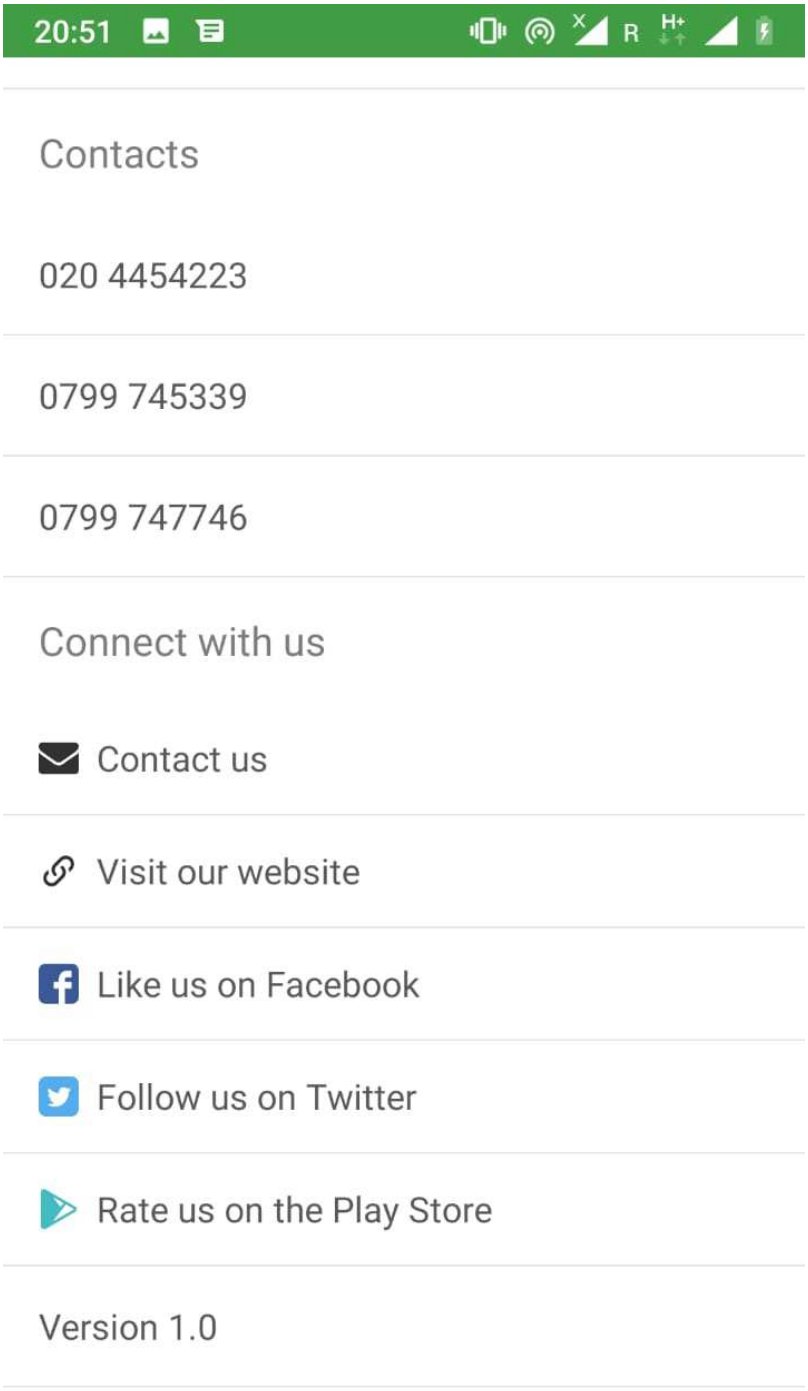
Appendix D: Confirming Order



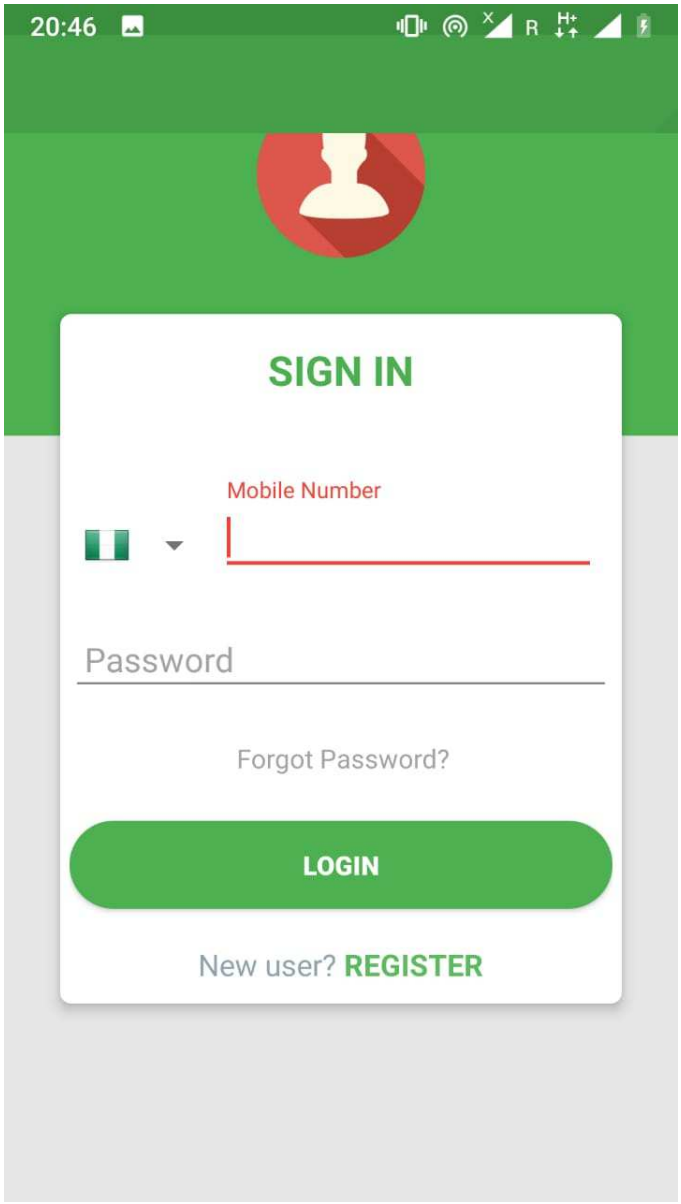
Appendix E: Adding a New Farm Product Using the Mobile Application



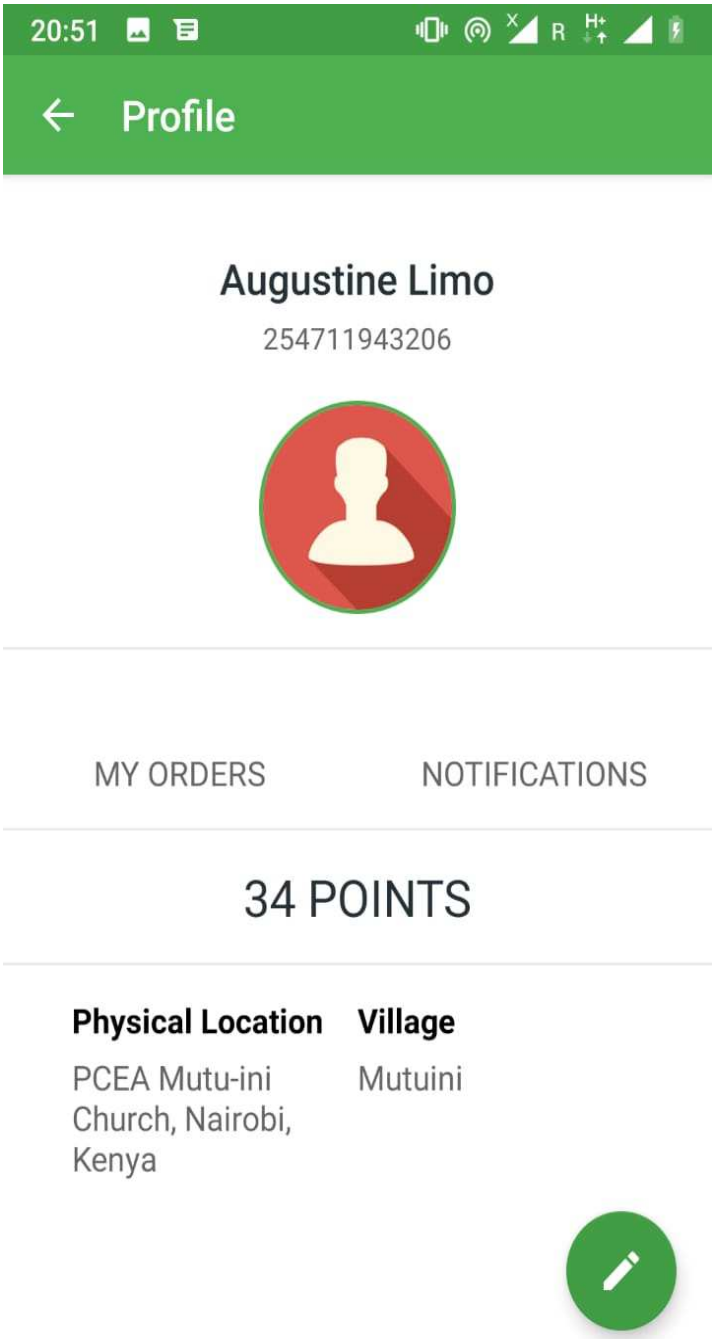
Appendix F: Contact Us Page on the Mobile Application



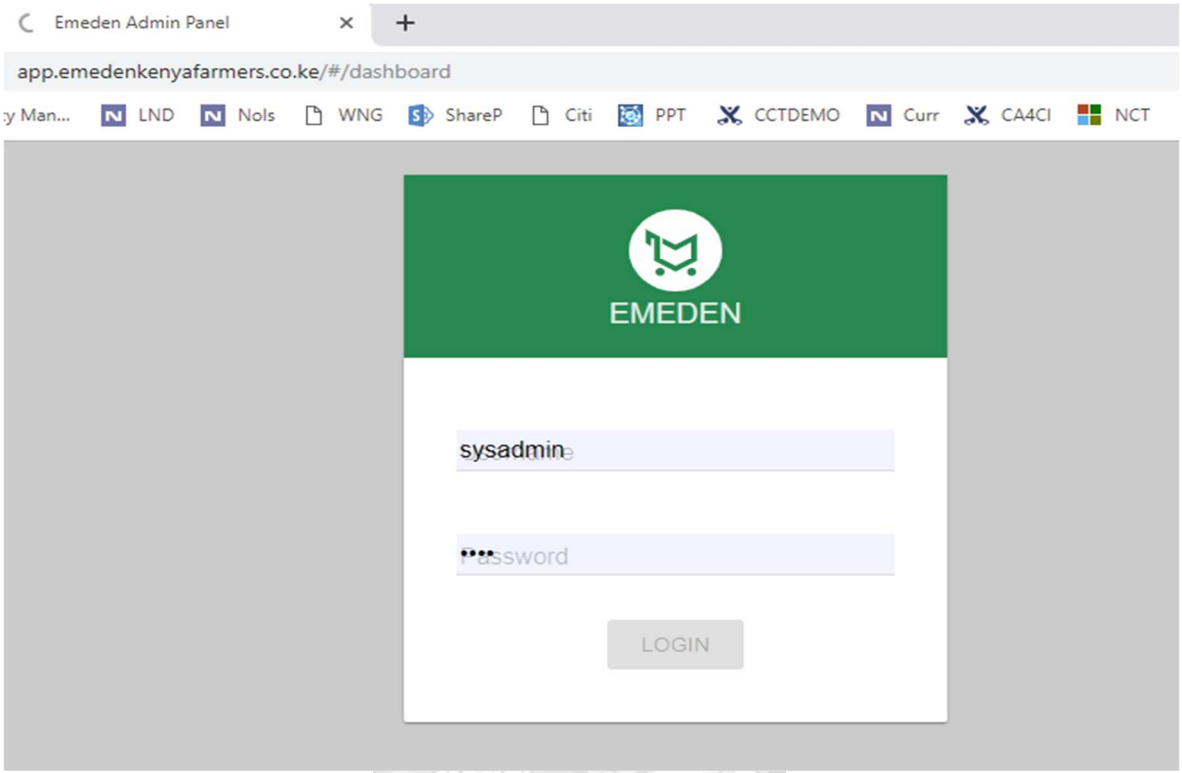
Appendix G: Farmers Login on the Mobile Application



Appendix H: List of Details on User Profile



Appendix I: Web Application Login Screen



Appendix J: Turnitin Report