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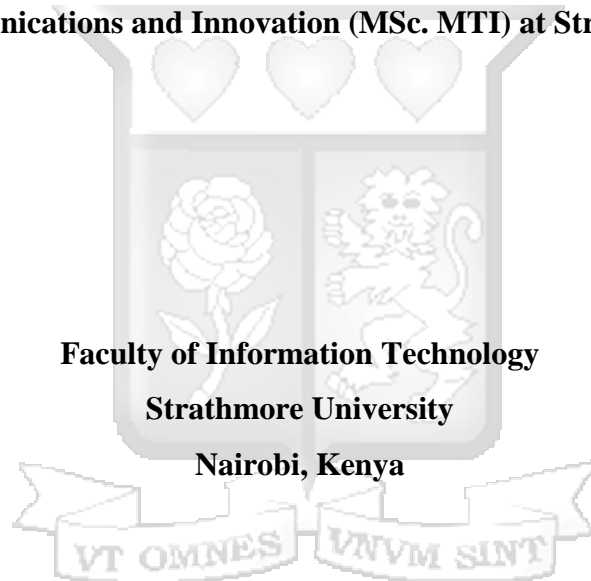
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**A MOBILE BASED MARKETING INFORMATION SYSTEM FOR FARMERS
AND BUYERS IN KENYA**

Brian Kipchumba Karoney

**Submitted in partial fulfillment of the requirements for the Degree of Master of Science in
Mobile Telecommunications and Innovation (MSc. MTI) at Strathmore University**



**Faculty of Information Technology
Strathmore University
Nairobi, Kenya**

June, 2016

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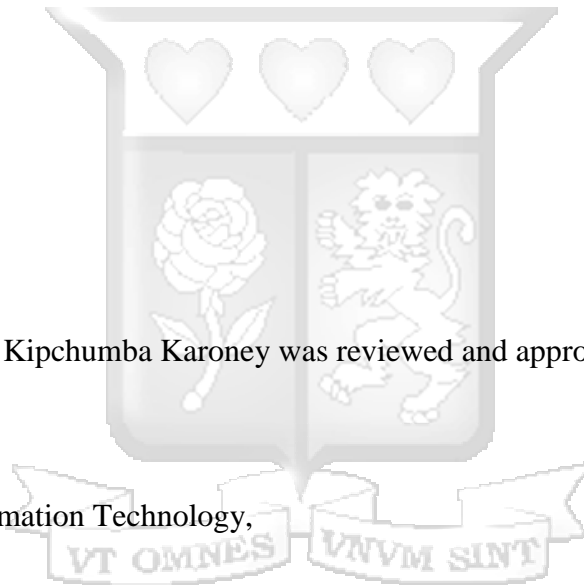
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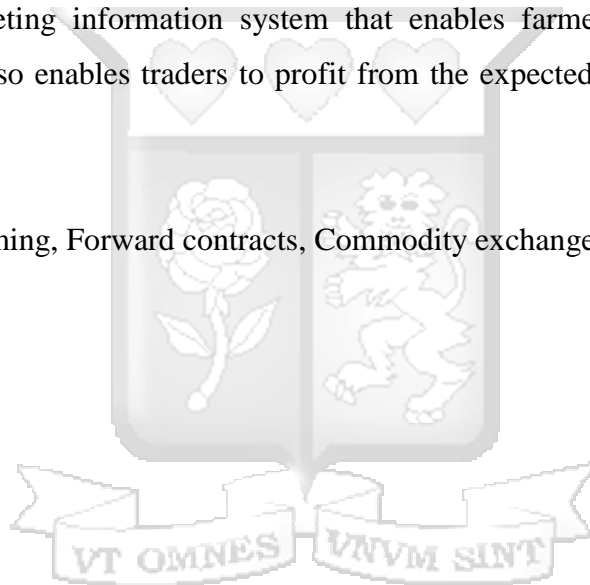
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ABSTRACT

Agricultural marketing information systems in Kenya have traditionally addressed the accessibility to pricing information, overlooking the fluctuation of market prices. This dissertation investigates a mobile based marketing information system that integrates contract farming as a means of mitigating the risk of price fluctuations in agricultural markets. The results of this study reveal that farmers continue to make losses despite usage of existing market information systems. Data collected implies that farmers and traders would prefer to trade using marketing information systems that provide mechanisms for hedging against fluctuating prices of agricultural commodities. Similarly, responses from traders indicate that profits are obtained through speculation on price movements. With these findings, the researcher developed a mobile based agricultural marketing information system that enables farmers and buyers to secure acceptable prices, and also enables traders to profit from the expected price fluctuations across agricultural products.

Keywords: Contract farming, Forward contracts, Commodity exchange.



DEDICATION

I dedicate this work to my parents Sammy and Loice Karoney, and my siblings Lyndsey, Celestine, Dr. Mercy and Carol.



ACKNOWLEDGEMENT

I would like to express my deepest appreciation to all those who facilitated my completion of this dissertation project. A special gratitude, I give to my supervisor Dr. Vitalis Ozanyi for his continued support and guidance throughout the progress of this dissertation. I would like to thank my colleagues for their input, peer reviews and criticisms during the drafting of this dissertation. Additionally I would like to recognize with much appreciation the vital role of my friends particularly Janet Bett and Kennedy Mukhwana for their unceasing support and encouragement. I am extremely thankful to my family for their moral support and encouragement in the duration of this study. Finally, to all and sundry who assisted directly or indirectly in the development of this dissertation, I extend to you my heartfelt gratitude.



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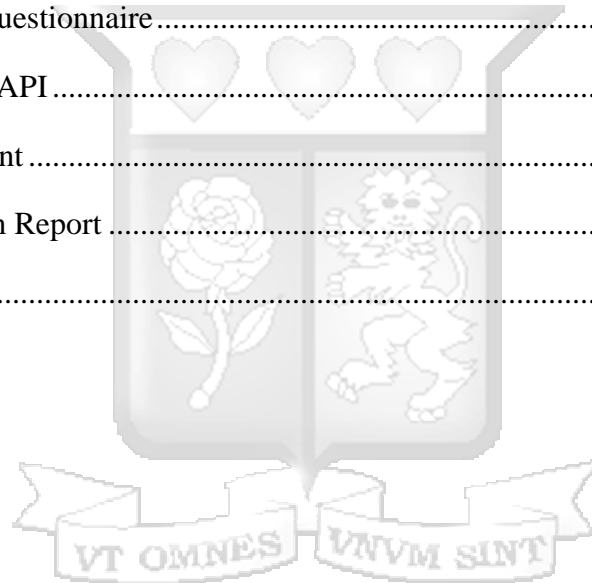
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ABBREVIATIONS

AJAX-Asynchronous Javascript and XML

API-Application Programming Interface

EPACC- Electronic Platform for Agricultural Commodities and Contracts

ECX- Ethiopian Commodity Exchange

GSM- Global System for Mobile communications

HTTP- Hypertext transfer protocol

IPN- Instant payment notifications

KACE- Kenya Agricultural Commodity Exchange

MIS- Marketing information System

OTC- Over the Counter

REST- Representational State Transfer

RFQ- Request for quotations

SDP- Service Delivery Platform

SMS- Short Message Service

SOA- Services Oriented Architecture

SOAP- Simple Object Access Protocol

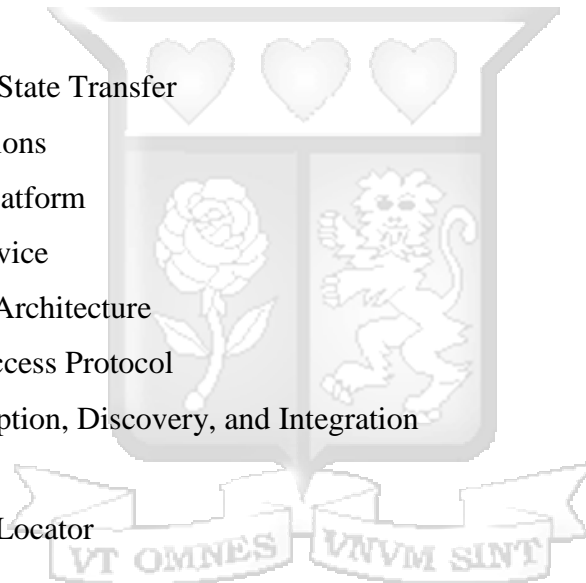
UDDI - Universal Description, Discovery, and Integration

UI- User Interface

URL-Uniform Resource Locator

UX- User Experience

WSDL- Web Services Description Language



DEFINITION OF TERMS

Commodity Exchange- A market place where products and their derivatives (e.g. financial assets, crude oil), are traded (Chatnani, 2012).

Contract Farming- An agreement in which farmers commit to supply a particular quantity and quality of a specified agricultural product at particular time in future, and in return, buyers commit to purchase the product (Will, 2013).

Forward Contract- An agreement between a buyer and farmer which the buyer chooses to offset his/her obligations to another buyer for a fee (margin) (Damodaran, 2002).



CHAPTER 1: INTRODUCTION

1.1 Background to the Research

Inaccessibility of market information is a problem faced by several farmers in Sub-Saharan Africa despite several decades of capacity building and development (IFAD, 2003). IFAD reports that inaccessibility of well-functioning markets is a major factor contributing to low incomes in agriculture. This results in poverty in the region as agriculture is the prevailing economic activity. In East Africa, several Marketing Information Systems (MIS) have been established to increase market transparency and provide price information to farmers in isolated rural locations (Zoltner, 2013).

According to Zoltner (2013), Agricultural Market Information Systems in East Africa were developed to provide farmers who lack contact with buyers and other elements in the value chain, with access to relevant market information. Objectively, the information systems were intended to eliminate the intermediaries who had traditionally taken advantage of the farmers' price ignorance. With increased affordability and accessibility to mobile phone networks, the market information systems in Africa enjoyed rapid growth due to accessible data collection and disbursement channels.

In Kenya, the leading information systems include Mfarm, Esoko and Regional Agriculture Trade Intelligence Network (RATIN) (Zoltner, 2013). These information systems provide market price services and agriculturally related information such as farming techniques, weather, pest information, financing options and sources of input. In addition to basic buying and selling functions, the platforms have diverse business models. For example due to the increasingly regional nature of agricultural trade, RATINs functionality is extended to monitor cross border trade movement. Some marketing information systems are private, others government in some cases a private/government partnership. Collectively, they seek an alternative approach to improving affordable access to price information to traders, small holder farmers and decision makers.

As a common feature, the agricultural market information systems implemented in Kenya and East Africa offer price information services as their core business. Increased access to mobile phones and demand for mobile-based market information, has contributed to their continued growth in Kenya and East Africa at large. However, Zoltner (2013), suggests that sustainability of these platforms are dependent on their capacity to increase income for the actors i.e. traders and smallholder farmers, by providing accurate and useful price services that create value for farmers. In an increasingly competitive agribusiness sector, pricing information does not always create value for farmers especially in cases of falling prices.

Principally, market information systems implemented in Kenya and the larger East Africa, address the lack of access to price information. The focus on pricing information provides a useful tool when farmers are selling produce in spot markets. However, this bias overlooks the risk of price fluctuations. While pricing information may inform the farmers on the best prices, it does not protect them from unpredictable fluctuations of these market prices.

Price fluctuations in agricultural commodity markets occurs as a result of several factors. According to Bäckman and Sumelius (2009), the factors can be characterized in two distinct groups, demand and supply factors. Demand factors include price of energy, consumer habits and population growth. Supply factors constitute input factors i.e. water and soil quality, weather, climatic conditions, technological development, public institutions and policies, and infrastructure. Generally the demand and supply factors affect prices of commodities.

In addition to this, Nzomoi (2008) suggests political instability is also a factor causing increased prices in Kenya. By citing the post-election violence of 2007, Nzomoi (2008) explains that due to disruption of agricultural activities and distribution chains during the political unrest, prices of essential commodities increased. The increase of more than 50% made it difficult for Kenyans to afford three meals a day. Nzomoi (2008) identifies Kenyan staple foods as commodities most affected by price fluctuations; these include milk, bread (wheat), maize, rice and sugar.

In seeking protection from price fluctuations, farmers and buyers have adopted contract farming, which involves farmers cultivating and harvesting for and on behalf of bigger business

establishments or government agencies (Chatnani, 2012). Typically, contract farming agreements involve buyers and sellers entering contractual obligations to be fulfilled at some time in the future (Will, 2013). By entering a farming contract, buyers guarantee a supply of produce of a particular quantity and quality of commodity at their desired time (Weiss & Khan, 2006). Similarly, sellers (farmers) guarantee a source of market for their produce before actual production (Eaton & Shepherd, 2001).

Chatnani (2012) further suggests that in addition to reduced price risk, contract farming agreements create an opportunity for investment. Investors benefit from price fluctuations in the market through trading in commodity exchanges. By speculating the price movements of agricultural commodities in the market, investors may buy and sell contracts on the specific commodities gaining profit by selling at higher margins than purchased. Chatnani (2012) explains that the market place where the commodities and contracts are traded is known as a commodity exchange.

Within a commodity exchange, contract farming agreements are categorized as forwards and futures. Forwards and futures are characteristically similar in nature, however, forwards are traded over the counter (OTC) and delivery is made as per the farming contract terms whereas futures are traded in a standardized exchange regulated by an authority (Adams, Booth, Bowie, & Freeth, 2003).

1.2 Statement of the Problem

In Kenya, price volatility affects several agri-commodity markets, causing farmers great losses and prompting buyers to source cheaper commodity from foreign markets. Farmers experience challenges in accessing suitable outlets for their commodities at acceptable prices. While existing market information systems have provided a solution to accessing pricing information, price fluctuations continue to affect agricultural incomes.

In addition to this, buyers and manufacturers use contract farming to ensure a source of quality produce delivered at their preferred time and price per quantity. Typically, farmers' access to contract farming agreements is limited whereas buyers experience a tedious task in sourcing for

contractors. Moreover, the current market information systems in Kenya do not provide an opportunity for third party investors to benefit from price fluctuations in the market via trading in a commodity exchange.

1.3 Research Objectives

1. To identify data required for contract farming in Kenya
2. To identify existing agricultural market information systems in Kenya
3. To identify channels used in advertising contract farming in Kenya.
4. To design a mobile based marketing information system integrated with contract farming.
5. To develop and test mobile based marketing information system.

1.4 Research Questions

1. What data is necessary for contract farming in Kenya?
2. What are the existing agricultural market information systems in Kenya?
3. What channels are used in advertising contract farming in Kenya?
4. How can a mobile-based marketing information system be integrated with contract farming?
5. How can a mobile based marketing information system be validated?

1.5 Significance of the Study

The findings of this study will be significant to farmers and buyers in establishing the relationship that exists between a commodity exchange and the performance of the agribusiness sector. Specifically, the findings of this study will shed light on the problems creating poor market prices and subsequent loss of revenue.

The findings of the study will be significant to hedgers and speculators in understanding the agricultural sector before trading contracts on agricultural commodities within a commodity exchange. The study will also provide insights in market price discovery using spot markets. This research will provide a detailed report that can advise government, investors, buyers, farmers and other participants in the agricultural commodity value chain.

1.6 Scope and Delimitation of the Study

This study will be delimited to investigating the impact of introducing agricultural contracts in market information systems. The contracts highlighted in this study will only include forward contracts, which are traded over the counter (OTC) and not future contracts; traded in a formal commodity exchange. The study focuses on Kenya as it is in its infant stage of establishing its commodities exchange. The target will include farmers, buyers and manufacturers, and traders. The traders in this case will include hedgers and speculators.



CHAPTER 2: LITERATURE REVIEW

This chapter provides a brief overview of how commodity exchange platforms and marketing information systems operate. It briefly outlines contract farming highlighting its relationship to electronic trading in commodity exchanges. It describes the various commodity exchanges in the world, focusing on their models of e-trading platforms. It discusses the agricultural market information systems that have been implemented in Kenya to provide spot market pricing information. It discusses the features and limitations of existing marketing information systems. Based on the literature review, it gives a conclusion highlighting the research gap needed for an efficient commodity trading platform.

2.1 Contract Farming

The Food and Agriculture Organization of the United Nations (FAO) describes contract farming as an agreement in which the farmer commits to supply a particular quantity and quality of a specified agricultural product at particular time in future. In return, the buyer commits to purchase the product, and may even sponsor production. The buyer determines the time and date when the farmer should supply the agricultural produce; this is referred to as the maturity date of the contract (FAO, 2016).

Margret Will (2013) defines contract farming as forward agreements specifying the obligations of farmers and buyers in business. In the journal, *Contract Farming Handbook* (2013), Will outlines that contract farming agreements provide a legal framework in which farmers (sellers) are obliged to supply specified volumes and qualities of commodity whereas buyers (traders/processors) are obliged to off-take the produce and realize payment agreements. Over recent years, contract farming has experienced a surging growth in popularity by linking farmers to buyers and buyers to supply sources, in a progressively concentrated and competitive agri-business sector (Will, 2013).

Margret Will (2013) traces the history of contract farming to a mixture of several approaches around the world. Most notably, she reports that in developed countries contract farming agreements are more widely used with large-scale farms whereas in developing countries contracts have majorly been successful with smallholder farmers producing high value

commodity segments for export or local processing. Will recognizes traditional approaches to contract farming in which small-scale farmers link with village-level or medium-scale sponsors by means of informal contractual agreements.

2.1.1 Typical Contracts

According to Baumann (2000), agricultural contracts can be classified in 3 main categories, these include:

- a. **Market Specification Contracts**-specify timing, quantity and price of commodities to be sold.
- b. **Resource-providing contracts**-specifies type of crop, production practices and standardization of the crop through provision of technical packages and credits
- c. **Production management contracts**-associated with large out grower and nucleus-estate schemes; buyer regulates production and labor processes of the grower.

2.1.2 Advantages and disadvantages of contract farming agreements

Contract farming bears significant value to buyers and farmers whilst creating opportunities in the agri-business value chain (FAO). For farmers, the primary benefit is that they guarantee market outlet hence reduce uncertainty brought about by price fluctuations. In addition to reduced price risk, farmers also enjoy: access to credit, access to technology and inputs, access to new markets, increased income and reduced production risk (Weiss & Khan, 2006). Purchasing firms (sponsors/buyers) also benefit by having a guaranteed supply of agricultural products at their desired time, consistent quality of commodity and protection from price fluctuations in the market (Eaton & Shepherd, 2001).

Conversely, Eaton and Shepherd (2001) suggest that contract farming has some disadvantages for both farmers and sponsors. Farmers risk production problems, unreliable or monopolistic sponsors, corrupt sponsors especially in allocation of quotas and obligatory debt due to unforeseen production problems. Similarly, sponsors may also encounter some challenges, these may include: inability of farmers to produce expected qualities due to socio-cultural constraints, lack of deliberation with farmers may lead to farmer dissatisfaction, extra-contractual marketing where farmers may sell produce outside of the contract, and misuse of input provided to farmers (Eaton & Shepherd, 2001).

2.1.3 Data required in contract farming in Kenya

According to a contract advertised in a request for proposals by the county government of Uasin Gishu in **Table 2.1**, the key items that define an agreement for contract farming include document title, requisition items, item metric, and quantity, price per unit, total quantity, issue date and deadline date.

2.1.4 Channels used in advertising contract farming agreements

Once the contractual specifications are specified, sponsors of contract farming agreements invite contractors to apply. In Kenya, manufacturers, buyers, sponsors use the below methods to advertise contract farming agreements.

1. Circulating request for quotations

Private and public organizations send suppliers invitations to quote competitively for contract farming agreements. An example of such an invitation is a Request for Quotation (RFQ) by Uasin Gishu County Government inviting pre-qualified farmers to quote for supply of macadamia seeds/seedlings. Its details are summarized in Table 2.1.

Table 2.1 Request for Quotation (UG County, 2016)

UASIN GISHU COUNTY GOVERNMENT REQUEST FOR QUOTATION					
Issued: 24 th FEB 2016			Quotation No: Q/AGRI/32/2015-2016		
#	Item Description	Unit	Quantity	Unit Price	Total KSH.
1	Grafted Macadamia seedlings-Muranga variety	no	1500		
2	Macadamia seed for rootstock	kg	2000		

2. Open Tender

Following guidelines set by the Public Procurement and Oversight Authority (PPOA), public institutions in Kenya invite farmers to open tender for contract farming agreements when the value exceeds Kenyan Shillings 500,000 (Hunja, 2008). Characteristically, open tenders are similar to request for quotations (RFQ). However, open tenders are advertised for all qualified farmers to apply, contrary to request for quotations which is limited to prequalified contractors.

3. Media (TV, Radio, Newspapers)

According to the Hunja (2008), all public tenders in Kenya must be advertised in the newspaper. The Ethiopian Commodity Exchange advertises contract information via Newspaper, TV and radio channels (Ethiopia Commodity Exchange, 2009).

4. Sales agents and referrals

Sponsoring organizations may also send sales agents to recruit contractors, or receive contractors referred to them by other individuals. For instance, Canken International Limited, a horticultural export firm based in Eldoret Airport, recruited 3,000 contract farmers by the end of 2008, through its extension officers in the grassroots (Ndung'u, 2012).

2.2 Commodity Exchanges

According to Chatnani (2012) commodity exchange is a subset of the larger commodity market. In explaining commodity markets, Chatnani (2012) describes a commodity as any good that possesses a physical attribute. In the context of agri-business any physical substance like wheat, maize or pepper which is interchangeable with other goods of the same type irrespective of producer, is a commodity. In effect, commodities are valuable items of uniform quality produced by many different producers. They are frequently used as input for production of other goods or services for example; maize is used to produce flour. Therefore, commodity markets are places where commodities are bought and sold.

Meena & Burark (2008) section commodity market into two distinct segments, spot and future markets. In spot markets, money is exchanged for goods immediately after the sale. In future markets the purchase of a commodity takes place at a particular time t , but the exchange of the physical goods take place at some specified time in the future (t +duration). In futures markets contracts such as contract farming agreements, discussed above, are traded for future delivery. Both spot and future markets are key factors in the commodity exchange discussion. Commodity exchange transactions are carried out in an electronic trading platform.

Therefore, Chatnani (2012) defines a commodity exchange as a centralized meeting place where buyers and sellers meet to trade commodities. This categorizes the three major roles of a commodity exchange as Setting rules and standardizing buying and selling practices in the market, resolution of business disputes and disseminating price related signals to exchange members (Via electronic trading platform)

Fundamentally the exchange exists only to facilitate trading and neither takes part in the trade nor establish prices, this structure eliminates counter-party risk. Financial instruments traded in a commodity exchange include contracts such as futures, forwards, and option contracts.

According to Damodaran (2002), futures, forwards and option contracts may be referred to as derivatives as they derive their value from the underlying commodity. However, as Damodaran (2002) explains, there are some distinct features in their workings. Futures contract has two parties: seller, who agrees to deliver the specified commodity at some time in the future and buyer who agrees to pay a fixed price and take the commodity, price changes in the commodity provides gains for one party over the other. Futures contracts are strictly traded in a formal exchange as a standardized financial instrument. Forward contracts are similar to futures contract in terms of finality; however it does not require the parties to settle up until the contract expires. Forward contracts may be traded over the counter, regulated by contract law. While futures and forward contracts are not much different from each other, they contrast significantly to options contract. In an options contract, the buyer is under no obligation to meet his end of the bargain, which is to buy the commodity at the agreed price (call option) or sell the commodity at the agreed price (put option). These financial instruments form the basis of an operational commodity exchange Damodaran (2002).

2.2.1 Relationship between contract farming and commodity exchanges

Whereas contract farming plays an important role in price risk management for buyers and farmers, price changes of the specified commodity causes one party to gain at the expense of the other (Damodaran, 2002). Essentially, if the price of the commodity drops, the seller gains at the expense of the buyer and vice versa. This creates an opportunity for investment where third party speculators can profit from price fluctuations of the commodity. The contract between buyers and sellers forms the basis for financial instruments to be used by the traders within commodity exchange electronic trading platform.

2.2.2 Activities in a Commodity Exchange

Mheen-Sluijer (2010) illustrates the typical functions of a trading platform by giving an example the workings of the Ethiopian Commodity Exchange (ECX) as shown in Figure 2.1. Generally,

the activities in a Commodity exchange trading platform (based on ECX) are summarized as below:

a. Registration of Members

The Ethiopian Commodity exchange works on a membership basis. Buyers and sellers are registered on the system and pay for a membership-seat

b. Grouping of Members

Most commodities in Ethiopia, such as coffee and sesame, are produced in small quantities by millions of smallholder farmers. Therefore, farmers group their produce in order to meet the standard lot size requirement of 5 tons per deposit.

c. Product deposition and grading

Members (Farmers and Traders) who wish to buy or sell their commodities deliver their produce of over 5 tons, for registration in the system. The physical produce may be delivered to any warehouse that is operated by the ECX. The products are graded and certified according to ECX standards, then recorded in the market place.

d. Issuing of Warehouse Receipts

Once a member deposits produce, the system issues a warehouse receipt, which provides proof of product deposition into the warehouse.

e. Bidding and price dissemination of pricing information

Trading takes place on a physical trading floor, where buyers and sellers take part in “open-outcry” bidding. Market prices continue to change during the trading hours.

f. Settlement

Once a deal is made, the ECX trading platform credits the sellers account and transfers title of the commodity buyer. The buyer needs to collect the goods within 10 days from the warehouse

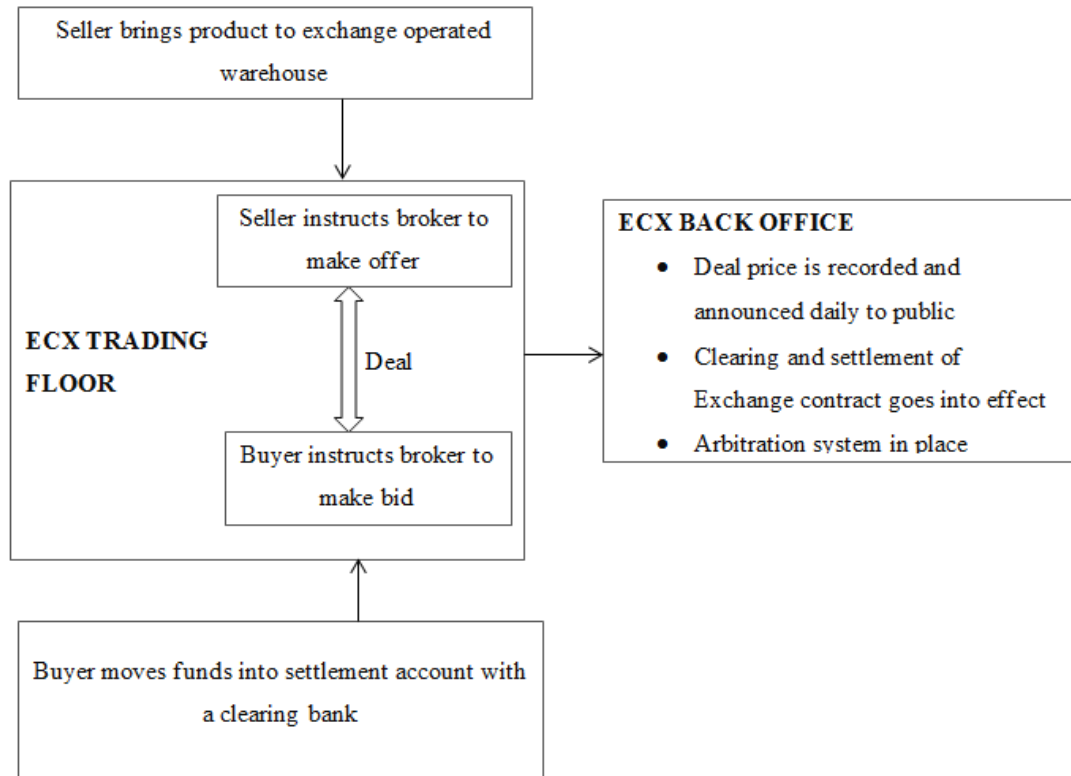


Figure 2.1 ECX trading platform adopted from Mheen-Sluijer (2010)

2.3 Existing Commodity Exchanges

Commodity exchanges have been implemented all over the world trading in a variety of commodities such as soybeans, maize wheat. Kulkarni (2011) identifies some of the leading commodity exchanges in the world as: Chicago Mercantile Exchange (CME), London Metals Exchange, New York Board of Trade, The Intercontinental Exchange, Tokyo Commodity Exchange (TOCOM), National Commodity and Derivatives Exchange Limited (India). In Africa, commodity exchanges have been established in Ethiopia (Ethiopian Commodity Exchange-ECX), South Africa (South Africa Commodity Exchange, SAFEX) and Rwanda (East African Commodity Exchange) (Bahigwa, 2014). Commodity exchanges are a single component of a structured trading system whose success depends on the broader functioning of spot markets. Constrictions affecting the spot markets include: absence of quality control, inadequate financial systems, inadequate contract dispute mechanisms, policy volatility, and insufficient market participants, all of which attract certain failure (Quinn, 2011).

In Africa, the exchanges in Ethiopia, Kenya, Uganda, Malawi, and Zambia have been reported to have cost millions of dollars each (estimates for the Ethiopia exchange have ranged from \$20 million to \$58 million). Despite these investments, all of these exchanges have yet to show a profit and remain under heavy subsidy. The efficiency of these Commodity exchanges can be enhanced through an improved business model and a robust information system to back up the exchange process (Quinn,2011).

2.3.1 Chicago Mercantile Exchange Globex

In 1898, the Chicago Board of Trade (CBOT) formed Chicago Butter and Egg Board (CBEB) to meet the needs of dairy producers and buyers of dairy products (Harris, 1970). According to Harris (1970), Chicago's geographical location favored its emergence as a world center for commodity trading. As the CBEB continued to expand into other agricultural commodities such as grains, it was reorganized into the Chicago Mercantile Exchange (CME) in 1919. CME has over the past 120 years continued to expand into trading contracts on agricultural commodities such as: soybeans, corn, wheat, live cattle (CME, 2016).

CME operations are facilitated by the CME Globex Trading platform. The CME Globex is a 24 hour electronic trading platform that supports trading of futures and options across all commodity classes (CME, 2016). It provides speculators with risk management features and a global access to financial instruments trading across the world. Its service access applications include CME developed as well as third party clients. CME Globex supports connectivity to third party networks, documented via its networking wiki.

Features of the CME Globex include: risk management tools, support of 3rd party applications and network interfaces, iLink order routing interface built on industry standard protocols and Market Data Platform(MDP) for integration of CME group data to third party applications

According to a reference guide published by (CME-GLOBEX, 2015), the following are the benefits of the CME Globex Electronic Trading Platform performance and speed. Trades in the CME Globex are completed and customer notified within microseconds. CME prioritizes reduction of response times for enhanced throughput, Open access and direct participation, and Diversity and innovativeness of products.

2.3.2 Johannesburg Stock Exchange

The South African Futures Exchange (SAFEX) was formed as a subsidiary of the JSE Limited in 1990 to specialize in trading of equity and agricultural derivatives (JSE). SAFEX consists of two main divisions. First, the Equity derivatives market which provides investors with a platform futures, options and complex derivative instruments. Secondly, the Commodity derivatives market which provides a platform for price discovery and price risk management for grains (JSE).

2.3.3 Ethiopian Commodity Exchange

The Ethiopian government launched the Ethiopian Commodity Exchange (ECX) in 2008 as a marketing system where buyers and sellers would come together to trade with assurance of quality, delivery and payment (Mheen-Sluijer, 2010). Commodities traded in the ECX include Coffee, Sesame, Maize, Wheat and haricot beans. The ECX electronic trading platform is available on the website link: <http://www.ecx.com.et> (Last accessed 29th Feb 2016)

According to the ECX website, EXC electronic trading platform provides real time market data, consisting of market price information which is constantly changing. The market data consists of prices of commodities in different markets, offers to sell, bids to buy and market notifications. A sample if this market data is illustrated in Table 2.2. Prices are in Birr/Feresulla whereby 1 Feresulla is equivalent to 17kg.

KEY:

Symbol represents the product specified in the contract, variety, grade and delivery center.

Open represents the opening price of the contract

Close closing price of the contract

High highest value of the contract throughout its trading period

Low lowest value of the contract throughout its trading period

Change difference between the opening/closing prices

Vol_in_Ton volume of the commodity in tons

Symbol	Open	Close	High	Low	Change	Vol_in_Ton
WYCBUGnp	900	900	900	900	0	8.38
WYCAQ2	1500	1508	1515	1500	8	15.61
WTP3	1050	1050	1050	1050	0	12.60
WSDBQ2	1320	1320	1320	1320	0	12.60
WSDB3	1230	1230	1230	1230	0	21.61
WSDA4	1195	1195	1195	1195	0	3.60
WLMAQ2	1275	1275	1275	1275	0	28.80
WLMAQ1	1350	1350	1350	1350	0	9.89
WKCAQ2	1550	1550	1550	1550	0	7.21
WGJQ2	1380	1382	1385	1380	2	23.39
WGDQ2	1095	1095	1095	1095	0	8.99
WANQ2	1150	1150	1150	1150	0	8.59
USDCQ1	1080	1080	1080	1080	0	31.74
USDAQ2	1500	1500	1500	1500	0	7.99

Table 2.2 Sample Market data showing commodity trades (ECX, 2016)

The ECX electronic trading platform includes a Marketing information system(MIS), which collates, processes, updates and disseminates real-time market data to all market participants and intermediaries (Ethiopia Commodity Exchange, 2009). Components of the ECX MIS include: Electronic Tickers, Mobile Phone Short Messaging Service (SMS), Interactive Voice Response (IVR) service, Market Intelligence, Mass media (radio, TV, print) and Information Centers.

a. Electronic Tickers

The ECX has placed electronic displays in over 200 strategic locations in regional markets. The electronic displays transmit real time (within 4 seconds) prices of all commodities traded in the trading floor. Such locations include: Addis Ababa, Nazareth, Shashemene, Awassa, Nekempe, Jimma, Dire Dawa, Harar, Gonder, Bahir Dar, Dessie and Mekelle.

A sample ticker located on the ECX headquarters, in Addis Ababa building is illustrated in Appendix I.1.

b. Short Messaging Service (SMS)

Since 2009, ECX provided market participants with mobile devices access to market prices, commodity related news, headlines, weather forecasts and other notifications, via SMS. The SMS platform is used to disseminate market information and intelligence (Ethiopia Commodity Exchange, 2009).

c. Interactive Voice Response (IVR) service

Interactive voice response (IVR) is an automated telecommunication service that provides stakeholders price information on demand. Participants in the ECX commodity markets access IVR system using mobile or fixed-line telephone networks to access market price information from anywhere in Ethiopia. The system features an interactive voice menu that disseminates historical/real-time information in English, Amharic, Oromifa and Tigrigna languages (Ethiopia Commodity Exchange, 2009).

d. Market Intelligence

The ECX provides a summary of price comparisons between local and international market prices. The system analyses market developments and provides analysis graphs (Ethiopia Commodity Exchange, 2009).

e. Mass media (radio, TV, print)

ECX disseminates market information via radio, TV and newspaper on a daily basis. The transmission is done in several languages including: English, Amharic, Oromifa and Somali (Ethiopia Commodity Exchange, 2009). The schedules are as follows: TV-three times a day, Radio-Four times a day and Newspaper-Daily, bi-weekly.

f. Information Center

EXC provides daily domestic/international prices, market trends, weather forecast, events and other market related news via its info center (Ethiopia Commodity Exchange, 2009).

2.3.4 Kenya Agricultural Commodity Exchange

Kenya Agricultural Commodity Exchange (KACE) is a private sector firm based in Kenya founded in 1997 with the aim of linking farmers and traders to trade in agricultural commodities. KACE staff members collect information on prices of a variety of commodities from market vendors in: Nairobi, Eldoret, Bungoma, Mumias, Kisii, Kisumu and Machakos.

The collated price information is forwarded to KACE headquarters where it is processed and published via the Regional Commodity Trade and information System (RECOTIS) on the KACE website and on notice-boards at Market Information Centers (MICs) (Karugu, 2011). Besides market price information, KACE staff also collect information such as government alerts and other notifications.

Karugu (2011) identifies the extensive use of telecommunication networks in the KACE electronic trading platform. KACE employs information and communication technology to provide market information accessibility to isolated traders/farmers in rural areas. Telecommunication elements of KACE electronic trading floor include Short message service, Interactive Voice Response, Marketing Information Center, Radio, Online Subscription.

a. Short message service

KACE in partnership with Safaricom Limited provides market price information to farmers via an on-demand SMS short code service available on 411. This is a premium rate service charging KES. 5/SMS. Farmers send an SMS with the name of the commodity to the short code, and get instant feedback on the specified commodities' wholesale price across major markets.

b. Interactive Voice Response(IVR)

An IVR service available on the phone number 0900552055 provides market participants with a simple menu steps to access market information.

c. Marketing Information Center

Marketing information centers (MICs) consists of KACE field offices with internet connectivity, which provides a link between KACE and remote market information points. Employees of

KACE record daily market information and forward to KACE headquarters via the MICs internet connectivity.

d. Radio

KACE disseminates information on prices of agricultural commodities via daily bulletins on the KBC Radio at 6pm.

e. Online Subscription

KACE website provides users with the option of subscribing to RECOTIS updates to gain access to prices of 25 different commodities daily.

2.4 Market Information Systems in Kenya

Zoltner (2013) identifies Regional Agriculture Trade Network and Mfarm as some of the marketing information systems in Kenya. Below is a discussion of the two, highlighting their features and limitations.

2.4.1 Regional Agricultural Trade Intelligence Network (RATIN)

RATIN is a market information system; a product of the East Africa Grain Council, developed to provide stakeholders and members with marketing and trade information for competitive agricultural transactions between surplus and deficit regions. (RATIN, 2016). It provides services to 5 countries in East Africa which include Kenya, Uganda, Tanzania, Burundi and Rwanda.

2.4.1.1 Features of RATIN Market Information System

SMS Service

RATIN provides access to market information via two way messaging system accessible from anywhere in the East African region. The messaging system consists of ordinary long code number operated from a modem. Different regions are accessed by different mobile numbers.

Users begin by registering; this involves sending a text to their respective regional number, with name and occupation in the format: NAME, OCCUPATION for example, “Brian, Farmer”. Once registered, the user can now send the name of their town and product in order to get prices in the format TOWN PRODUCT. For example, “Bungoma Maize”

Cross border trade monitoring

RATIN monitors movement of commodities across countries, keeping track of volumes in metric tons of goods moving from source to destination countries. Table 2.3 shows an excerpt from the RATIN MIS (as of 29th Feb 2016), showing cross border trade volumes of maize.

Source Country	Destination Country	Product	Border	Volume (mt)	Date
Uganda	Kenya	Maize	Busia Border	37	2016-02-29
Kenya	Tanzania	Maize	Isebania	40	2016-02-29
Uganda	Tanzania	Maize	Mutukula	45	2016-02-28
Uganda	Kenya	Maize	Busia Border	179	2016-02-27
Uganda	Rwanda	Maize	Gatuna	310	2016-02-27
Uganda	Tanzania	Maize	Mutukula	65	2016-02-27
Uganda	Kenya	Maize	Lwakhakha	10.5	2016-02-26
Uganda	Kenya	Maize	Busia Border	201	2016-02-26
Uganda	Kenya	Maize	Malaba	3.78	2016-02-26
Kenya	Tanzania	Maize	Isebania	45	2016-02-26

Table 2.3 Cross border trade volumes (RATIN, 2016)

Warehouse mapping

RATIN provides functionality for geographical visualization of warehouses across East Africa including real time volume-tracking of commodities stored in warehouse. Figure 2.2 is an example of a warehouse map drawn from RATIN MIS.

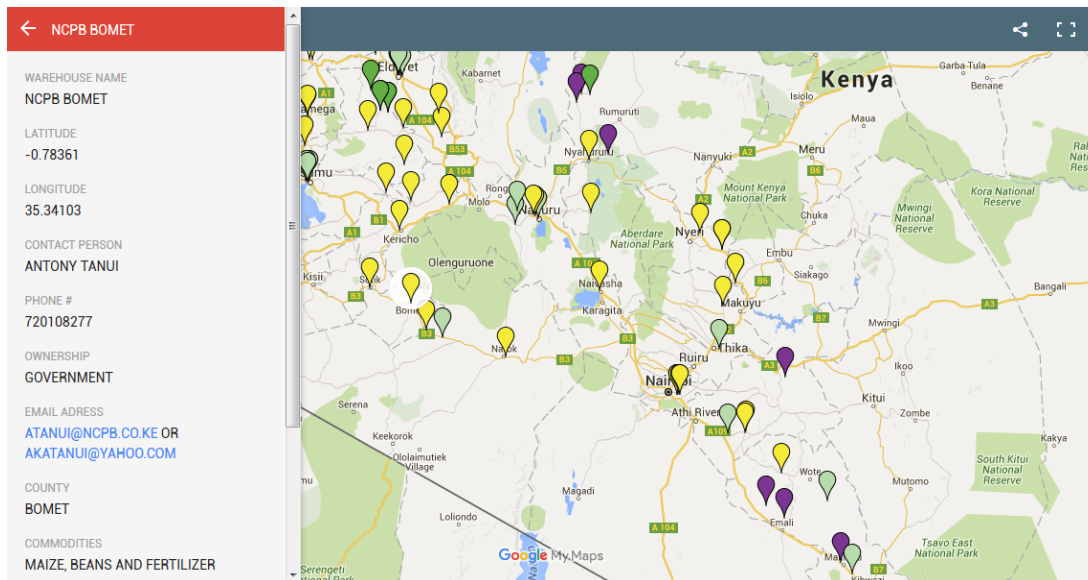


Figure 2.2 RATIN Warehouse map (RATIN, 2016)

News and Bulletins

RATINs news and bulletins feature provides market participants with updates in market related information, e.g. Government policies, Events, weather forecasts.

- a. Limitations of RATIN MIS
 - i. Market data analysis is presented in a complex format that favors consumption by decision makers and sophisticated users only
 - ii. Market price information system does not mitigate risk of fluctuating prices
 - iii. Does not create opportunity for non-members to profit from fluctuating prices via derivative trading
 - iv. Does not guarantee buyers quality, quantity or acceptable pricing.
 - v. Does not guarantee farmers of market outlets at acceptable prices, or provide them with financing options.

2.4.2 Mfarm

Mfarm is an online marketplace where farmers connect with buyers to sell produce (MFARM, 2016).

- a. Features of M-FARM Market Information System

Provides daily prices and an online market place, where sellers and buyers create accounts to access items on sale

- b. Limitations of M-FARM MIS
 - i. Market price information system does not mitigate risk of fluctuating prices
 - ii. Does not create opportunity for non-members to profit from fluctuating prices via derivative trading
 - iii. Does not guarantee buyers quality, quantity or acceptable pricing.
 - iv. Does not guarantee farmers of market outlets at acceptable prices, or provide them with financing options.

2.5 Marketing Information System Architectures

Zoltner (2013) identifies that different marketing information systems have different business models, hence implement different system architectures and technologies. Typically, marketing information systems adopt architectures similar to Figure 2.3

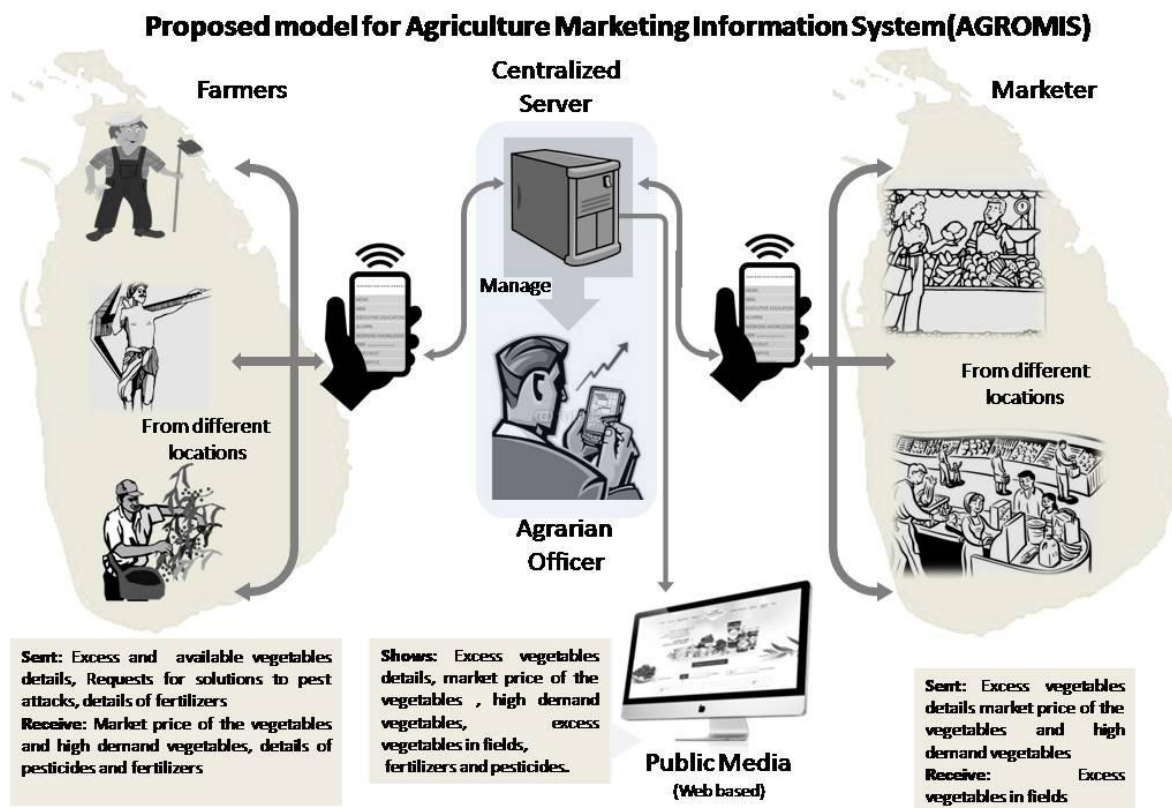


Figure 2.3 Marketing Information System Architecture (Nilashan, 2012)

Figure 2.3 illustrates farmers and marketers from different locations accessing a centralized server via a mobile device; an agrarian officer has direct access to information in the centralized server and information is also published to the public via Web technology.

2.6 Technologies implemented in Market information systems

Technologies implemented in Kenyan marketing information systems include SMS, Mobile Applications, USSD and IVR (Zoltner, 2013). These components interact with a core system residing in the data center as illustrated in Figure 2.4.

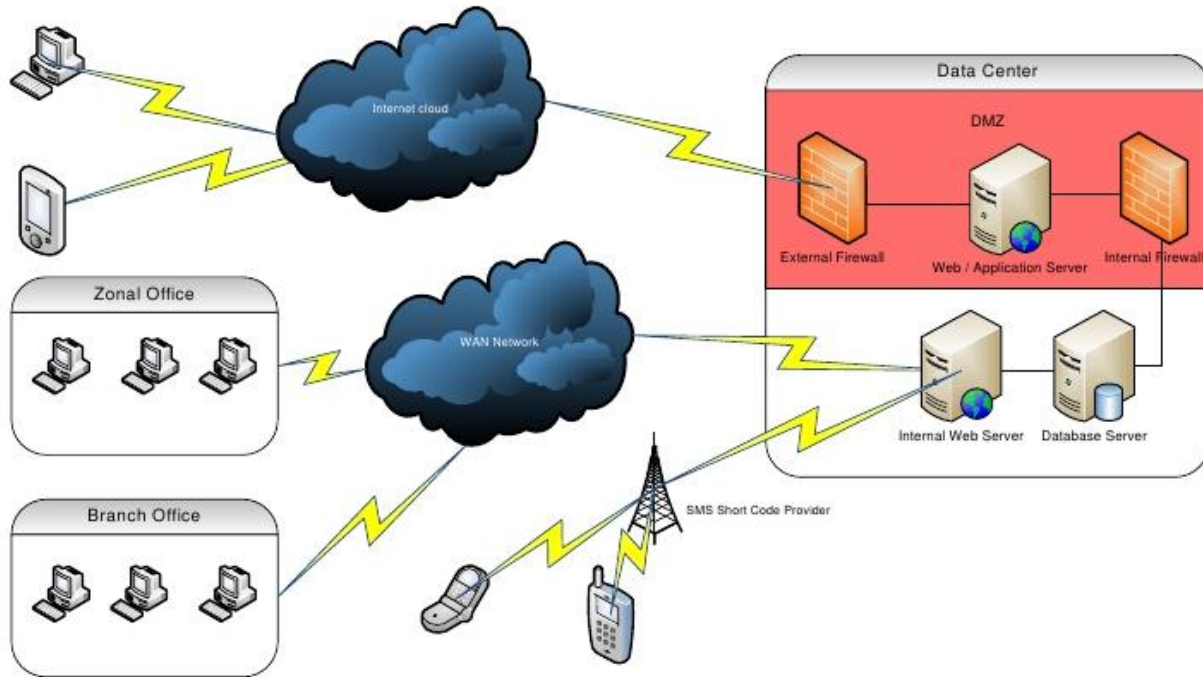


Figure 2.4 Application Architecture (Gosavi & Ismail, 2011)

Figure 2.4 illustrates mobile technologies interacting with the web application server. SMS, USSD and IVR interact with the web application server via SMS short code provider on the GSM network. Mobile applications interact via Internet cloud to reach the web server. Web clients access the data center via the internet cloud using web browsers. Web clients residing on particular networks also access the data center via the WAN network. Both mobile and web clients access the data center via the internet.

2.6.1 Short Message Service Architecture

According to GC (2013), SMS uses the text messaging standard to enable mobile based applications, through sending of service commands to pre-defined numbers by the user. SMS applications interact with the web application via the Mobile Service Center (MSC) which opens

a connection to the SMS gateway via the SMS center (SMSC). The SMS gateway forwards messages to and from the web application. This is illustrated in Figure 2.5.

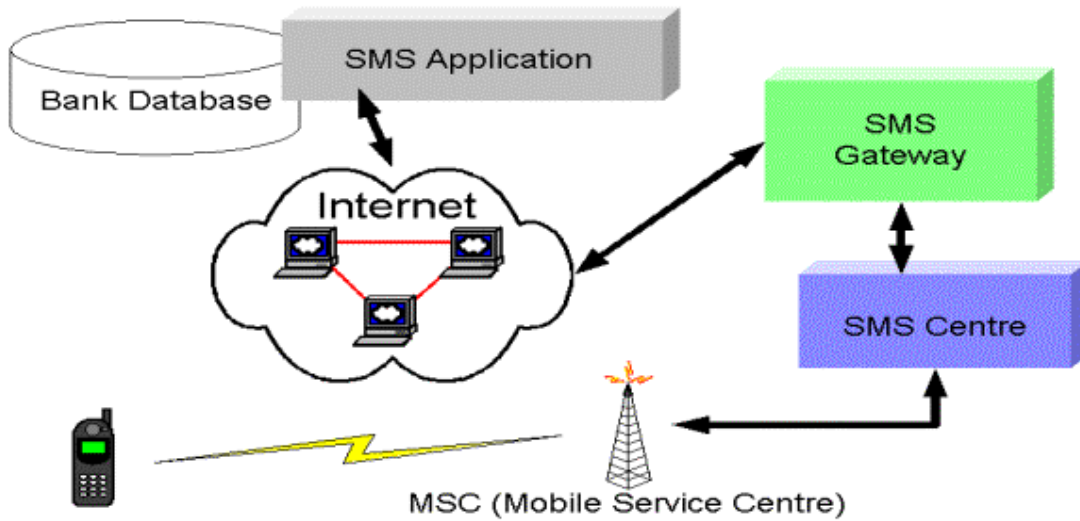


Figure 2.5 SMS Architecture bank example (GC, 2013)

2.6.2 Unstructured Supplementary service data Architecture

USSD works of existng GSM-based handsets to provide sessional communication for a variety of applications in real time (TelecomSpace, 2016). The USSD architecture is illustrated in Figure 2.6.

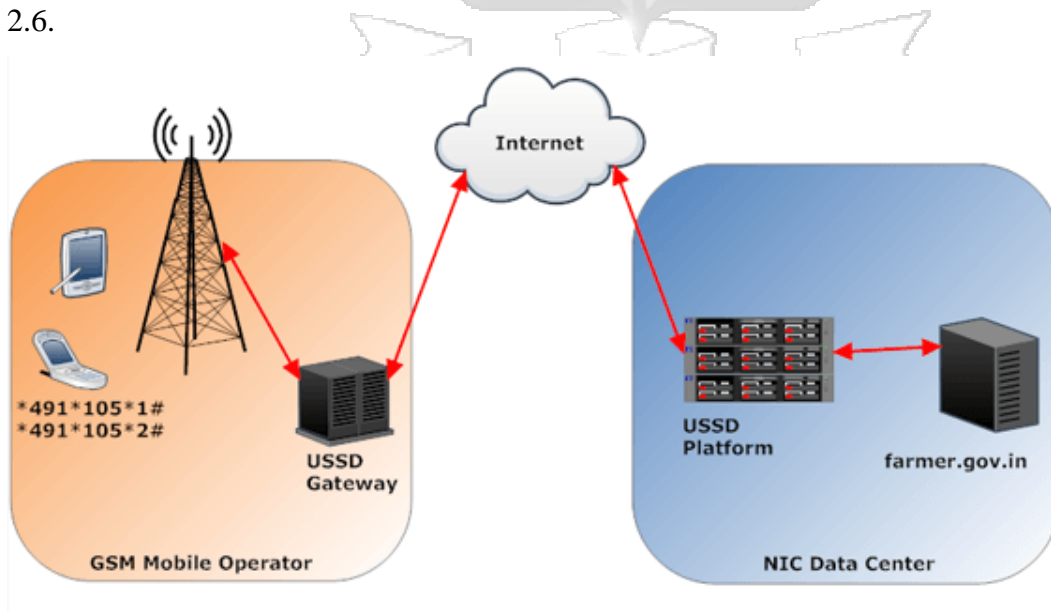


Figure 2.6 USSD Architecture (MKisan, 2014)

Figure 2.6 describes the USSD architecture. Users dial special codes as indicated (*491*105*1#) the Call is routed via the GSM network to the USSD gateway, which channels the request over the internet to the terminal web application, the responses are channeled back to the user in textual format.

2.6.3 Interactive Voice Response Architecture

Interactive Voice Response (IVR) provides users with the ability to access service menus and provide routing to relevant service helpdesk during calls (Center, 2013). The IVR architecture is illustrated in Figure 2.7

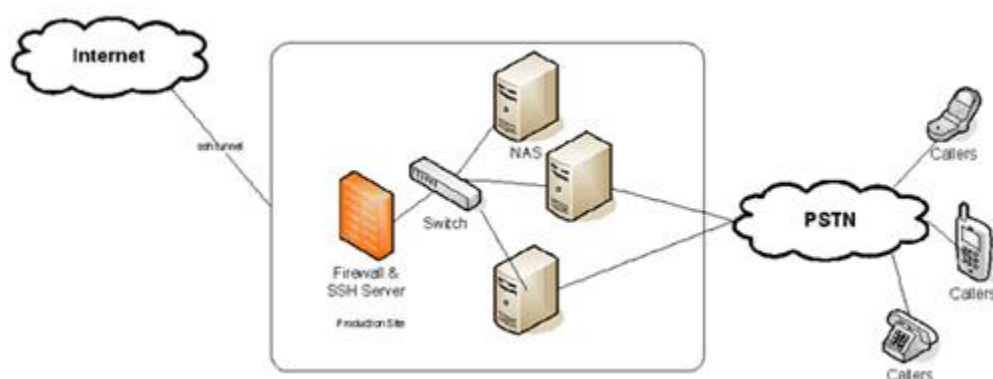


Figure 2.7 IVR Architecture (Kanhan, 2009)

Figure 2.6 illustrates the IVR architecture in which callers access the Public Switched Telephone Network (PSTN) which routes the call over the network to the web application on the internet. Responses from the web application are channeled back to the caller as audio instructions to select next menu option.

2.7 Gaps and limitations

Review of the existing systems in agricultural marketing in Kenya reveals that the risk of price fluctuations has not been addressed.

In review of RATIN, CEREALMART and MFARM Market information systems, there is no mechanism provided for mitigation of price risk. The market information systems focus on pricing information overlooking the movement of the prices. This leaves a significant gap as price fluctuations affect agricultural incomes, therefore the information systems may not address their intended objectives in a price volatile market.

In addition to this, the review of KACE commodity exchange in Kenya shows that it does not provide options to trade in contract farming agreements. From the review of ECX and CME Globex commodities exchange, it is evident that contract farming agreements provide a source of investment for investors who speculate on price fluctuations in the duration of an agreement. This creates a gap as the commodity exchange systems implemented in Kenya do not provide avenues for investment through offsetting contract farming agreements.

2.8 Summary

Contract farming provides a mechanism for farmers and buyers to lock down mutually acceptable prices before production. It protects farmers from unpredictable price drops, and buyers from price increases. On the other hand, commodity exchanges provide buyers and sellers with a market place where they can meet to trade different commodities. When contract farming agreements are traded within a commodity exchange, they create an opportunity for third party speculators to profit from price fluctuations of the contract value before its maturity.

In Kenya, existing commodity exchanges provide basic buying and selling of commodities but not contract trading. While current commodity exchanges provide a platform for farmers and buyers to participate in the spot market, they do not create opportunities in the value chain for third party speculators to gain from the fluctuating nature of prices.

In addition to this, Kenyan market information systems are production oriented; they look for markets once production has been done. This bias on output exposes the farmer to risk of low selling price and or lack of markets for produce due to misinformed production. Similarly, existing marketing information systems do not provide mechanisms to safeguard farmers and buyers from price fluctuations in the market.

In conclusion, there is a research gap in Kenya's agricultural commodity markets, which stems from poor integration of contract farming into existing marketing information systems. Commodity exchanges and market information systems implemented in Kenya do not factor in contract farming agreements which provide a useful tool in securing markets before production to mitigate price fluctuations. In addition to this, the contract farming agreements create an opportunity in the agribusiness value chain by providing financial assets (derivatives) that may be traded within a commodity exchange electronic trading platform. This research investigates the impact of introducing contract farming in market information systems.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

This chapter discusses the software design methodologies and research design employed in this dissertation. It provides an overview of the Agile software development methodology as the selected software design methodology approach. Specifically, it outlines the dynamic systems development (DSD) as the selected form of agile techniques. Services Oriented Architecture (SOA) forms the core architectural style of the agricultural trading platform. The architecture implements Simple Object Access Protocol (SOAP) protocol in communication between networked system components. The chapter also describes object oriented programming techniques implemented, as well as client side technologies used. For web based clients, this chapter gives an overview of the MVC (Model View Controller) framework, Angular JS, used in developing the web portal. The research design adopted for this dissertation study is discussed.

3.1 System Development Methodology

3.1.1 Agile Software Development Methodology

Agile methods are defined as contemporary approaches for creating new software based on teamwork, customer collaboration iterative development and response to change (Rico, Sayani, & Sone, 2009). According to (Highsmith & Cockburn, 2002), agile development purposes to create and respond to provide return on investment in harsh business environments. It combines collaboration with focus on maneuverability and effectiveness. It promotes use of people to transfer ideas faster and cheaply to developers, as opposed to traditional document driven processes. Highsmith and Cockburn (2002) suggest that when developers interact with end users, they can adjust priorities, iron out difficulties and examine alternative paths to intended objectives.

According to Rico, Sayani and Sone (2009), agile methods deliver high quality, inventive software to the market fast and cost-effectively. It provides a solution to incorporation of innovation, management of product development and quality assurance. They identify 4 common values of agile methods as: customer collaboration, teamwork, adaptability and iterative development. Koch (2011) also identifies several advantages of agile techniques which include: meeting of user needs due to collaboration between users and developers, quick replacement of

inefficient processes, early warning of problems, greater agility to meet changing business requirements among others.

Due to the highlighted advantages, the agile approach was chosen as a suitable methodology for development of the proposed system. Rico, Sayani and Sone (2009) identify numerous forms of agile development as Extreme Programming, Scrum, Dynamic Systems Development, Feature Driven Development, Crystal Methods and others.

The development of this agricultural trading platform implements Dynamic systems development discussed in Chapter 3.1.1.1.

3.1.1.1 Dynamic Systems Development

According to Rico, Sayani and Sone (2009) Dynamic Systems Development (DSD) was created in 1993 by an association of 16 industrial and academic institutions with a goal of achieving a nonproprietary Rapid Application Development approach.

Rico, Sayani and Sone (2009) identify 5 major stages feasibility study, business study, functional model iteration and build iterations illustrated in Figure 3.1.

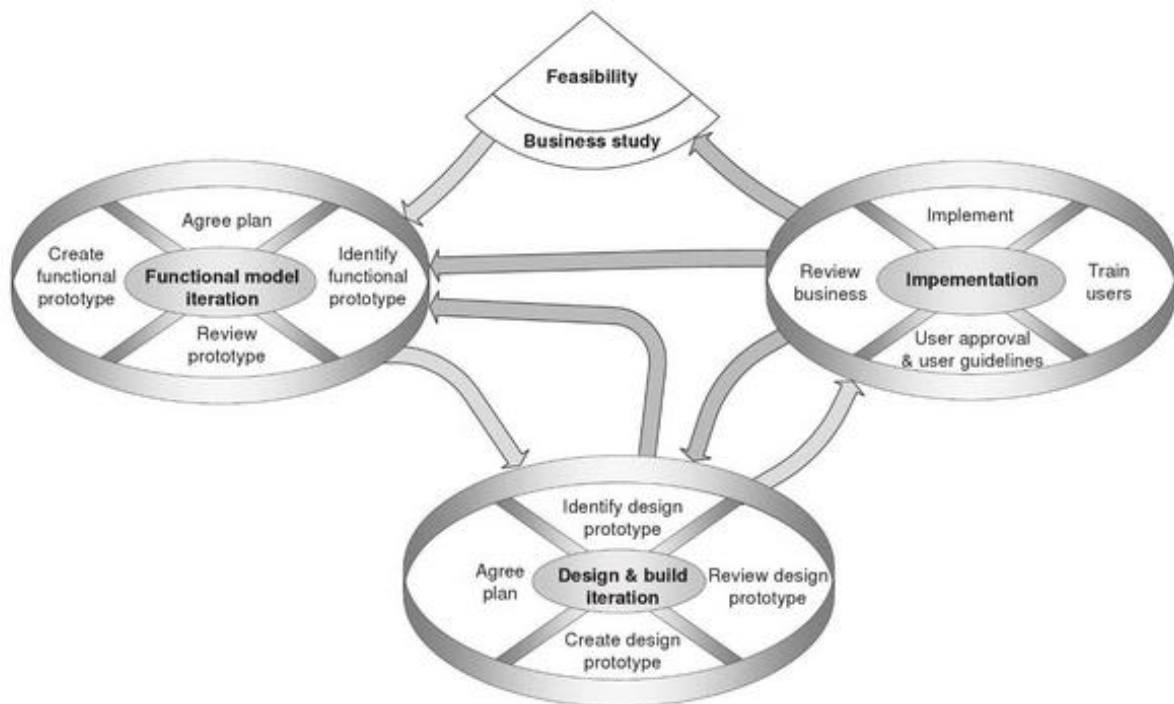


Figure 3.1 Five Stages of DSD adopted from Rico, Sayani, & Sone (2009)

3.1.1.2 Reasons for using Dynamic Systems Development

According to Rico, Sayani and Sone (2009), DSD has 3 critical success factors which include communication between developers and end users, skilled developers and flexible customer requirements.

The success factors provided in DSD coupled with the advantages of the overall agile development methods, made it a suitable software development method to use in this dissertation project.

3.1.2 Services Oriented Architecture (SOA)

Services Oriented architecture can be defined as an application design in which all functions (services) are designed using a description language and have callable interfaces invoked to perform business processes (Bieberstein, Bose, Fiammante, Jones, & Shah, 2006).

Essentially, this definition refers to any solution architectures implementing web service technologies such as REST, SOAP, WSDL and UDDI. The implementation of this system employed the user of RESTFUL and SOAP web services.

Reason for Service Oriented Architecture: This provided a standardized form of communication between system components, and the separation of client applications from core system provided additional security.

3.1.3 Object oriented tools

Galeon (2013) identifies that of many system development methods, object oriented design provides a success factor through modeling to define and analyze requirements. According to Galeon (2013), object oriented design is a process that groups interacting items to create a model that represents the proposed objective of the system (Galeon, 2013). In this dissertation project, the following object oriented tools were used:

- a. Use cases
- b. Class diagram
- c. Interaction diagram
- d. Entity Relationship Diagram

3.1.4 Programming tools

3.1.4.1 Web Application

The Core system consisted of a web application developed using a PHP5 Server framework, integrated with AJAX client side framework. The reasons for using a PHP5 Framework included its: flexibility, inbuilt security features, dependency management and MVC framework that provides easy dependency management.

3.1.4.2 SMS Gateway

The SMS component was used for registration, buying and selling of commodities, purchasing of contracts and account queries. It was developed on a PHP5 client listening to MPESA API requests. The reason for using MPESA API based SMS platform is its cost-effectiveness and higher revenue compared to traditional 5 digit short codes.

3.1.4.3 Database

The core system was developed on MySQL for data storage. This was because of its open source nature, robustness and compatibility with PHP5.

3.1.5 Proposed System Modules

The system was designed to include the below core modules Membership, Contracts, Spot Market, Offset Contracts, Reporting module and 3rd Party API module.

3.2 Business Study

3.2.1 Research Design

An exploratory research design using qualitative and quantitative approaches was implemented in this dissertation. The reason for using exploratory research is due to the infancy stage of Kenya's agricultural derivatives market, which provided limited sources of information for trading in contract farming agreements. The qualitative approach was instrumental in providing insights on how Kenyan marketing information systems and agricultural commodity exchanges operate, in order to inform the development of the system. The quantitative approach served to estimate potential number of farmers, traders and speculators to use the new electronic commodity exchange platform.

3.2.2 Location of Study

The study was carried out in 2 Kenyan counties, Nairobi and Uasin Gishu. Nairobi provided a site for investigation of existing marketing information systems and commodity exchanges. The Capital Markets Authority was an instrumental location in studying the rules of contract (derivatives) trading in Kenya to inform this research. Uasin Gishu County provided a source of potential users (farmers and buyers) as respondents for questionnaires. Nairobi County provided a source of investors who speculate on fluctuation prices of agricultural commodities for profit.

3.2.3 Target Population

This study focused on farmers, buyers and speculators. Farmers and buyers get into buying and selling agreements, which are later traded by speculators in an electronic trading platform. For this reason, the three groups played a big role in this research. The researcher sought to perform a descriptive survey on a minimum of 50 farmers and 15 buyers; this was guided using Equation 3.1.

3.2.4 Sampling Strategy

The target population consisted of farmers and buyers from Uasin Gishu County. The sample population of farmers was drawn from a sample population of 9500 farmers at a confidence level of 95% and confidence interval of 14. This gave a sample size of 50 farmers as per **Equation 3.1**.

Similarly the sample population of buyers was drawn from a sample population of 22 buyers at a confidence level of 95% and confidence interval of 14, resulting in a sample size of 15.

$$SS = \frac{Z^2 * (p) * (1-p)}{c^2}$$

Equation 3.1 Sample Size formula (Survey System, 2016)

Where:

Z = Z value (e.g. 1.96 for 95% confidence level)

p = percentage picking a choice, expressed as decimal

c = confidence interval, expressed as decimal

3.2.5 Data collection procedure

Before the data collection process, the researcher obtained a forwarding letter from Strathmore University which was used to provide credentials while approaching organizations and respondents to administer research instruments.

3.2.6 Description of Research Instruments

In this study, data collection was done through the use of interviews and questionnaires. The interviews consisted of a number of unstructured questions (See appendix C and D). The interviews were administered face to face and via research assistants. The researcher recorded responses by respondents for the cases where data is solicited via interviews.

Reasons for interviews: to explore the experiences, views, plights and motivations of the sample population.

The questionnaires consisted of closed and open format questions and were administered to farmers and buyers in Uasin Gishu County.

Reasons for interviews: Questionnaires were used mainly for easier data analysis, simple administration, and familiar format for most respondents and collection of data in a standardized way.

In selected cases, historical data was aggregated from third party databases. The data was sought from the following sources:

- a. RATIN MIS
- b. ECX WEBSITE
- c. CEREALMART MIS
- d. Capital Markets Authority

Reasons for historical data: provided information about market prices over a long period for better understanding of the agribusiness market behavior.

3.2.7 Validity and Reliability of Research Instruments

3.2.8 Pilot Testing of Research Instruments

The interview and questionnaire questions were pre-tested to a dry run sample similar to the actual sample to be used in the study. The pilot study involved a select group of farmers and

buyers from Uasin Gishu County. This pilot approach ensured deficiencies such as vague instructions, unclear questions and lacking responses were identified beforehand.

3.2.9 Validity of Research Instruments

The instruments used in this research were proofread by the researcher's lecturers and peers who provided suggestions for appropriate modification of the research questions. Other research experts from the faculty were also consulted and their contribution incorporated in the modification of the research.

3.2.10 Reliability of the Instruments

A test-retest method was used to establish the reliability of the instruments. The researcher administered the instruments to the same group of respondents at two different times after a span of 3 days.

3.2.11 Description of Data Analysis Procedures

In this research, both qualitative and quantitative data was collected. Once the data had been collected, responses from all questionnaires were validated to facilitate coding and processing before analysis.

3.2.12 Ethical Considerations

The researcher sought a letter from the Strathmore University which endorsed the researchers request to collect information. The researcher avoided plagiarism by acknowledging other peoples work and ensuring confidentiality and privacy of the information provided by the participants by not revealing the identity of the respondents.

The researcher also conformed to the principle of informed consent by ensuring respondents willingly participated in the study without undue coercion. The respondents were not obliged to participate in the research, and were furnished with full information pertaining the research and objectives before participation.

Honesty was also be adhered to as the researcher disclosed the true objectives for conducting this research without any hidden details. The researcher avoided harming respondents by avoiding: to ask awkward questions, expressing disgust or shock while collecting data, using intimidating statements and causing anxiety among the respondents.

3.3 Summary

The researcher sought to use questionnaires and interviews as reliable instruments for comprehensive data collection in the dissertation study. The target population consisted of farmers, buyers and speculators. The research process sought to provide a descriptive survey of the sample population. It also sought to identify the role of Mobile and web technologies in providing access to market information and pricing. Object oriented approach was used in the development of the proposed solution.



CHAPTER 4: SYSTEM ANALYSIS

This chapter provides an analysis of data collected by the researcher and delivers a conclusion based on the information collected from the sample population. Based on this conclusion, the chapter discusses the system design. The researcher was able to collect responses from 40 farmers and 15 buyers via questionnaires. Interviews were also conducted with officials at the Capital Markets Authority. In addition to this, the researcher also aggregated data from historical sources which include RATIN and CEREALMART market information systems.

4.1 Response rate

The target sample population consisted of 50 farmers, 15 buyers. The responses received consisted of 40 farmers, 15 buyers. This consisted of an 84.5% response from the target population of 55 respondents.

Historical data was obtained from 2 market information systems from the initial target of 4. These included RATIN and CEREALMART marketing information systems.

4.2 Findings and discussions

The data was collected using primary and secondary sources. Primary sources included interviews and questionnaires, whereas secondary sources included historical data from marketing information systems. Primary sources provided qualitative and quantitative data on potential usage and feasibility of the electronic trading platform for agricultural commodities. Secondary sources shed light on commodity price movement trends in Kenya. The below discussions were drawn from the data collected and analyzed.

a) Channels used by respondents to sell produce to market

Respondents (Farmers) were asked how they get their produce to the market

Figure 4.1 shows the channels used by respondents (farmers) to sell their produce to the market. From the diagram; it is evident that most farmers employ the use of middlemen in the supply chain. This implies that the farmers may not realize the full revenue from their produce due to the use of brokers in distribution. In addition to this Market information systems come in 3rd position after Supplying to institutions and hotels.

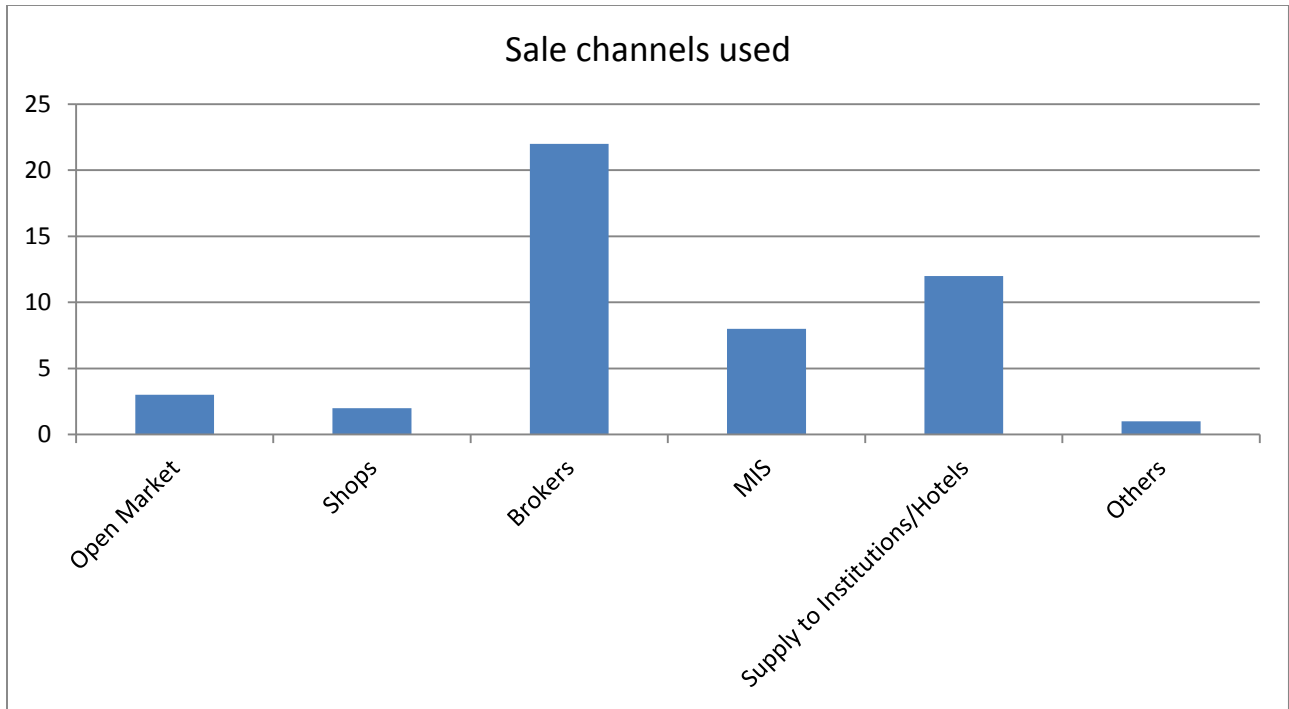


Figure 4.1 Sales channels used by respondents

b) Channels used by respondents to procure produce

Respondents (Buyers) were asked how they procure produce

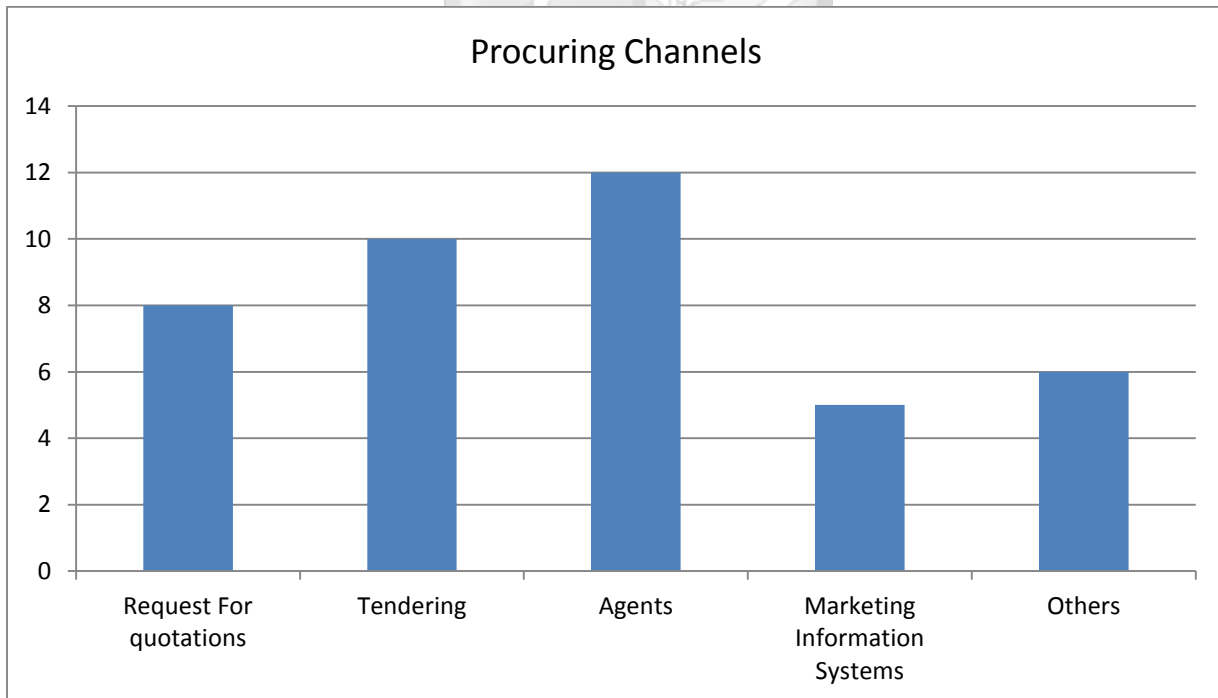


Figure 4.2 Channels used by respondents to procure supplies

Figure 4.2 illustrates the channels used by buyers to seek agricultural commodities. From the diagram, it is evident that most buyers send agents to the market place to source for produce. Marketing information systems comes in as the least preferred channel to procure supplies by buyers. For the “Others” category, some of the channels sited by respondents included: Door to door sales and market days.

c) Percentage of respondents aware of Marketing Information Systems

Respondents were asked if they were aware of any existing Market information Systems.

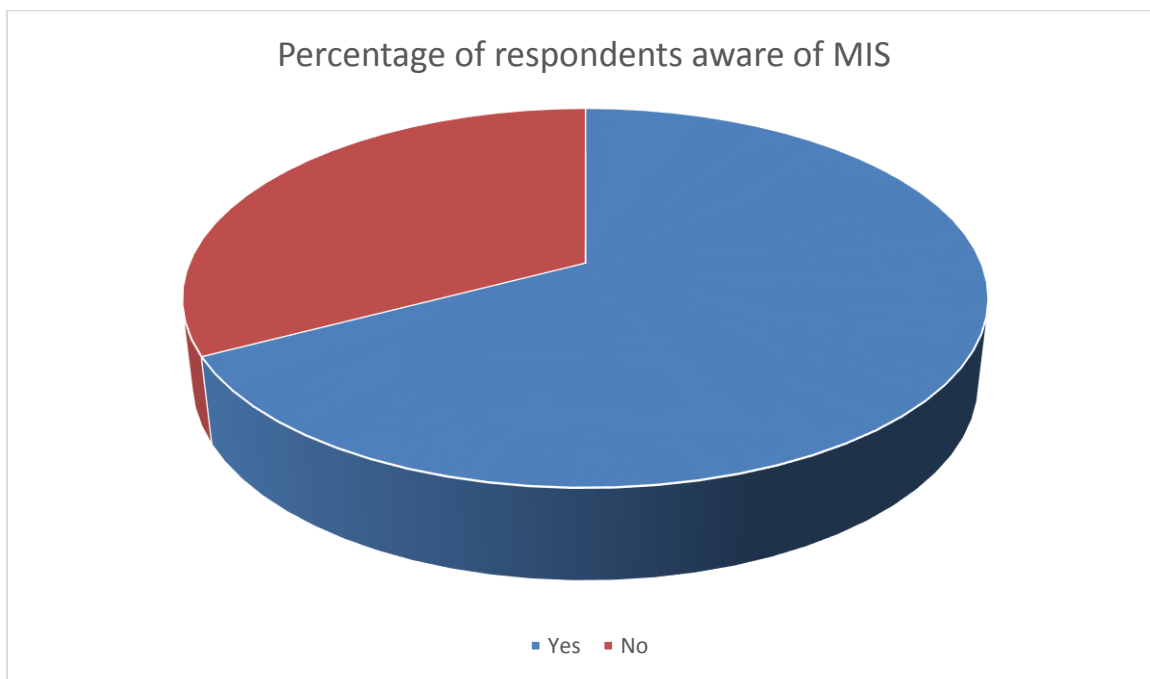


Figure 4.3 Percentage of respondents aware of existing MIS

Figure 4.3 illustrates the level of awareness across respondents both farmers and buyers, on Marketing information systems. Evidently, most respondents are aware of existing systems. This implies that the concept of a new information system will be received by a population of majorly conversant users.

d) Marketing Information Systems used by respondents

Respondents who are aware of existing marketing information system were asked which marketing information system they use.

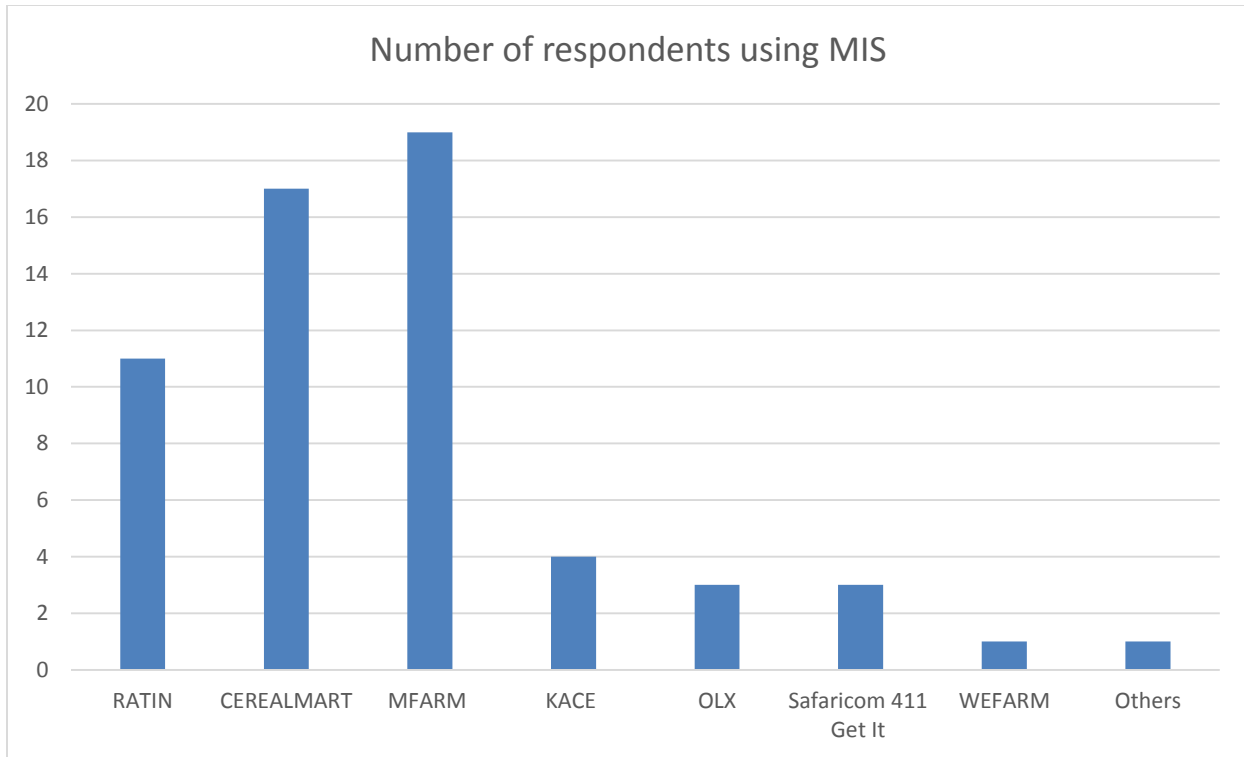


Figure 4.4 Number of respondents using Kenyan MIS

Figure 4.4 shows the usage of Kenyan Marketing information systems by farmers and buyers. As per the evidence illustrated, the leading market information system is MFARM. The “Others” category consisted of electronic platforms such as Facebook, Whatsapp. This information implies that the proposed system shall be used well as the 3 leading information systems each have over 10 users from the sample population.

e) MIS usage by aware respondents

Respondents who are aware of existing marketing information systems were asked how frequently they use the aforementioned systems.

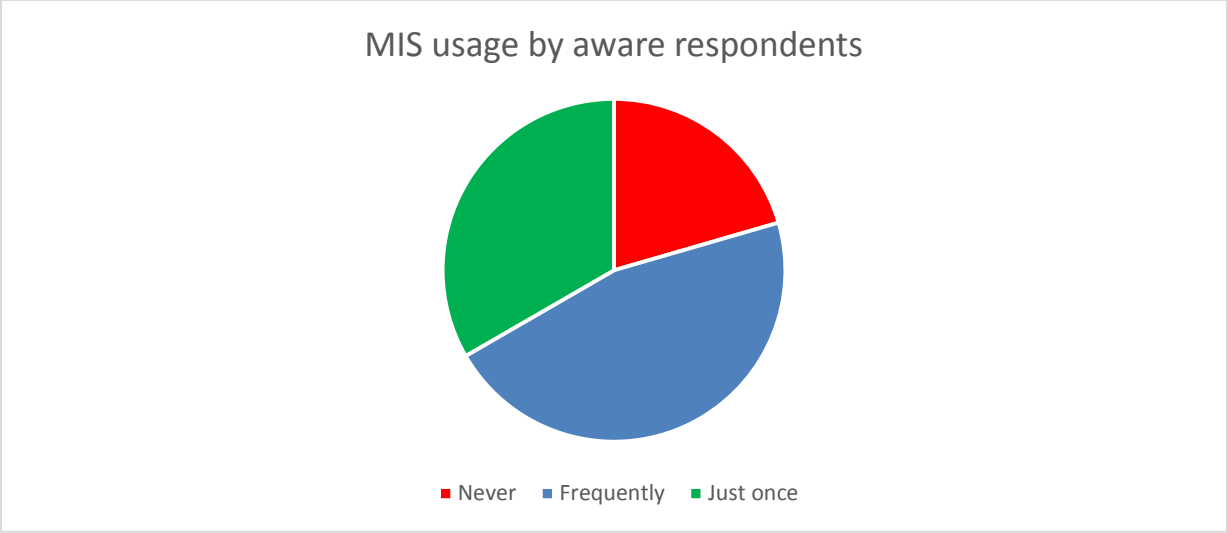


Figure 4.5 MIS Usage by aware respondents

Figure 4.5 illustrates the frequency of MIS usage by respondents who claimed to be aware of existing market information systems. From the evidence presented, 79% users have at least once used marketing information systems; with 46% frequently using it. This implies that the proposed system shall be useful on several occasions for users.

f) Respondents affected by price drops in the market.

Respondents (Farmers) were asked if they are negatively affected by price drops in the agricultural commodity market.

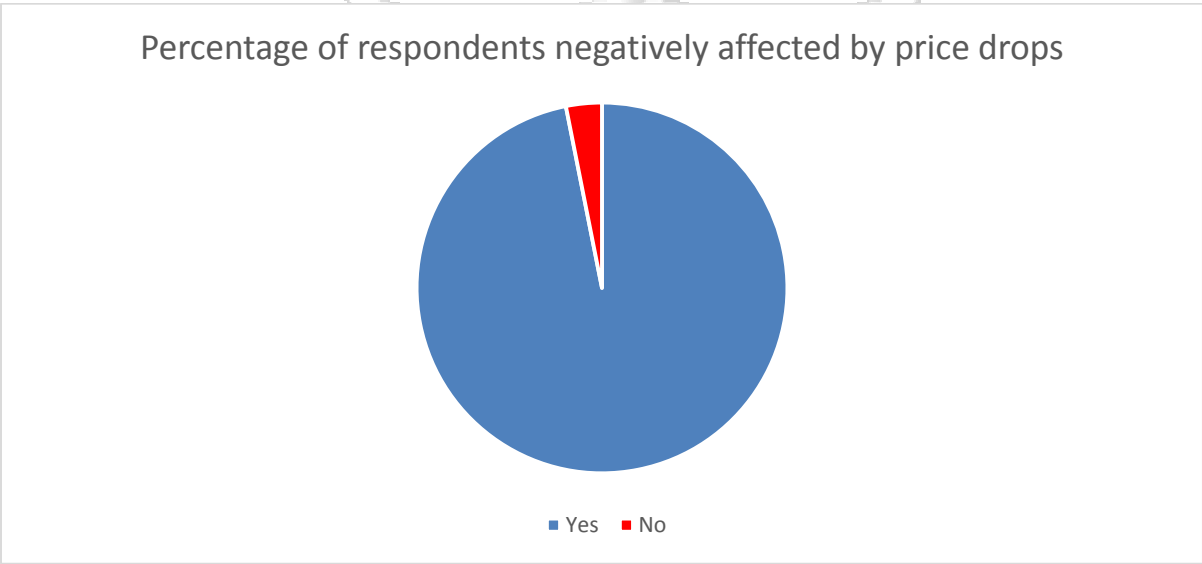


Figure 4.6 Percentage of respondents affected by commodity price drops

Figure 4.6 shows farmers from the sample population affected by price drops in the market. 97% of the sample population has been affected by falling prices of agricultural commodities; hence there is a need for the proposed system which provides mechanism to mitigate price fluctuations in the market.

Some of the consequences of the fluctuating prices as cited by the respondents include:

- High competition and poor quality production
- Low demand from buyers hence lower profits and lots of wastage of products as they are perishable
- Reduced or zero profit margin
- Abandoned the venture
- Unable to service Agricultural Finance Corporation loan
- Changed the time for planting
- Scaled down the production or sought loans to sustain it.

g) Respondents affected by price increases in the market.

Respondents (Buyers) were asked if they are negatively affected by price increases in the agricultural commodity market.

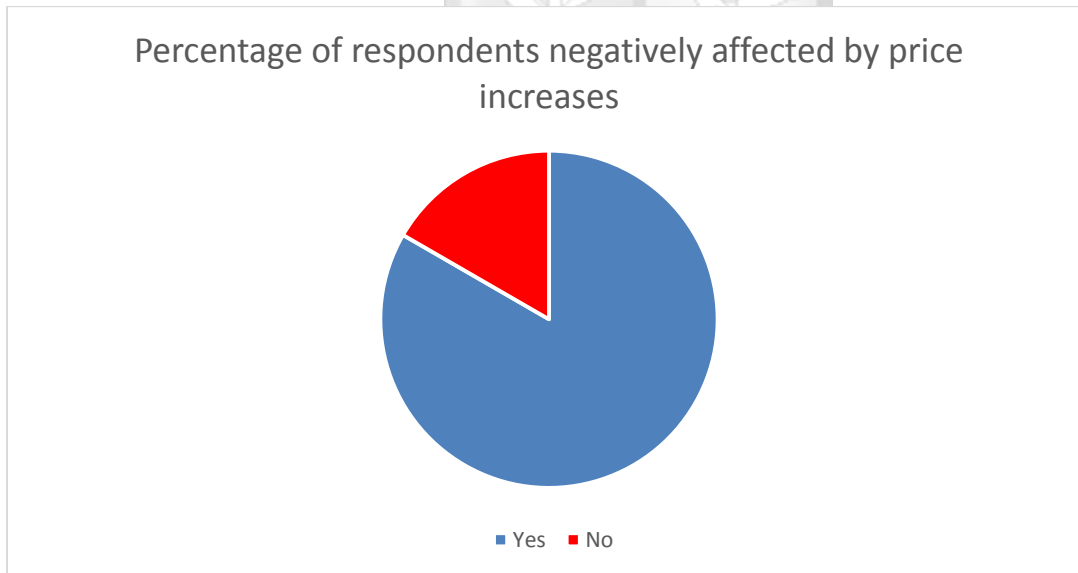


Figure 4.7 Respondents affected by price increases in the market

Figure 4.7 illustrates sample population affected by price increases of agricultural commodities. Evidently, 83% of the sample population has been affected by increasing prices at one time. This

justifies the need for the proposed system which provides mitigation for the risk of increasing prices.

h) Percentage of respondents aware of contract farming agreements

Respondents were asked if they were aware of farming contract agreements.

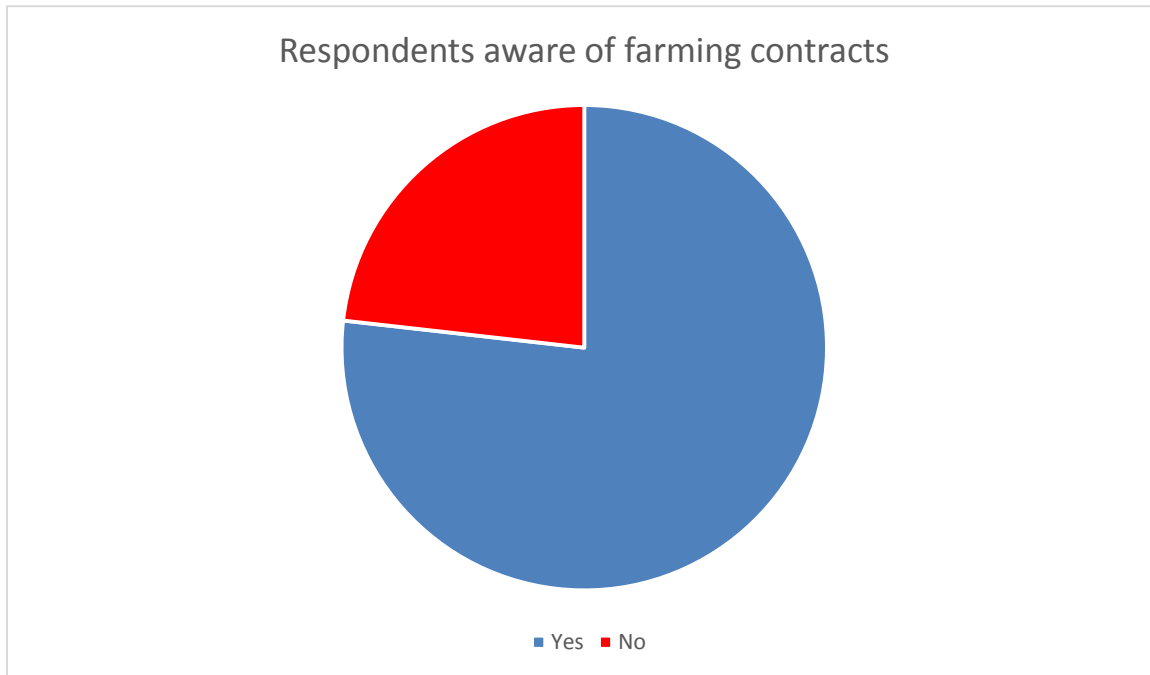


Figure 4.8 Awareness of respondents on farming contracts

Figure 4.8 provides evidence that 77% respondents are aware of contract farming agreements; this provides a good precondition for the proposed system as most users are already aware of the underlying concept of contract farming.

i) Respondents willing to enter contract farming agreements with buyers

Respondents (Farmers) were asked if they were willing to enter contracts with buyers to secure markets be for production

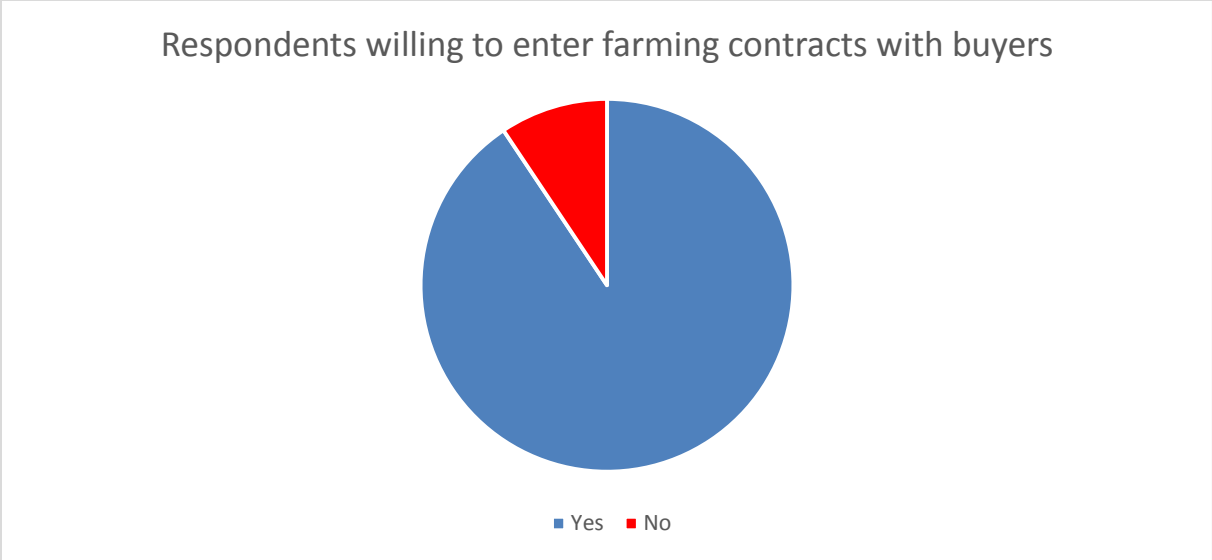


Figure 4.9 Respondents willing to enter contract farming agreements with buyers

Figure 4.9 illustrates that most respondents (farmers) would be willing to enter into contract farming agreements with buyers to secure market and prices before production begins. This provided positive feedback for the proposed system as farmers are ready to enter contracts provided on the system.

j) Respondents willing to enter contract farming agreements with farmers

Respondents (Buyers) were asked if they were willing to enter agreements with farmers for supply of produce.

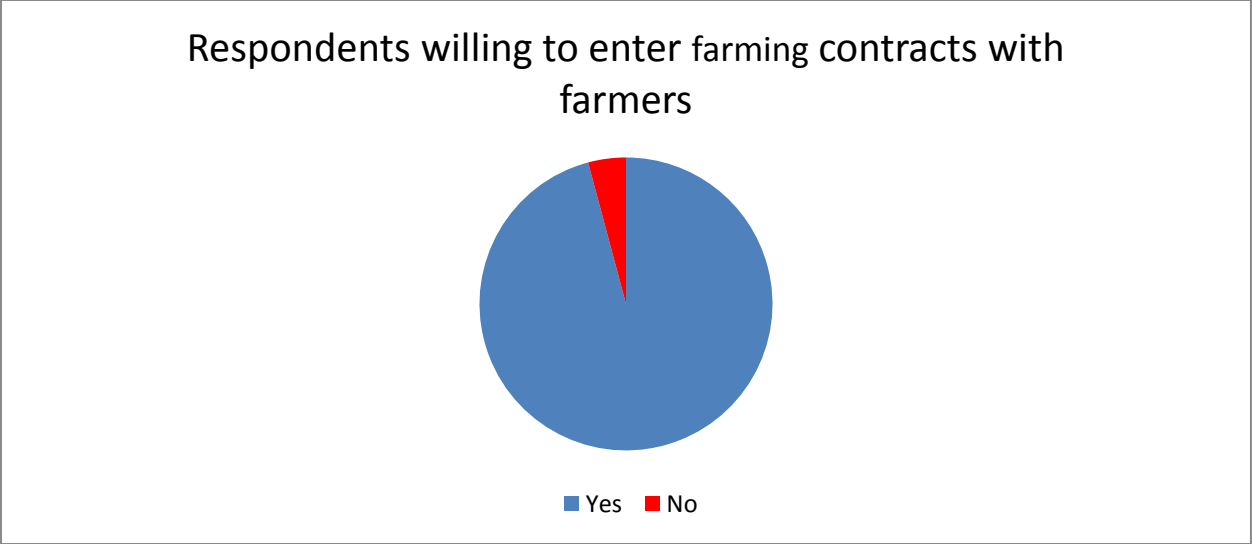


Figure 4.10 Respondents willing to enter contract farming agreements with farmers

Figure 4.10 illustrates that most respondents (buyers) would be willing to enter into contract farming agreements with farmer to secure quality supply and prices before production begins. 96% of the sample population is willing to enter contract farming agreements with farmers. This provided positive feedback for the proposed system as buyers are ready to create contracts on the system.

k) Respondents willing to use an MIS that guarantees market and price before production

Respondents were asked if they would be willing to use a marketing information system that enables them to secure price and market before production



Figure 4.11 Respondents willing to use an MIS to secure market and price

Figure 4.11 Provides ideal justification for the proposed system, as 100% of respondents are ready to use a MIS platform that enables them to secure prices and markets before production.

l) Respondents preferred client application for accessing MIS

Respondents were asked their preferred client applications for accessing market information systems.

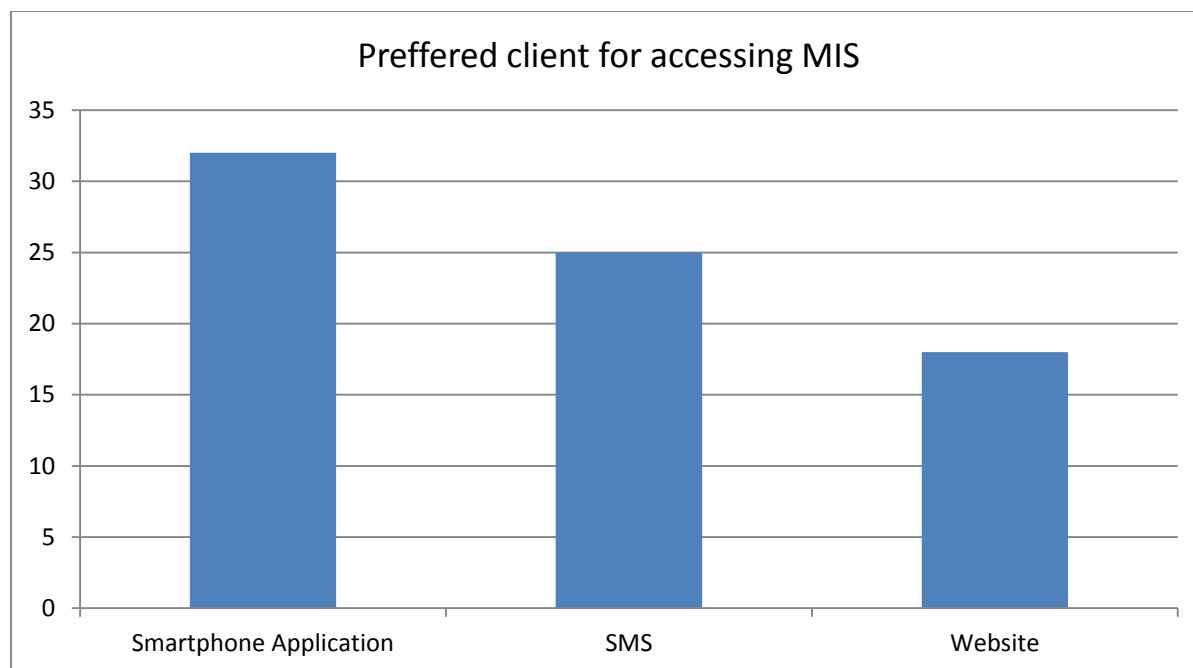


Figure 4.12 Client applications preferred by respondents in accessing MIS

Figure 4.12 shows the client applications preferred by respondents in interacting with MIS. The evidence points to the inclination that users prefer smartphone applications then SMS.

4.2.1 Feedback from interview at Capital Markets Authority

Based on feedback received from the capital markets authority (CMA), the Kenyan commodity exchange regulations do not currently accommodate trading of agricultural contracts (derivatives); it is currently open for trading of financial derivatives only. This implied that the scope of the system would include forward contracts and not future contracts. While similar in nature, the respondents at CMA explained that forward contracts are traded over the counter; regulated by contract law, referring to the agreement between the two parties. Future contracts, are traded in a formal commodity exchange regulated by CMA, this however, is not yet available in Kenyan policy. Before implementation of a formal commodity exchange, the Kenyan parliament must pass the warehousing act warehouse receipts forms the backbone of commodity exchange transactions.

4.2.2 Feedback from Historical Data

Based on the feedback received, the researcher was able to gain the following insights on the awareness and usage of farmers and buyers on the current Marketing information systems. The sub-sections below illustrate different research questions and response from the respondents.

4.2.2.1 Agricultural commodity price movement

Based on historical data collected from RATIN and CEREALMART information systems, the researcher was able to draw price movement information for various products in various markets in Kenya as illustrated below. For this dissertation study, the researcher sampled 3 products to monitor daily price movements; the products included maize, beans and wheat.

4.2.2.1.1 Maize

The movement of retail and wholesale market prices of maize in Kenya during March 2016 is summarized in Table 4.1.

Table 4.1 Maize prices for March 2016(Source: RATIN)

Country	Date	Retail (KES/90KG)	Wholesale (KES/90KG)
Kenya	15 th Mar, 2016	3833	2772
Kenya	16 th Mar, 2016	2700	2250
Kenya	17 th Mar, 2016	3151	2701
Kenya	18 th Mar, 2016	3869	2520
Kenya	19 th Mar, 2016	2592	2421
Kenya	20 th Mar, 2016	2520	2250
Kenya	21 st Mar, 2016	3149	2699

The above table can be represented in a linear chart showing price movement direction as show in Figure 4.13.

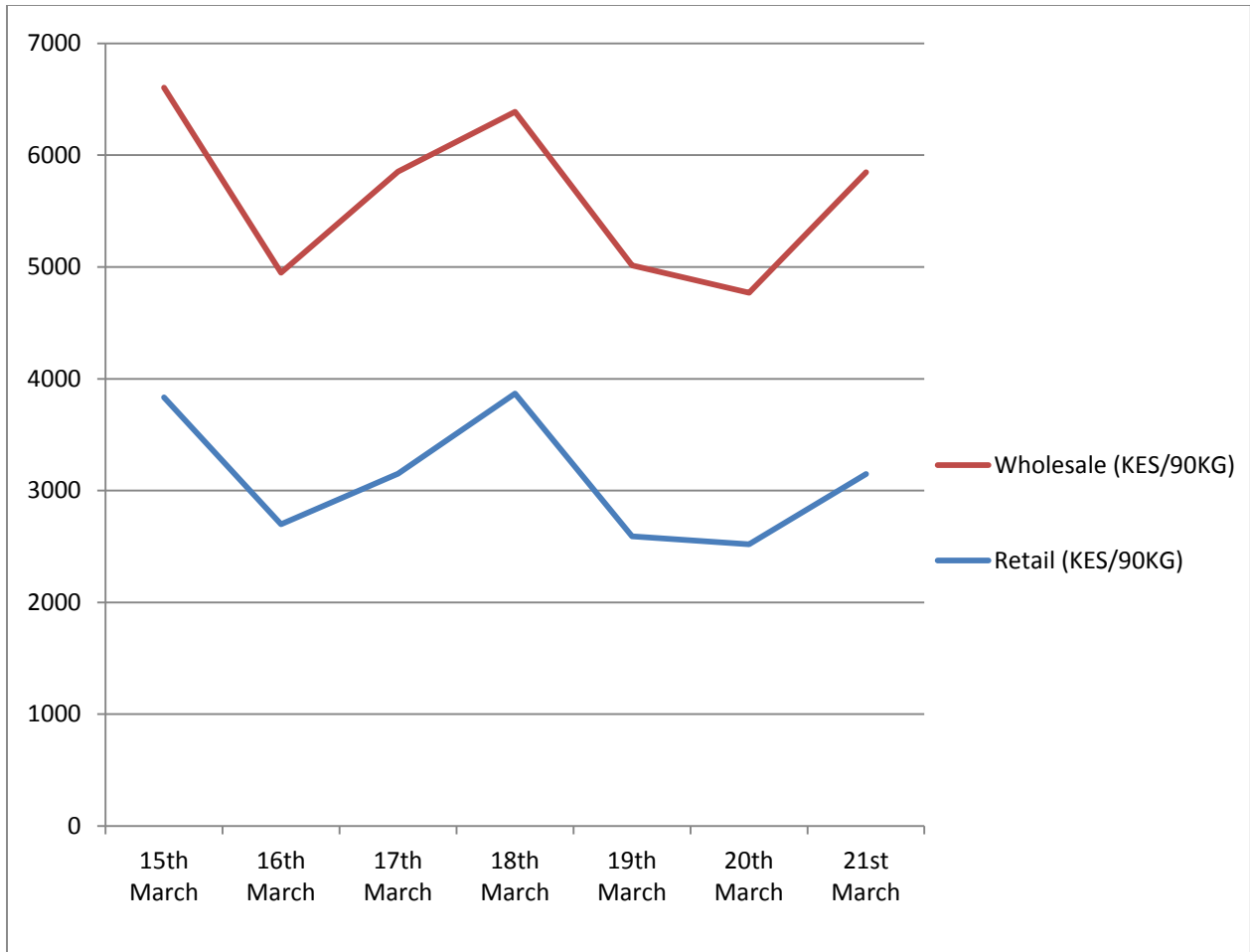


Figure 4.13 Price(KES/90kg) movements of Maize in March 2016(Source: RATIN)

Historical data from CEREALMART MIS shows maize prices over a longer duration of 3 months (June-August 2015), summarized in Figure 4.14.

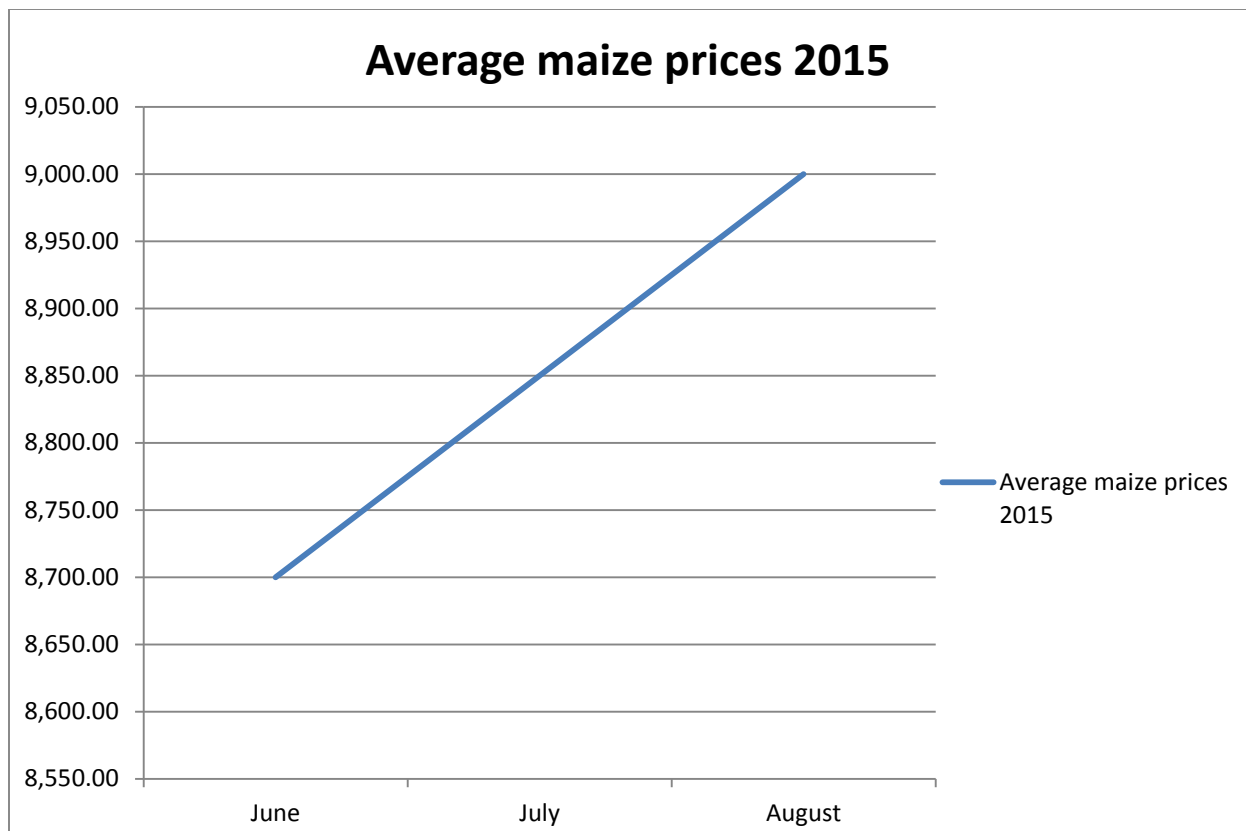


Figure 4.14 Price movements of Maize over 3 months

The upward movement of prices as shown in Figure 4.14 illustrates buyers concerns of rising prices, which ultimately reduces profit for them due to significantly increased buying price in the month of August.

4.2.2.1.2 Beans

The movement of retail and wholesale market prices of beans in Kenya during March 2016 is summarized in Table 4.2. These prices were recorded by RATIN officials across different markets in Kenya.

Table 4.2 Movement of beans market Prices in Kenyan markets 2016(RATIN)

Market	Date	Retail	Wholesale
Nakuru	2016-03-21	6301	4951
Eldoret	2016-03-21	7200	6480
Makueni	2016-03-21	6301	5401
Mombasa	2016-03-21	6751	4501
Machakos	2016-03-21	7200	5400
Eldoret	2016-03-18	7560	6300
Makueni	2016-03-18	6297	5398
Mombasa	2016-03-18	6747	4498
Nakuru	2016-03-17	6297	4948
Eldoret	2016-03-17	7646	6477
Makueni	2016-03-17	6297	5397
Mombasa	2016-03-17	6747	4498
Machakos	2016-03-17	7200	5400
Nakuru	2016-03-16	6300	4950
Eldoret	2016-03-16	7200	6300
Makueni	2016-03-16	6300	4500
Mombasa	2016-03-16	6750	4410
Eldoret	2016-03-15	7200	6480
Mombasa	2016-03-15	6750	4410

Table 4.2 can be represented in a linear chart showing price movement direction as in Figure 4.15.

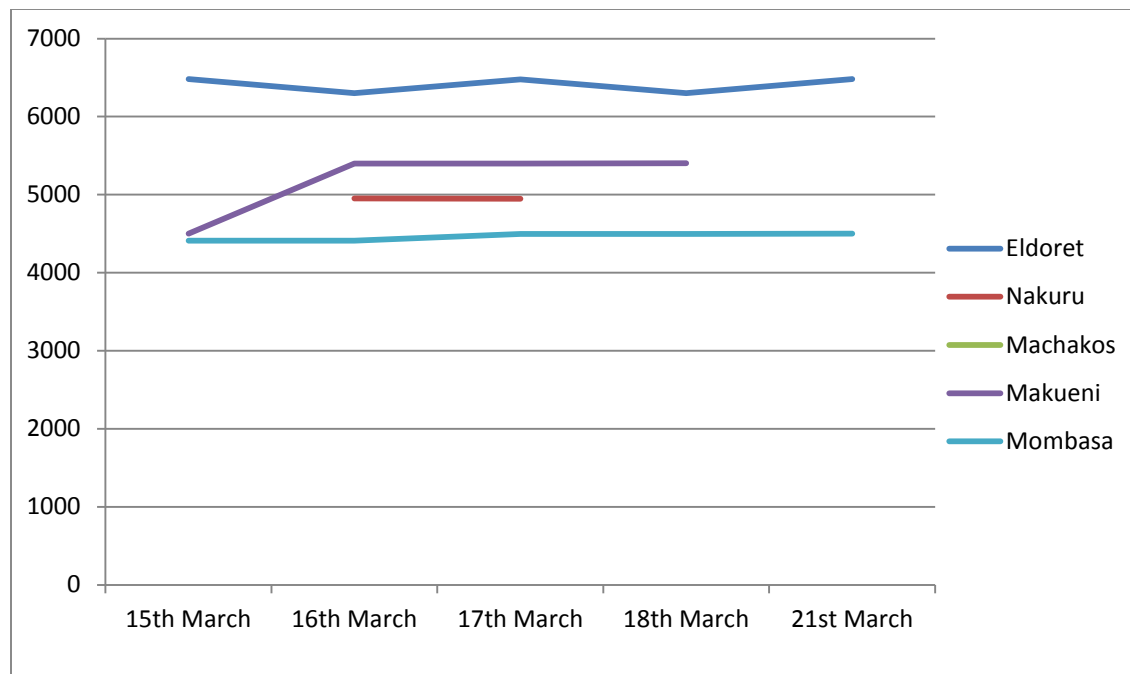
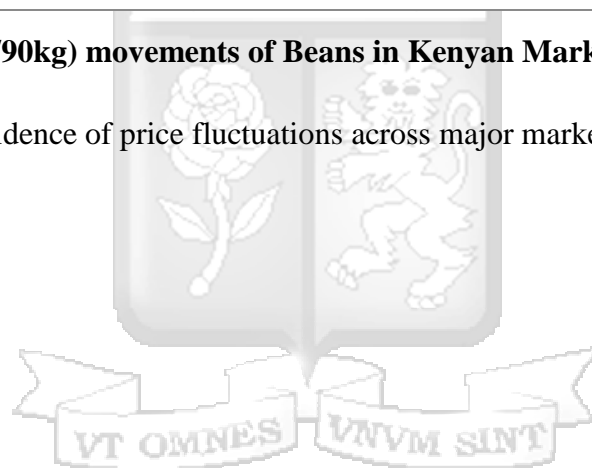


Figure 4.15 Price (KES/90kg) movements of Beans in Kenyan Markets in March 2016

Figure 4.15 illustrates evidence of price fluctuations across major markets in Kenya.



CHAPTER 5: SYSTEM DESIGN

This chapter describes the approach to designing the architecture of the system. It discusses the stakeholders involved and their expectations, and describes functional and non-functional requirements of the system based on the requirements gathered during data analysis. It also describes the data and process modeling approach implemented in the system. The system shall be referred to as Electronic Platform for Agricultural Commodities and Contracts (EPACC)

5.1 Agricultural Trading Platform Stakeholders

The Electronic Platform for Agricultural Commodities and Contracts (EPACC) brought different players in the agribusiness value chain together by creating a common solution their agricultural marketing systems. These actors included: Farmers, buyers and speculators, who interact with the system to transact in different ways.

5.1.1 Farmers

Farmers use the system primarily to source for markets for their produce. Their interaction with the system revolves around pricing and contract information. They want to access buyers for their ready produce in the spot markets, and also secure market prices before production through contract farming agreements. This interaction is made possible exclusively on mobile platforms via GSM and packet data technologies.

5.1.2 Buyers

Buyers mainly interact with the system to source suppliers of produce. They use the system to advertise contract farming agreements and order for commodities in the spot market. This interaction is done via mobile and web. Buyers also have the option of selling their forward contracts, to other buyers looking to acquire the commodity upon reaching the maturity date. The buyers' ability to sell off their contracts provides an opportunity for speculators.

5.1.3 Speculators

Typically, the role of the speculator in the system, is to off-set contracts from buyers and resell said contracts to other buyers before the contract maturity date. When the speculator anticipates that the price of a commodity such as maize is going to rise in the future, he purchases forward contract on maize, and resells it when the market price is higher. These transactions are done via mobile and web.

5.2 System Requirements

The system has an architecture based on the requirements gathered by the researcher both functional and non-functional. This architecture is composed of various components interacting together as shown in Figure 5.1. To achieve this architectural design, the researcher came up with functional and non-functional requirements for the system.

5.2.1 Functional Requirements

These are the primary objectives for building of the system, therefore must be implemented for the system to function as required.

a) Buy Products

Market participants use this function to buy products in the spot market. When a user visits the system on any client, he/she is able to see products on sale, and may bid for the item, if the seller accepts this bid the sale is completed.

b) Sell products

Market participants use this function to advertise products in the spot market. When a user (farmer) has products to sell, they post the product name, quantity, quality and offer price. If the user wishes to auction the produce, the offer price is considered as the starting bid. As buyers place bids, the bids are electronically transmitted to the buyer via SMS/push notifications. Once the user receives an acceptable bid, he/she may close the sale.

c) Advertise contract

Buyers use this function to source for suppliers through contract farming agreements. A buyer defines the product, quality, quantity, delivery-date and offer price. Once the details of the contract are ready the buyer posts this on the system and interested farmers apply/bid. Conversely, farmers can advertise contracts on their own produce to source for buyers before production.

d) Bid for contracts

Market participants use this function to engage in competitive price determination of prices when applying for contract farming agreements on the system.

e) Offset forward contract

A market participant holding a forward contract uses this function to sell the contract to a third party; essentially, the third-party off-sets the contract from the user during a purchase. This

function is available before maturity date of the contract after which current holding parties will do actual exchange of the commodities.

5.2.2 Non-functional requirements

These requirements describe how the system works rather than what it does. They include the following quality characteristics: performance, scalability, maintainability, interoperability, availability, capacity, security, usability and recoverability.

5.2.3 Technical requirements

The core system requires a Virtual Private Server running on a cloud service with over 1TB monthly bandwidth and over 500GB storage space. To access the system via an Android client, the user requires an Android device API level 9 or above. For access via SMS, the user simply requires a GSM handset with an active SIM card. Users accessing the system via the web client require a web browser with Javascript enabled.

5.3 System Architecture

5.3.1 Core system Architecture

The core application resides on a RESTFUL web service listening and serving requests from clients, and storing data in a relational database. See Figure 4.6. Authenticated clients are able to pass requests to the core system via the internet, and interpret responses for consumption by the end user. This setup is illustrated graphically in Figure 5.1.

5.3.2 Android Client Architecture

As illustrated in Figure 5.2, the android client interacts with the core system via internet connection, linking to the RESTFUL web service.

5.3.3 SMS Client Architecture

The SMS Client is integrated via Bulk SMS gateways and mobile money platforms. This includes, Safaricom Limited's Service Delivery platform (for bulk SMS) and its MPESA Instant Payment Notification service (IPN). A user makes a request by making a payment to their respective mobile money service provider (e.g. MPESA); the mobile money service provider forwards the request to the system via an IPN request to the web service, which is actively listening. This setup is illustrated in Figure 5.2.

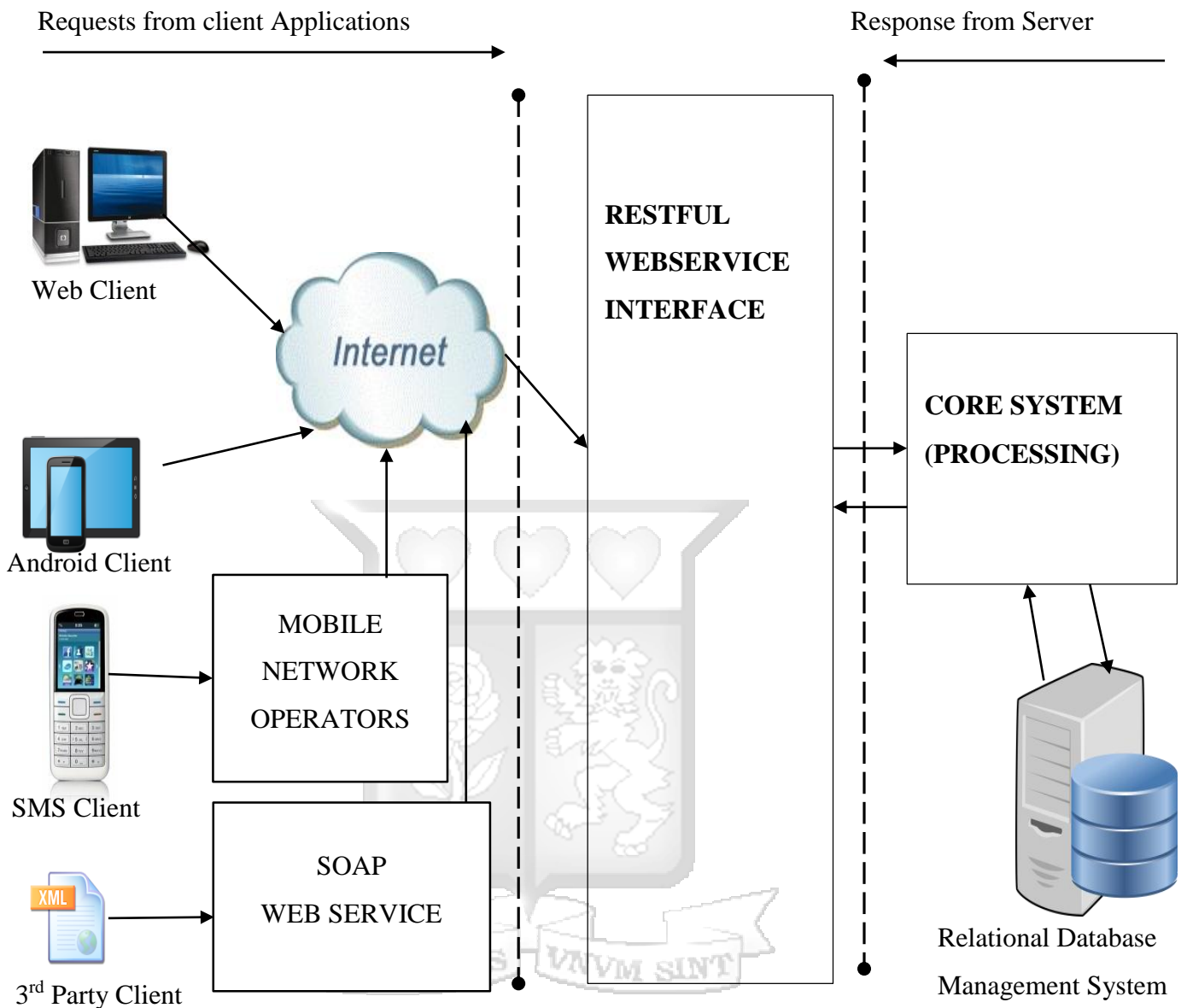


Figure 5.1 Core System Architecture

Figure 5.1 illustrates the system architecture in which requests from different client applications, Android, Web, SMS and 3rd Party applications; are served to the web application server via a RESTFUL web service. The web service serves the requests to the core web application system, which processes and relays the output to the client applications via the web service. Requests from 3rd party clients are mediated by a SOAP web service, whereas SMS client requests are received from SMS gateways provided by mobile network operators.

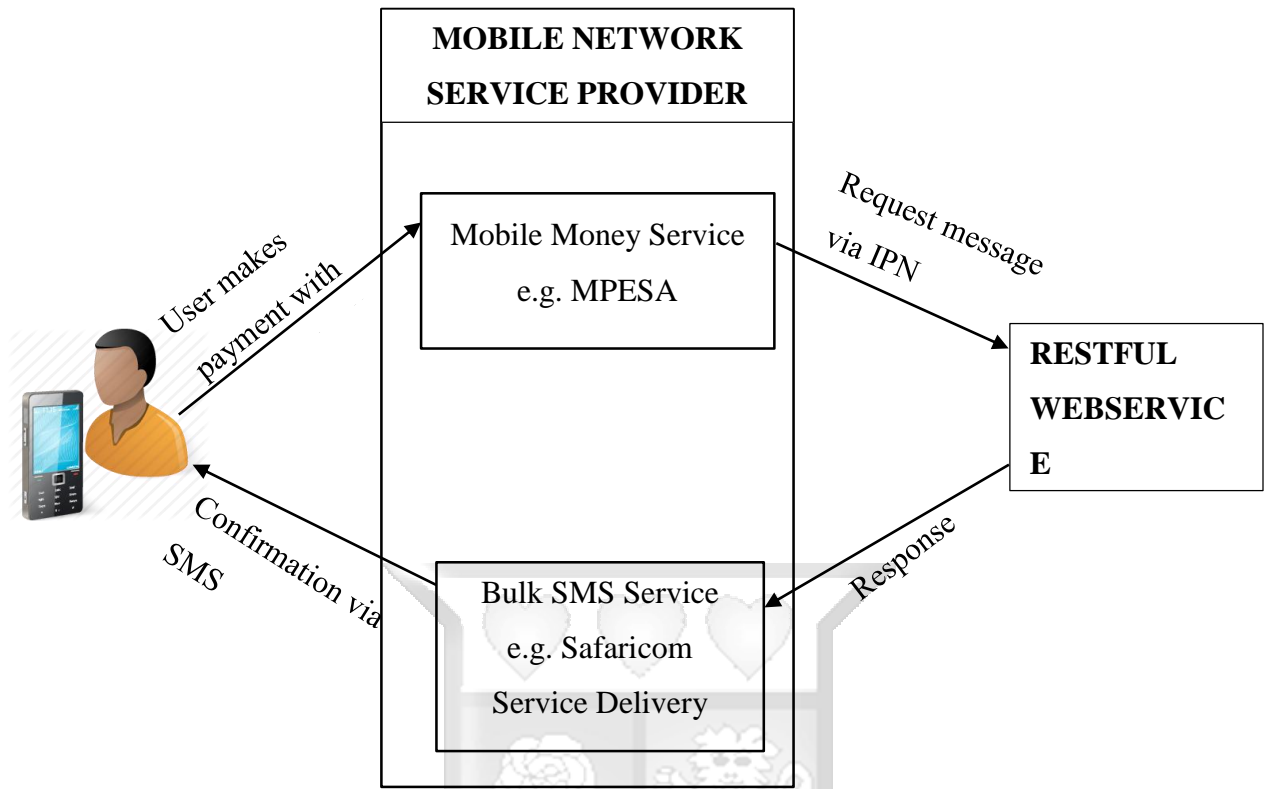


Figure 5.2 SMS client architecture

The payment made by the user in the initial step, is meant to verify the transaction is legitimate by deterring malicious or unusable requests. This requires a minimal amount of about 10 KES. When making the payment, the account paid to will be paired with the users phone number (a unique parameter) to form the request message passed to the core system.

5.3.4 Web Client Architecture

The web client adheres to a Model View Controller (MVC) framework Angular JS. This involves use of JQuery libraries in passing requests to the RESTFUL interface which serves the core application. A sample illustration of the Angular JS MVC framework can be seen in Figure 5.3.

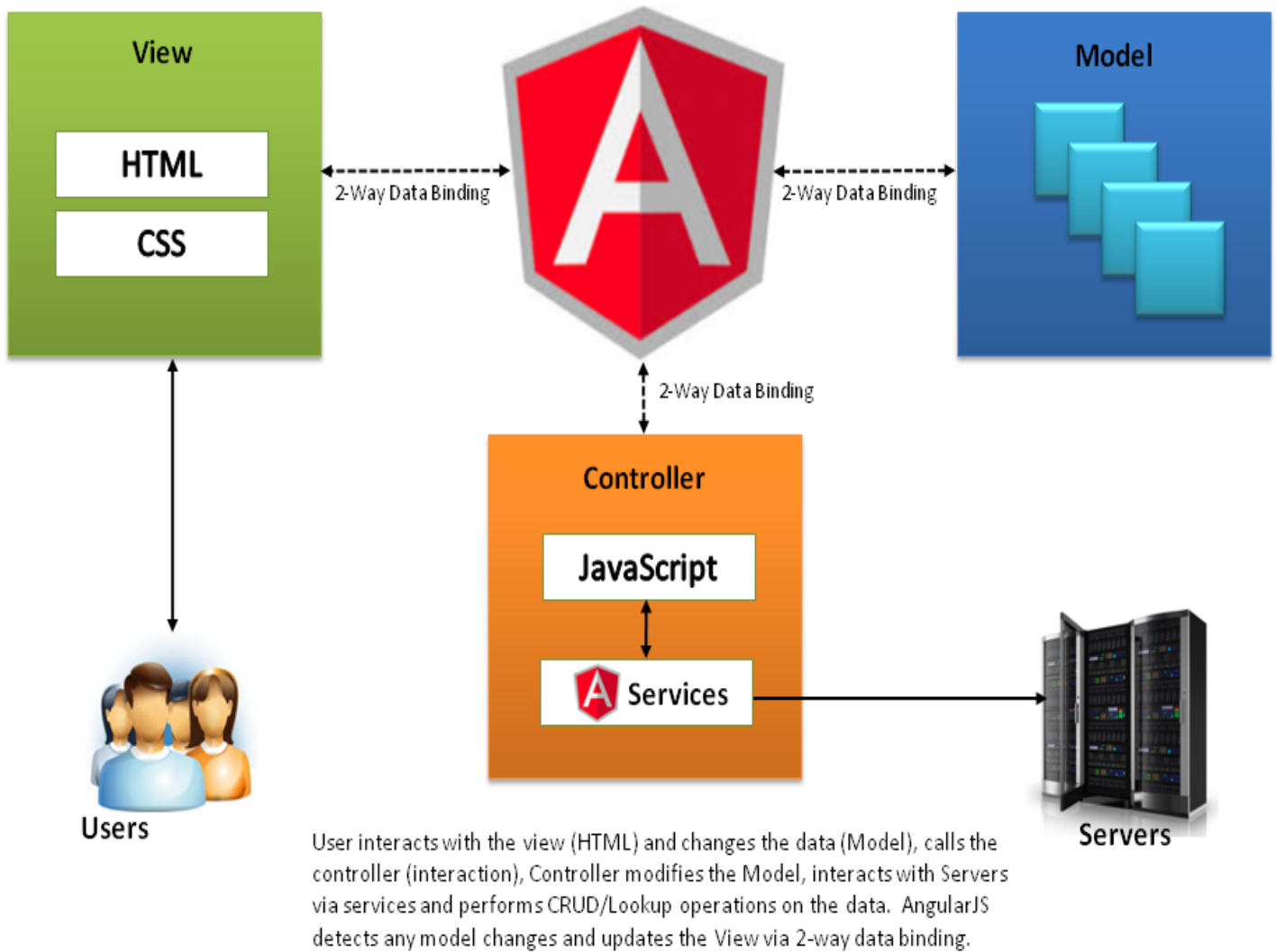


Figure 5.3 Angular JS MVC Overview from Avaldes (2014)

5.3.5 3rd Party API Architecture

Third parties access the core system functions via a SOAP web service. Endpoints are provided for 3rd party applications to consume data in JSON format, by passing GET/POST requests.

5.4 Interface Design

5.4.1 Mobile application Mockups

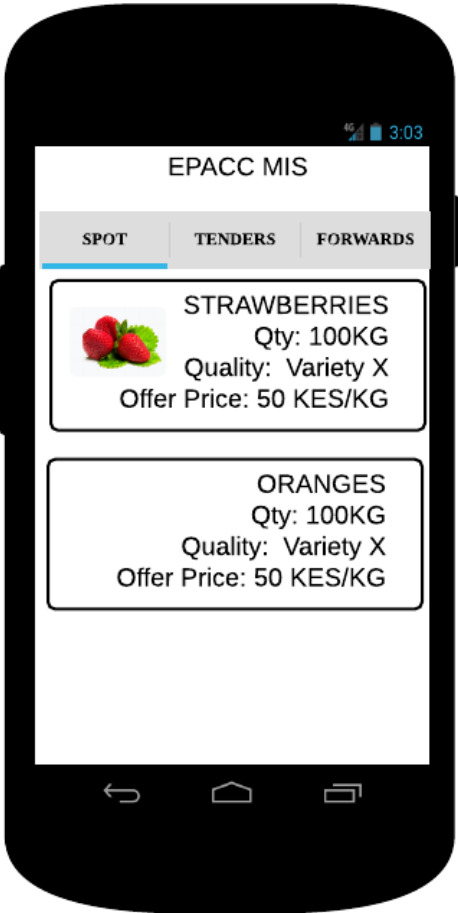


Figure 5.4 Displays the opening displayable for a registered user. The android application uses a tabbed layout with the spot market listings as the default tab.



Figure 5.4 List of Spot Market Listings

Figure 5.5 Displays the list of advertised farming contracts (tenders) when a user is interested in a particular tender, he/she clicks on the list item, and is redirected to the place bid interface shown in **Figure 5.7**

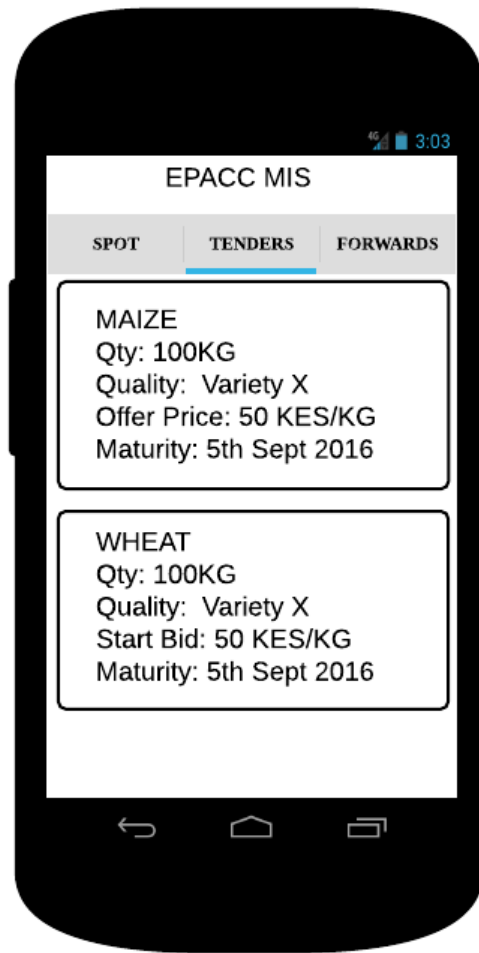


Figure 5.5 Mockup showing list of available farming contracts(tenders)



Figure 5.6 Displays the list of forward contracts available. If a user anticipates the Margin of a particular product shall rise in the future, he/she may purchase a forward of that specific commodity and selling it at a later date when the margin has increased. This is done by selecting the forward which prompts the MPESA API.

Figure 5.6 Mockup showing list of forward contracts



Figure 5.17 Provides an interface where users may place bid on attractive tenders so as to enter into farming agreements with the buyers.

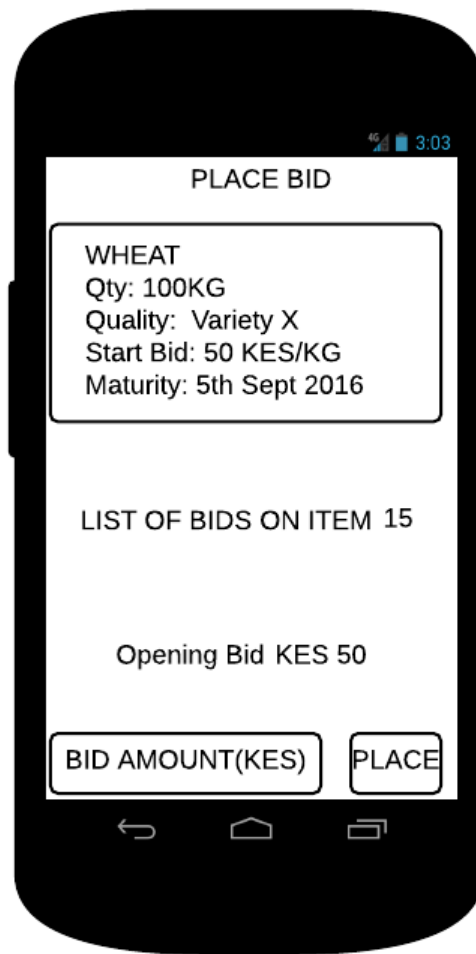


Figure 5.7 Mockup displayable for placing bid on contract

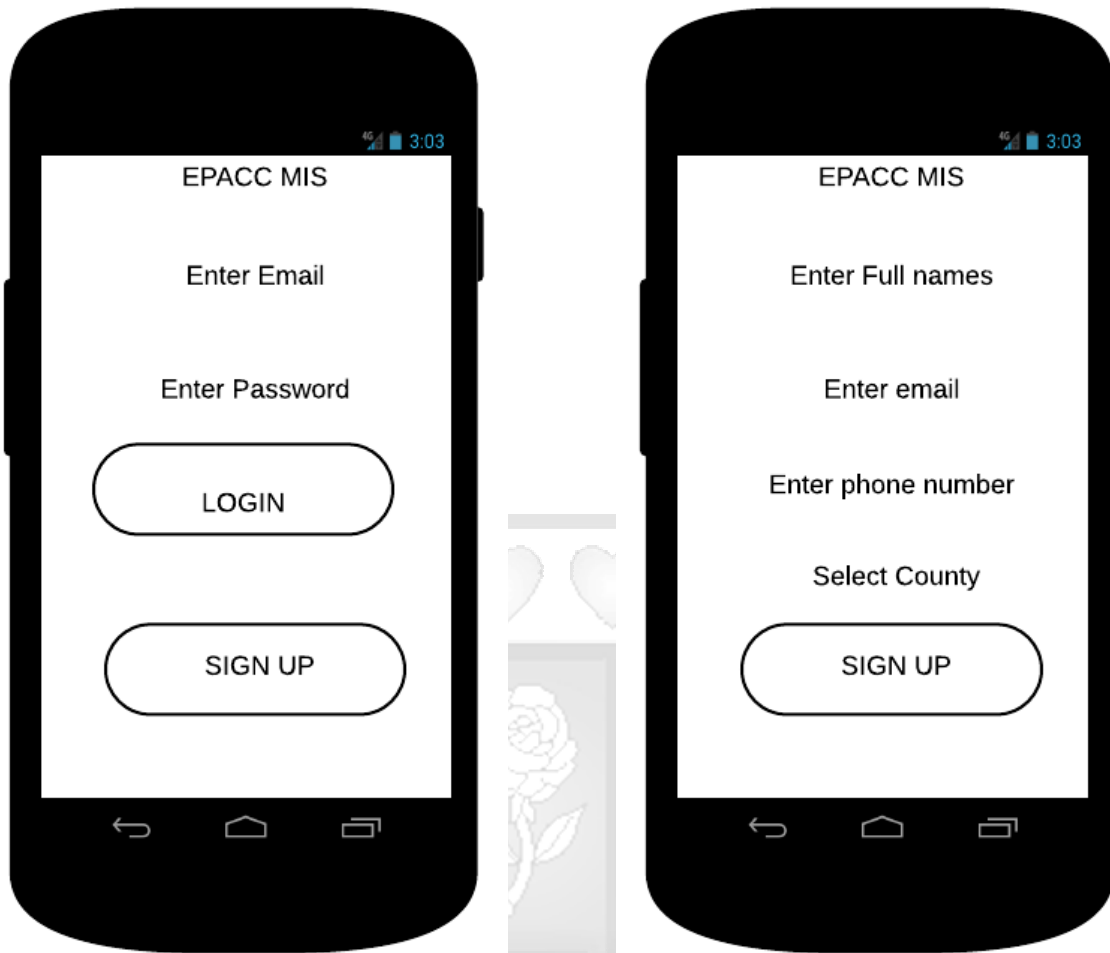


Figure 5.8 Login Interface

Figure 5.9 Register Interface

5.4.2 Web application wireframes

Figure 5.10 illustrates the web application wireframe; it consists of a menu and content section. The menu section contains the application title, and menu items which invoke other interfaces via AJAX calls. The menu also has a drop down menu item to the right, titled with the users name, this provides access to settings options such as change password, manage details or logout. The menu is static across all web interfaces. The content section provides an area where invoked interfaces are loaded.

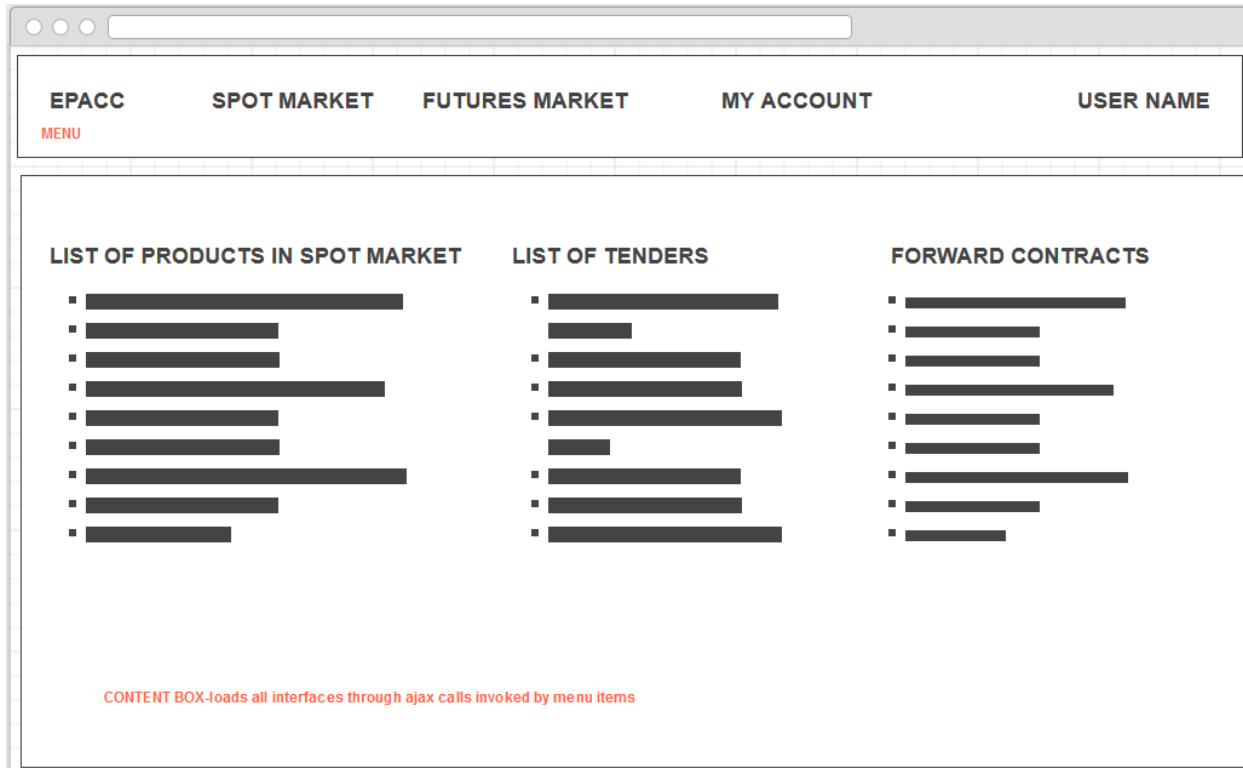


Figure 5.10 Web application dashboard wireframe

5.5 Security design

5.5.1 Web application security

The web application components are verified against the OWASP (Open web application security project) top 10 vulnerabilities. This applies to the core system, web service interfaces and SMS functions, as they reside on a web application.

5.5.2 Mobile application security

The mobile application code was obfuscated to slow down potential reverse engineering attempts. In addition to this, the application installable file(.apk) is signed to protect the application from unauthorized use.

5.6 Design diagrams

5.6.1 Use Case Diagrams

a) User Roles


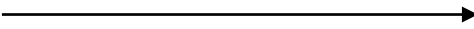
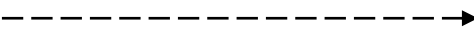


Table 5.1 Use case diagram-user roles

USE CASE	RELATED ACTORS
Register	Buyer, Farmer, Speculator
Login	Buyer, Farmer, Speculator
Buy/Sell	Buyer, Farmer
Create Contract	Buyer, Farmer
Bid Contract	Buyer, Farmer
Offset Contract	Speculator
View Report	Buyer, Farmers, Speculators, System Admin
Query	3 rd Party Client
Calculate Margin	Daemon
Send Notifications	Daemon
Deactivate Account	System Admin

b) Use case diagram notation

The use case diagram consisted of notations as shown in Table 5.2

Table 5.2 Use case diagram notation

NOTATION	DESCRIPTION
	Action/Use case
	Dataflow to system/.database
	Dataflow from system
	User
	Entity

c) Use case diagram

Figure 5.4 shows the use case diagram.

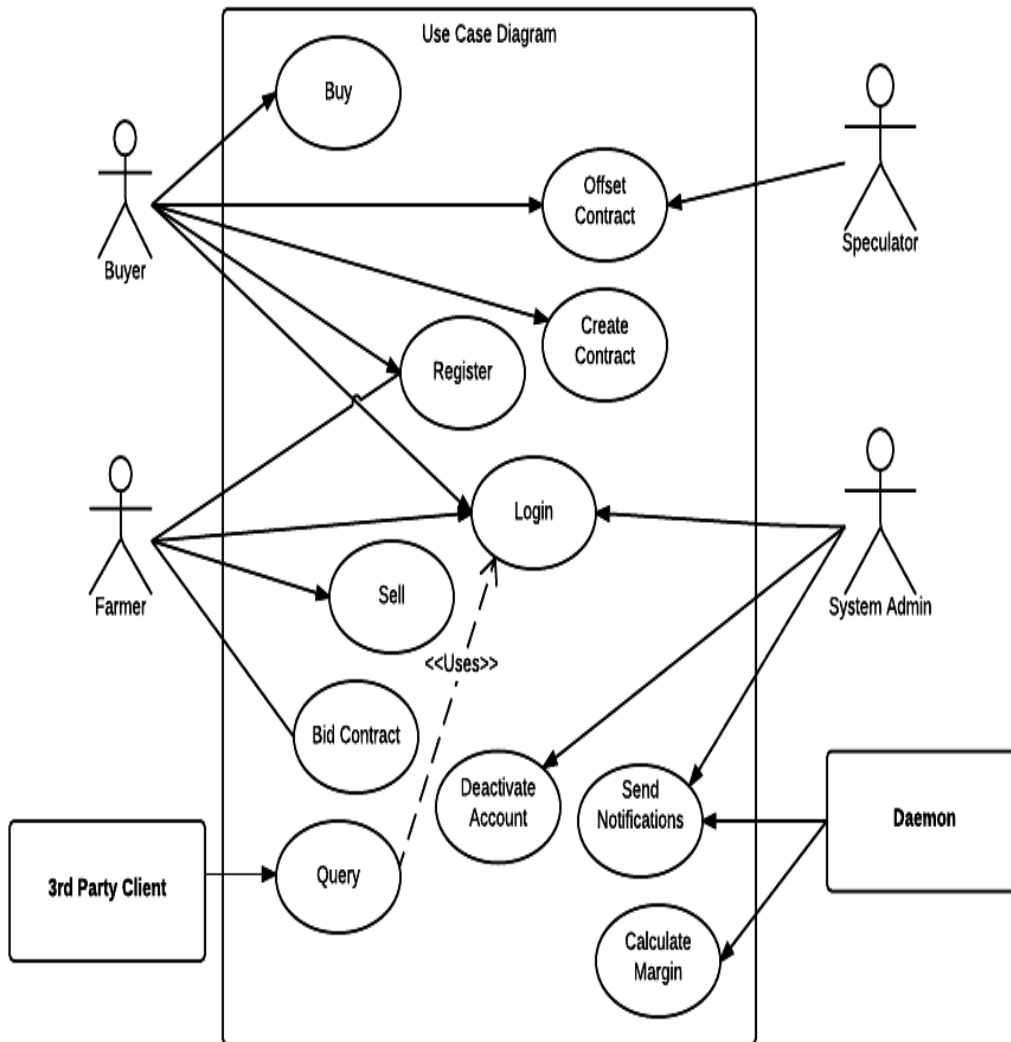


Figure 5.11 Use case diagram

d) Use case descriptions

i. Use case: Buy()

Table 5.3 illustrates full description of the Buy use case: **conversational style**

Table 5.3 Buy Use case in conversational style

ACTOR INTENTIONS	SYSTEM RESPONSIBILITY
------------------	-----------------------

1. Actor initiates this use case by selecting option to Buy/Sell product on the client application(i.e. Mobile or Web)	2. Client application provides displayable for input of purchase details
3. Actor enters details (Selects option to buy, enters quantity, quality, offer price and delivery date)	4. Client application validates details and posts data
	5. System receives data and checks that user is authenticated to transact
	6. System validates the delivery date to ensure it is logical
	7. System Processes the request
	8. Confirms successful transaction and list item request in spot market.
9. Receives confirmation response, with transaction code.	
Alternatives	
Step 4: Request fails due to network connectivity, actor is prompted to try again	
Step 4: Request fails due to invalid details, actor is requested to fill in all details correctly	
Step 5: Request fails due to unauthorized user, user is logged out of client application	
Step 6: Request fails due to bad date, actor is notified and requested to enter valid date	
Step 7: Request fails due to server error, action is rolled back	

ii. Create Contract

Table 5.4 illustrates full description of the Create Contract use case: **conversational style**

Table 5.4 Create contract use case in conversational style

ACTOR INTENTIONS	SYSTEM RESPONSIBILITY
1. Actor initiates this use case by selecting	2. Client application provides displayable

option to Create contract on the client application(i.e. Mobile or Web)	for input of contract details
3. Actor enters details (Selects option to buy, enters quantity, quality, offer price and delivery date)	4. Client application validates details and posts data
	5. System receives data and checks that user is authenticated to transact
	6. System validates the delivery date to ensure it is logical
	7. System Processes the request
	8. Confirms successful transaction and list item request as a tender.
9. Receives confirmation response, with transaction code.	
Alternatives	
Step 4: Request fails due to network connectivity, actor is prompted to try again	
Step 4: Request fails due to invalid details, actor is requested to fill in all details correctly	
Step 5: Request fails due to unauthorized user, user is logged out of client application	
Step 6: Request fails due to bad date, actor is notified and requested to enter valid date	
Step 7: Request fails due to server error, action is rolled back	

iii. Bid Contract

Table 5.5 illustrates Full description of the Bid Contract use case: **conversational style**

Table 5.5 Bid Contract use case in conversational style

ACTOR INTENTIONS	SYSTEM RESPONSIBILITY
1. Actor initiates this use case by clicking	2. Client application pulls interface for

button to Bid on a particular contract from the list of contracts on the client application(i.e. Mobile or Web)	filling bid amount on contract.
3. Actor confirms bid amount	4. Client application validates details and posts data
	5. System receives data and checks that user is authenticated to transact
	6. System validates the bid amount
	7. System Processes the request
	8. Confirms successful transaction and places the bid
9. Receives confirmation response	
Alternatives	
Step 4: Request fails due to network connectivity, actor is prompted to try again	
Step 4: Request fails due to invalid details, actor is requested to fill in all details correctly	
Step 5: Request fails due to unauthorized user, user is logged out of client application	
Step 6: Request fails due to invalid bid amount, user requested to try again	
Step 7: Request fails due to server error, action is rolled back	

iv. Offset Contract

Table 5.6 illustrates Full description of the Offset Contract use case: **conversational style**

Table 5.6 Offset contract use case in conversational style

ACTOR INTENTIONS	SYSTEM RESPONSIBILITY
1. Actor initiates this use case by	2. Client application provides displayable for

selecting option to offset contract(Buy) from a list of forward contracts available on the client application(i.e. Mobile or Web)	confirmation of purchase
3. Actor approves option to offset contract and makes payment of margin via mobile money service	4. Mobile money network validates payment and forwards details to system for reconciliation
	5. System receives data and checks that the paid margin is accurate
	6. System validates the contract information to ensure it is a forward contract
	7. System Processes the request
	8. Confirms successful transaction and the ownership of the contract is changed to new holder
9. Receives confirmation response, with transaction code.	
Alternatives	
Step 3: Request fails due to network connectivity, actor is prompted to try again	
Step 4: Request fails due to invalid service provider error, user contacts system administrator for resolution	
Step 5: Request fails due to insufficient margin amount, the payment is rolled back user asked to try again with sufficient funds	
Step 6: Request fails due to invalid contract, payment is rolled back, user notified.	
Step 7: Request fails due to server error, action is rolled back	

5.6.2 Sequence Diagram

Figure 5.5 shows the system sequence diagram.

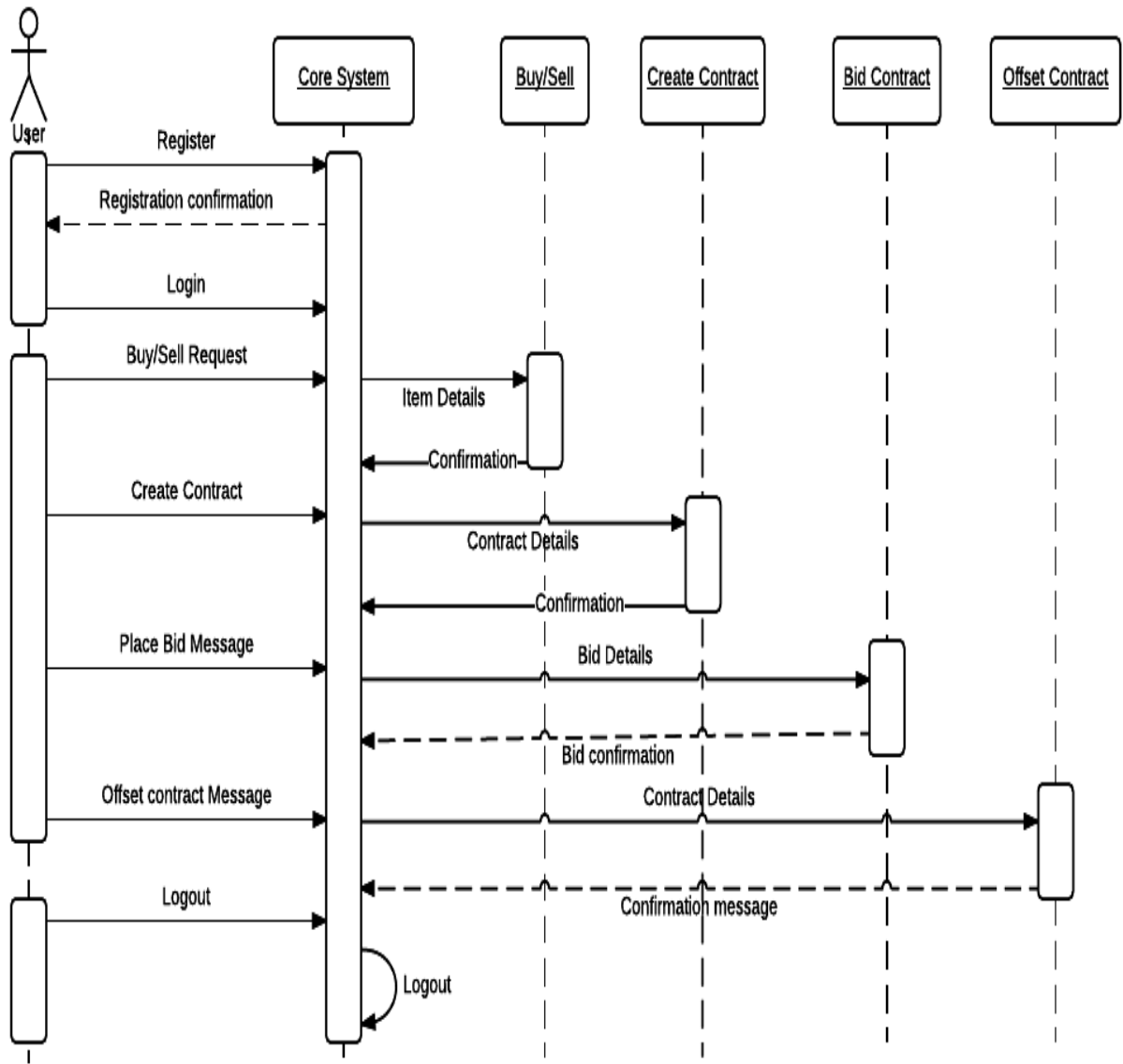


Figure 5.12 System Sequence Diagram

5.6.3 Entity Relation Diagram

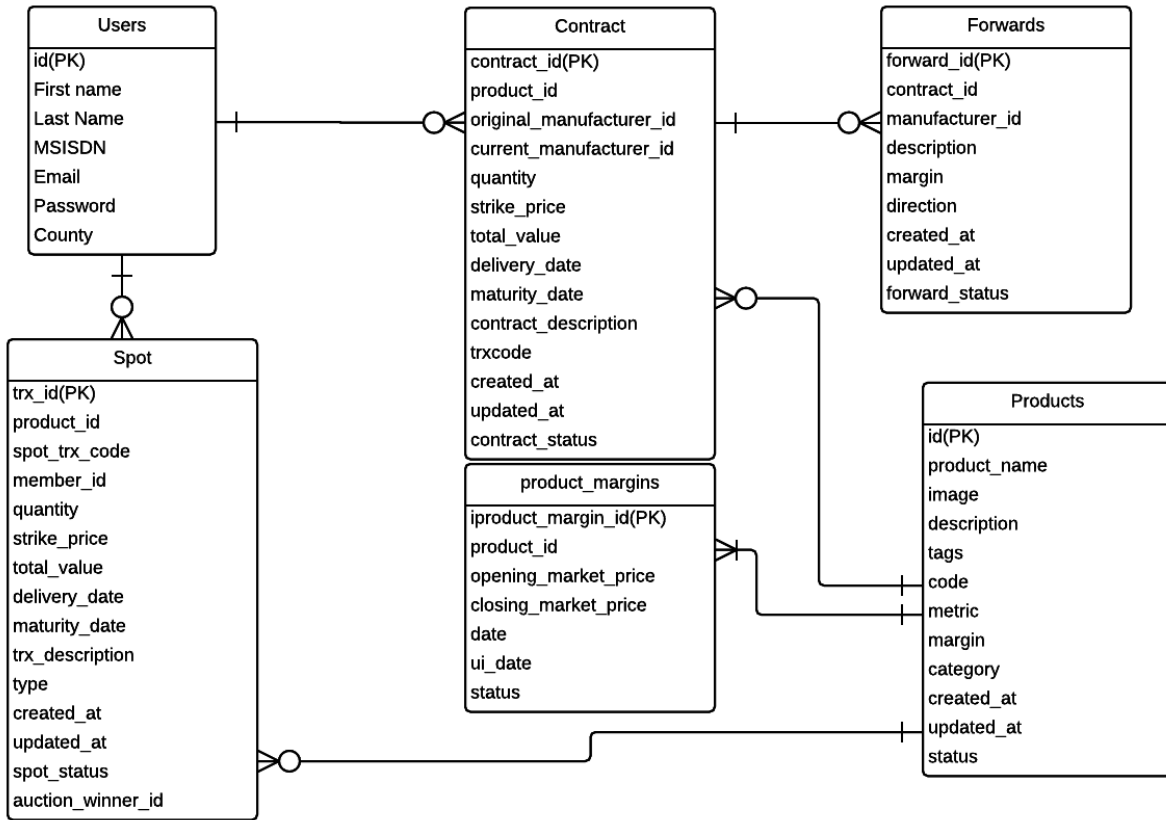


Figure 5.13 ERD Diagram

The connectors in the ERD diagram illustrated in **Figure 5.6** may be interpreted as shown in the ERD notation diagram on **Figure 5.7**.

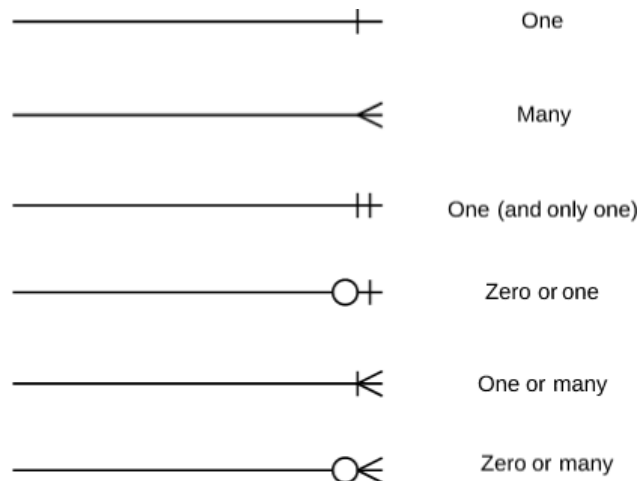


Figure 5.14 ERD notation diagram

5.6.4 Database Schema

a) Members Table

Table 5.7 Members database table schema

Column	Data Type	NULL	Description
id (PK)	Numeric(10), Primary Key	NO	Primary Key
fname	Alphanumeric(255)	NO	Members First name
lname	Alphanumeric(255)	NO	Members Last name
msisdn	Alphanumeric(20), Unique	NO	Members phone number
county	Alphanumeric(255)	NO	Member home County
bio	Text	NO	Members description
gcm_api_id	Alphanumeric(255)	NULL	Members cloud messenger ID for push notifications
api_key	Alphanumeric(255)	NULL	Google Cloud messenger Server Key
email	Alphanumeric(255)	NO	Members email address, Unique
password	Alphanumeric(60)	NO	Members password
updated_at	Timestamp	NO	Last time members details was updated
status	Numeric(11)	NO	Flag (1-member active, 0-member deactivated, 2-member opted out)

b) Contracts Table

Table 5.8 shows the database schema for the contracts table.

Table 5.8 Contracts database table schema

Column	Data Type	NULL	Description
contract_id	Numeric(10)	NO	Primary Key
product_id	Numeric(11)	NO	Foreign Key(Products table)
original_manufacturer_id	Numeric(11)	NO	Foreign Key (Members table)- member who creates the contract
current_manufacturer_id	Numeric(11)	NO	Foreign Key (Members table)- member who currently holds the contract after offsetting
quantity	double(15,8)	NO	Total quantity
strike_price	double(15,8)	NO	Price/unit at which contract is givem
total_value	double(15,8)	NO	Quantity multiplied by strike price
maturity_date	Alphanumeric(255)	NO	Date in future where contract matures
contract_description	Text	NO	Details of contract
trxcode	Alphanumeric(255)	NO	Transaction code for contract
created_at	Timestamp	NO	Date of contract creation
contract_status	Numeric(11)	NO	Flag(1-Contract is a forward, 2- contract is issued but not offset, 3- Contract is still a tender)

c) Forwards Table

Table 5.9 Forwards database table schema

Column	Data Type	NULL	DESCRIPTION
forward_id	Numeric(10)	NO	Primary Key
contract_id	Numeric(11)	NO	Foreign Key(Contracts table)
manufacturer_id	Numeric(11)	NO	Foreign Key(Members table)
description	Alphanumeric(255)	NO	Details about forward
margin	double(15,8)	NO	Price at which forward is acquired
direction	Alphanumeric(5)	NO	Positive/negative direction based on price of previous forward of the same contract
created_at	Timestamp	NO	Date/time forward is created
updated_at	Timestamp	NO	Date/time forward us last updated
forward_status	Numeric(11)	NO	Flag(1-Active forward,0-Sold forward)

d) Products table

Table 5.10 Products database table schema

Column	Data Type	Null	Description
id	Numeric(10)	NO	Primary key
product_name	Alphanumeric(255)	NO	Product name
image	Alphanumeric(255)	NO	Link to product image
description	Text	NO	Description of product
tags	Text	NO	Key words associated with product
code	Alphanumeric(255)	NO	Unique System code for product
metric	Alphanumeric(255)	NO	Measurement unit for product
margin	Double	NO	Current margin for product forwards
category	Alphanumeric(255)	NO	Classification of product
updated_at	Timestamp	NO	Last time product was updated
status	Numeric(11)	NO	Flag(1-Product available, 0-product unavailable)

e) **Spot Table**

Table 5.11 Spot database table schema

Column	Data Type	Null	Description
trx_id	Numeric(10)	NO	Primary Key
spot_trx_code	Alphanumeric(10)	NO	Transaction code for spot market item
product_id	Numeric(11)	NO	Foreign Key(Products table)
member_id	Numeric(11)	NO	Foreign Key(Members table)
type	Alphanumeric(255)	NO	Transaction type(Buy/Sell)
trx_description	text	NO	Transaction description
quantity	double(15,8)	NO	Quantity of product for purchase/sale
strike_price	double(15,8)	NO	Price agreed for sale/purchase
total_value	double(15,8)	NO	Strike price multiplied by quantity
auction_winner_id	Numeric(11)	NO	Foreign Key(Member ID) member awarded spot request
delivery_date	Numeric(11)	NO	Expected for product to be delivered
maturity_date	Alphanumeric(255)	NO	Deadline date for product to be delivered
created_at	Timestamp	NO	Date/time spot transaction request was made
updated_at	Timestamp	NO	Date/time Spot transaction request is edited
spot_status	Numeric(11)	NO	Flag(1-Pending,2-Deleted,0-Sold)

f) Product Margins table

Table 5.12 Product margins database table schema

Column	Data Type	Null	Description
product_margin_id	Numeric(11)	NO	Primary Key
product_id	Numeric(11)	NO	Foreign key(Products table)
opening_market_price	Double	NO	Product margins at opening of daily trading
closing_market_price	Double	NO	Product margins at closing of daily trading
date	Numeric(11)	NO	Date in format (Year-month-date)
ui_date	Alphanumeric(50)	NO	Date displayed on interface
status	Numeric(1)	NO	Flag(1-Active, 0-Past)

5.7 Summary

The data collected provided justification to the researcher on the necessity of building the electronic trading platform for agricultural commodities and contract farming agreements. Based on the analysis of data, it became evident that farmers experience fluctuating prices and existing marketing information systems have no mechanism of mitigating this risk. The respondent's feedback displays a need for a marketing information system that guarantees market outlets for farmers at acceptable prices. Similarly, buyer's responses indicate a need for a source of quality produce at acceptable prices. Market speculators are also looking for a means to invest in agricultural markets and gain from the fluctuating prices, evident from the responses cited. The electronic trading platform for agricultural commodities and contract farming agreements would be welcome as a key tool in the agribusiness ecosystem. It serves as a hedging tool for farmers and buyers, whereas creating opportunities for speculators to gain from the evident price fluctuations of agricultural commodities. The system design was achieved based on data collected and analyzed.

CHAPTER 6: SYSTEM IMPLEMENTATION

This chapter describes the system development and testing process for the core system and associated clients. The core system is implemented on a PHP5 web server, whereas the clients are developed across GSM, Android and Web 2.0 technologies. The SMS clients deployed are integrated with MPESA IPN services as well as Safaricom SDP. The Android clients are developed using native programming tools. Web clients are implemented using HTML5 and Javascript using Google's Material design user interface framework. Third party clients are enabled access via SOAP web services, which provides strict messaging protocols between the third party clients and the core system. This chapter also discusses the process of system testing.

6.1 Core System

This tool provides the core functionality of the agricultural commodities and contracts trading platform. It is the central point where all functionality manipulating data are carried out and the data stored in a relational database management server. The system is built on a publicly web server, for easy access by clients over the internet.

6.1.1 Development Tools

The core system resides on an easy apache 2 web server compiled with PHP5 and MySQL 5.6. The web server environment is implemented on a PHP5 framework. The PHP5 web application implements all data management and processing functions and is available to system clients via a RESTFUL web service. The RESTFUL web service is implemented to receive requests via POST/GET from clients and respond with JSON encoded data for processing. The database environment is implemented on MySQL with user interface accessibility via PHPMYAdmin. Service endpoints are also defined via WSDL to give third party clients access to the core system.

6.1.2 Application Components

The core system allows client applications to perform the following key functions.

a) Buy Product

This function is invoked when a user submits the "Buy Product" form via the respective client application, specifying details of: product code, quantity, quality and offer-price. This function of the core system will enable the request to be validated and the product purchase request to be

listed in the spot market. It will also invoke a notification to be sent out to all suppliers of the specified product within the users' geographical area.

b) Sell product

This function is invoked when a user submits the "Sell Product" form via the respective client application, specifying details of: product code, quantity, quality and offer-price. This function of the core system will enable the request to be validated and the product sale request to be listed in the spot market. It will also invoke a notification to be sent out to all buyers of the specified product within the geographical area of the user.

c) Create contract

This function enables buyers to source for suppliers through creation of contract farming agreements on the system. A buyer specifies the product, quality, quantity, delivery-date and offer price on the client application and submits. Conversely, suppliers (farmers) can also create contracts on their own produce to source for buyers. Created contracts are listed as tenders and interested parties invited to bid via SMS notifications.

d) Bid for contracts

Market participants use this function to engage in competitive price determination of prices when applying for contract farming agreements on the system. Users place bids via client applications and these bids will be availed to contract sponsor for approval.

e) Daemon

The core system provides a daemon feature that runs every five minutes to trigger events. Events managed by the daemon include the following:

- Sending of scheduled notifications
- Updating product margins based on changing spot market prices
- Deactivating inactive accounts
- Sending reminders

f) Offset forward contract

This function enables users to transfer contract sponsorship from one user to the other. Users access this function by clicking the offset button available on their list of contracts.

6.2 SMS Clients

This tool provides users on the GSM network easy access to core system functionality via their respective mobile service provider networks.

6.2.1 Development Tools

The SMS client is a PHP5 interface that is developed on the Safaricom Service Delivery Platform, which provides access to bulk and premium rate SMS gateways. It has a listening interface that receives requests via MPESA IPN and responds to the requests via Bulk SMS.

6.2.2 Application Components

a) MPESA IPN Interface

This function enables the user to send requests to the system through paying with the MPESA mobile money platform.

For example a user would like to buy 10KG of Tomato; this request is sent to the SMS client as follows. The user visits the MPESA menu on their mobile device, selects Lipa na Mpesa->Pay bill->Enters business number(965600)->Enters account number(e.g. BUY TOMATO 10)->Enters PIN and submits. Once the payment is verified on M-PESA, the mobile money system will automatically send a HTTP/GET request to the MPESA IPN Interface, with details of the payment. The details will be processed using the mobile number of user (MSISDN) and account number (Requested service). Once processing is done the interface will invoke a bulk SMS response to the user with details of the completed transaction.

b) Bulk SMS Gateways

This tool provides a means of sending notifications to users post-transaction. It is mainly used in response messages to give feedback or notifications; such notifications include:

- Registration confirmation
- Tender win notification

c) Premium SMS Gateway

Similar to the Bulk SMS Gateway, this option also provides notification services; however, the notifications are paid for by recipient of the message via airtime. To use this function, the user subscribes by sending a key word to the service short code.

For example, a user selling Tomato would like to get notifications every time there is an order for tomatoes. The user begins by sending the word “SELL Tomato” to the short code 20009;

once this is done the user will be notified every time there is a request for tomatoes on the system.

d) Subscribe Manager Interface

This function enables users to register for SMS notifications on important updates e.g. availability of contracts, orders for products, and pricing information. The notifications may be sent via Bulk or Premium SMS gateways, depending on the user's preference.

6.3 Android Clients

6.3.1 Development tools

This application was developed on a native platform, hence is able to access native functionalities such as GPS, Barcode reader camera and others. The client was developed using Android Studio 1 tested on Huawei G7 mobile device.

6.3.2 Installation details

To install the android client, the user requires an android device, API level 9 or higher. The application is available on the Google play store, or on the download link as provided on the system web application. When installing, the user is required to provide the application permissions for Internet, reading external storage, vibration, waking the device and receiving push notifications.

6.3.3 Application Components

The core application functions for the android client are illustrated in Figures 6.1-6.10.

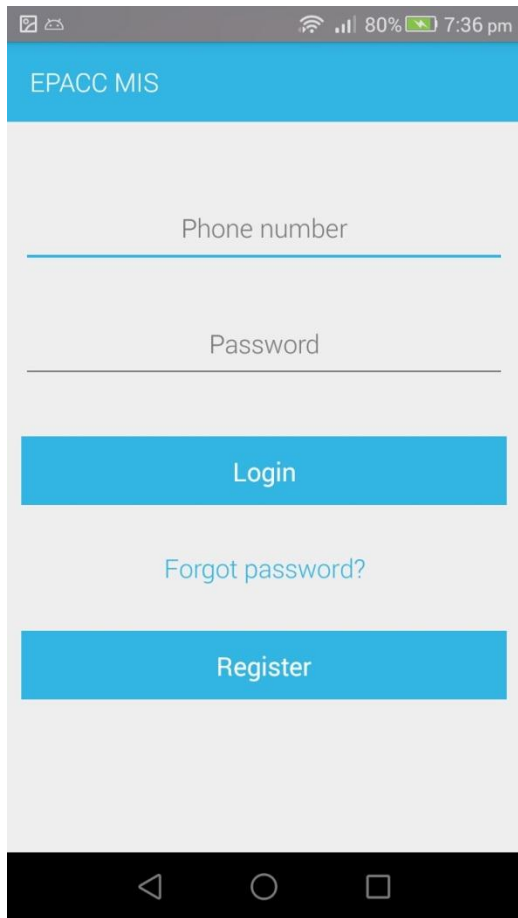


Figure 6.1 Mobile Login Screen

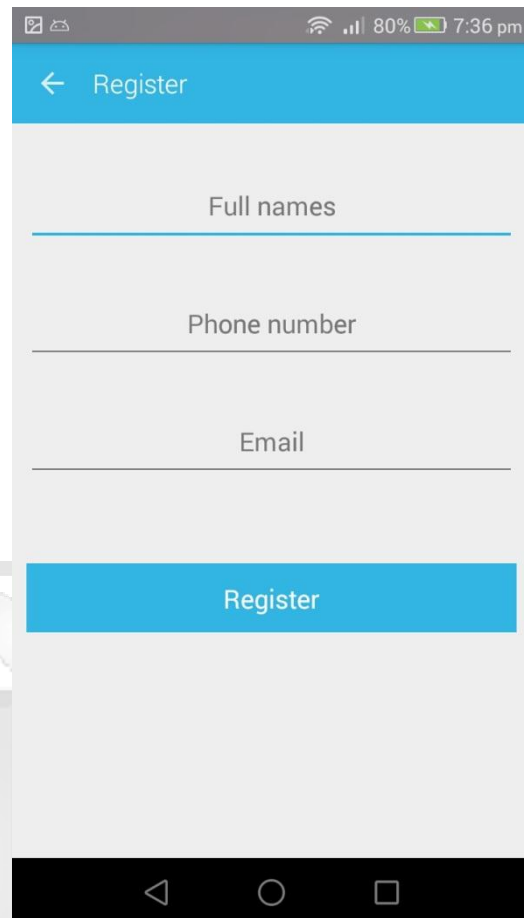
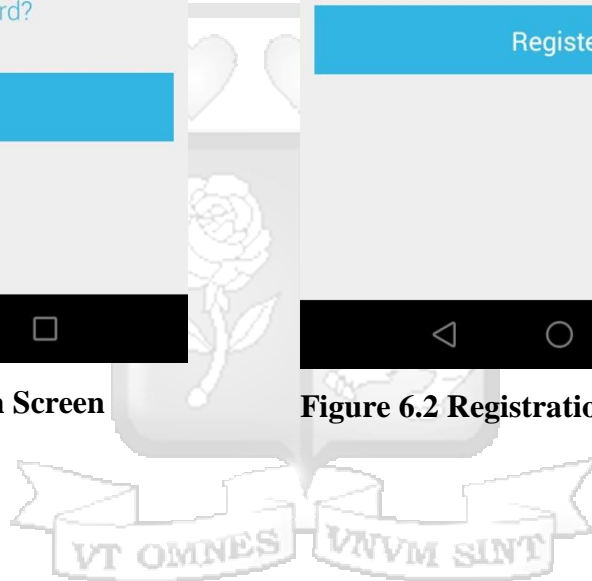


Figure 6.2 Registration Screen



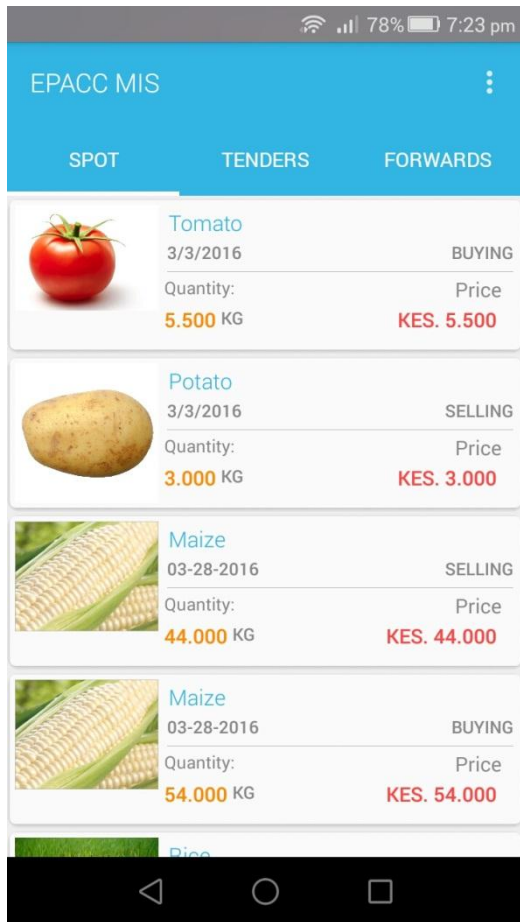


Figure 6.3 Main page tabs with Spot market selected

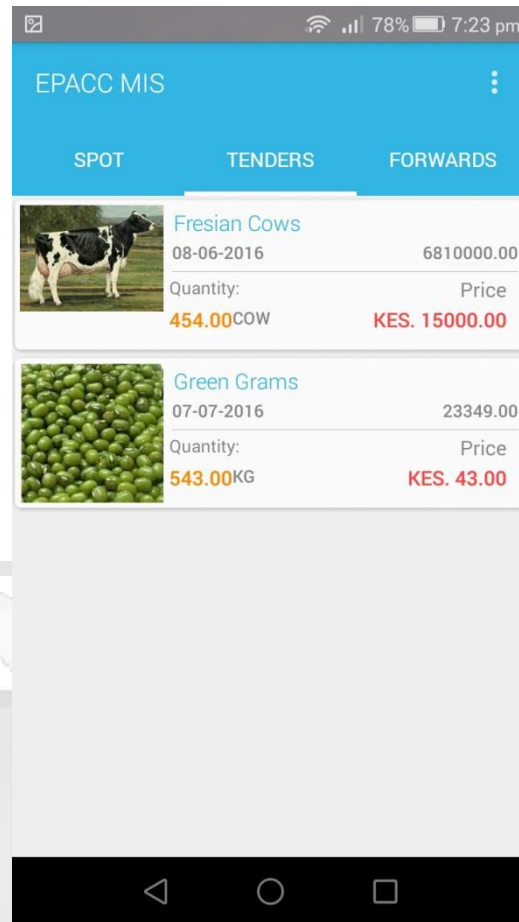


Figure 6.4 Main tabs with Tenders selected

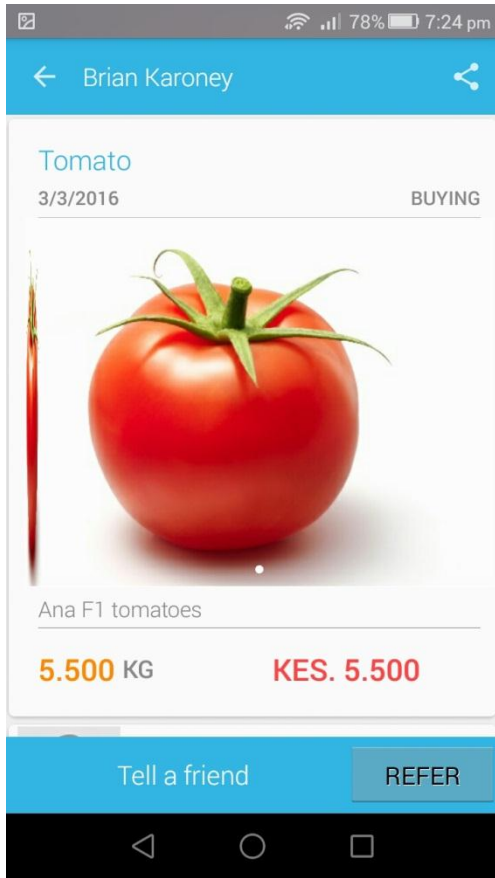


Figure 6.5 Single spot market item

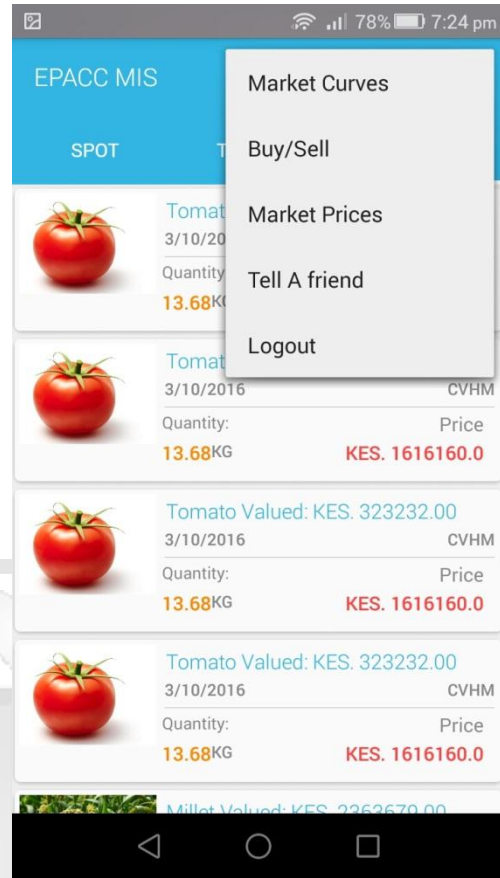


Figure 6.6 User Menu

Figure 6.7 Draw Market Curve Form

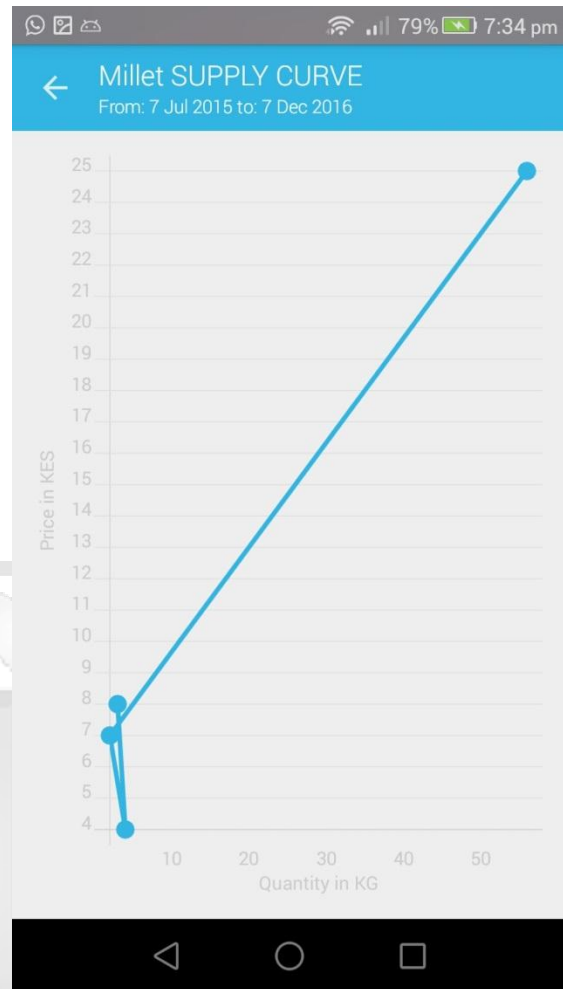


Figure 6.8 Market Curve Showing supply of millet

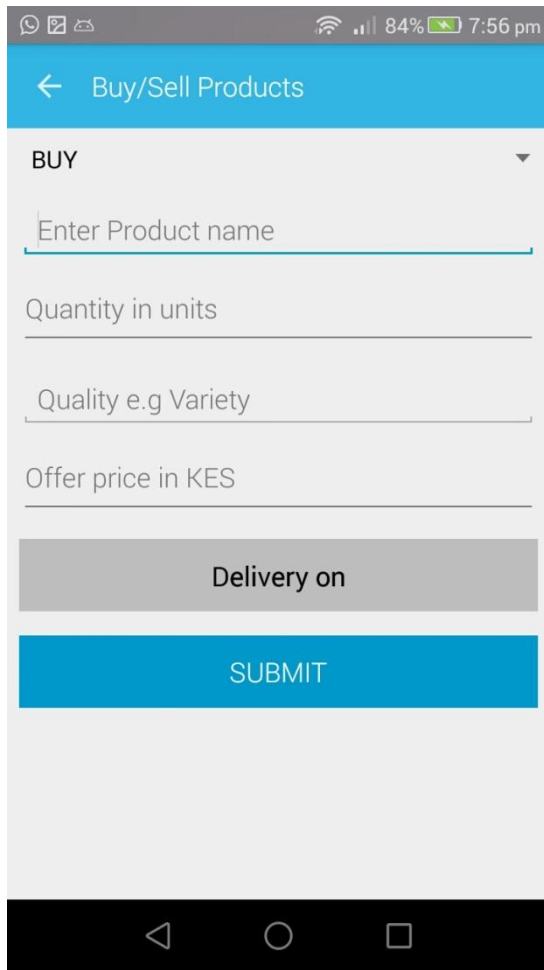


Figure 6.9 Buy/Sell Product form

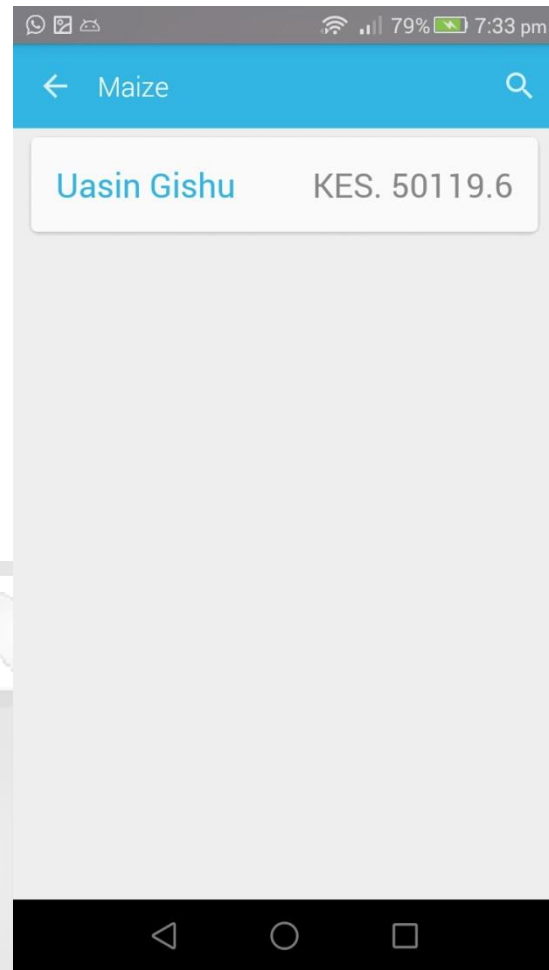


Figure 6.10 Market prices of Maize

Other key functions are implemented on the Android client.

a) Push Notification Engine

The push notification engine provides a communication tool for sending notifications via the Google Cloud Messenger (GCM). It provides a capacity to send over 50,000 messages daily to registered users.

b) Calling feature

The android device provides users with the capability to call other users to complete transactions once a strike-price has been arrived at. This feature maps the receivers' phone number and enables the device to invoke a call from a button.

c) GPS Zoning Component

This component enables android devices to submit geo-location data, for zoning of users and respective market regions.

6.4 Web Clients

6.4.1 Development tools

The web client is developed using the following languages:

- i.** HTML
- ii.** Javascript
- iii.** CSS
- iv.** PHP

The design on the web portal implements Google's material design

6.4.2 Installation details

The web clients are available on web browsers, both mobile and desktop. To access the system, the user may install Firefox, Edge, Internet Explorer or Chrome web browsers.

6.4.3 Application components

The web application consists of several web pages each providing access to particular interfaces on the RESTFUL web service. The key components of the web application include:

a) Dash board

This function provides an overview of the users account, with navigation links to key areas and summarized system reports as illustrated in Figure 6.11.

Dashboard

Market Prices			
COPY PRINT SAVE			
Search:			
#	Product	Market	Average Price
1	Fresian Cows		43.00/COW
2	Maize		15,980.67/KG
3	Fresian Cows	Uasin Gishu	4,343.00/COW
4	Green Grams	Uasin Gishu	434.00/KG
5	Maize	Uasin Gishu	434.00/KG
6	Millet	Uasin Gishu	3,040.00/KG
7	Potato	Uasin Gishu	30.00/KG
8	Rice	Uasin Gishu	54,656.00/KG

Product Margins					
#	Product	Opening price(KES)	Closing price (KES)	Date	Trend
1	Tomato	120	320	28-Mar-16	200 ↑
2	Potato	430	140	28-Mar-16	-290 ↓
3	Tomato	78	120	27-Mar-16	42 ↑
4	Tomato	120	320	26-Mar-14	200 ↑
Product margins					

Figure 6.11 System dashboard for web application

b) Landing Page

The landing page provides a brief introduction to new visitors on the web portal, with navigation links to login, register and other relevant functions.

c) Google analytics

This component enables tracking of visitors on the web application to report user behavior on the site.

6.5 3rd Party API

The third party component enables pulling of data from the core system to external applications. This feature enables government agencies and other institutions to pull data from the core market information system for analysis, reporting and decision making.

6.5.1 Development tools

The 3rd Party API is developed using SOAP over HTTP. It implements the use of WSDL and PHP5 endpoints. The system WSDL is located on the web address: http://198.12.159.194/commodity/api/wSDL/commodity_exchange.wSDL whereas the endpoint address is: <http://198.12.159.194/commodity/classes/api.php>. The platform is tested using SOAP UI software as illustrated on figure 6.12.

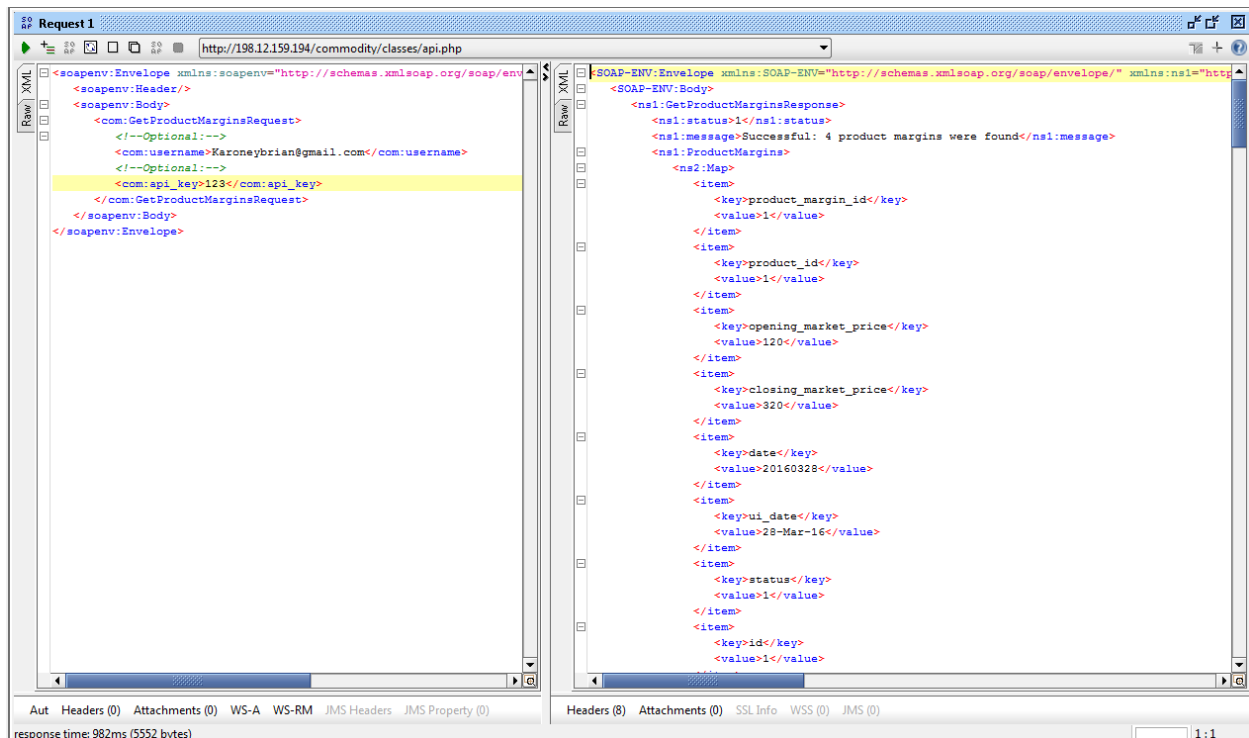


Figure 6.12 SOAP Web service testing on SOAP UI Software

The integration process involves the use of a SOAP client which may be developed in several platforms such as PHP, Java, Python and other languages. A sample PHP client is shown in Appendix E(ii)

The SOAP client submits 2 key parameters, username and API Key of the user, to the server for authentication.

6.5.2 Application Components

The third party API provides access to the following core operations

a) GetPricesInMarkets

This operation retrieves the average price of a particular commodity in a given market. If the market is unspecified, it retrieves the national price of the commodity. The SOAP messages used to retrieve commodity prices are illustrated in (Appendix E iii).

b) GetListOfContracts

This operation retrieves a list of all available contracts for purchase. The Message format is as shown in (Appendix E IV).

c) GetProductMargins

This operation retrieves the prices of purchasing contract farming agreements (margins). The margins are constantly changing based on increasing spot market transactions. The SOAP messages used to retrieve product margins are shown in (Appendix E v).



CHAPTER 7: SYSTEM TESTING

7.1 Introduction

This section describes the approach to system testing which is an important stage of any system development process as it establishes the achievement of functional and non-functional requirements.

7.2 Test Plan

To test the EPACC system, a two pronged approach was employed, to ensure that all requirements were tested under sound test cases. These two approaches implemented included:

a) Unit Testing

This method involved testing each component of the core system as well as clients to ensure proper functionality as per system requirements outlined in Chapter 5.3 and use cases defined in Chapter 5.5.1.1

b) User acceptance testing

In this approach, the systems' readiness to be deployed in a live environment was thoroughly tested. The main objective of this approach was to verify the systems' usability, user experience and its ability to match user requirements and expectations.

7.3 Users involved in Testing

The testing process involved the use of 5 sophisticated users for Alpha and Beta testing. The alpha tests were done by the researcher, whereas beta testing was done with the assistance of 4 of the researchers' peers. 15 naïve users were involved in user acceptance testing.

7.4 Features and functions tested

7.4.1 Functions

EPACCs core system contained majority of the functions for testing. Clients such as Mobile, SMS and Web were simple tested for validation. Below are the core system functions that were tested.

a) Authentication

The core system was tested to ensure that authentication is done correctly and securely. When a user submits login credentials via whichever client, the credentials are sanitized by the system to remove malicious characters in the credentials. The system then verifies the credentials, both

username and salted password; and provides a feedback message. The system also checks the access level of the particular user and ensures they do not access unauthorized functions of the system. 3rd party clients were validated using an API key and username.

b) Validation

Validation minimizes the occurrence of errors and enhances good quality of the database. All user input in the system was validated to ensure integrity and security. Validation took place at both client level and core system level; this ensured that no incorrect or unusable data reaches the database. Inputs such as phone numbers were processed to capture full format that can be used to relay SMS via mobile networks.

c) Buy/Sell product

Users are able to buy or sell products in the system. To buy or sell, users visit their preferred client and provide details of the sale/purchase. These details are verified both at the client and server level.

d) Create Contract

Users can create contract farming agreements on the system and determine prices via competitive bidding.

e) Bid for contract

Users may place bids on contracts and the bids are available to the contract sponsor who awards the contract to their preferred contractor.

f) Offset Contract

Users may transfer their contracts to other users at a price (margin) which is determined by the current market price of the product in the spot market.

g) 3rd Party API

The 3rd Party API web service provides an interface for consumption of data from the core system. This functionality was tested on SOAP UI Software as shown in Appendix E. 1.

7.4.2 Features

a) Usability

All the client applications were tested for usability. The web client adhered to Google's Material design, which provided a visual language synthesizing user experience principles with the

innovation. The SMS client is developed on a technology frequently used by most users, hence provided an easy-to-use service access point for the system.

b) Navigation

Menus on both web and mobile were tested for navigability; this was mainly to ensure a logical flow of steps in achieving a process.

c) Accessibility

Tests were carried out to ensure only authorized users can access specific parts of the system web and mobile clients.

7.5 Test Cases

Tests cases were developed to thoroughly interrogate core system functionality. As per the system architecture implemented see Figure 5.2, all instructions from client applications are handled through the RESTFUL web service which interacts with the core system. Therefore, the test cases were designed to interrogate the core system with the notion that all client applications interact with the system in the same way.

The results were evaluated based on a pass/fail criteria and CRUD (Create, Read, Update, and Delete) matrix.

7.5.1 Pass/Fail Criteria

Table 7.1 System Test Cases with Pass/Fail Criteria

ID	TEST CASE	USER INPUT	PASS CRITERION	FAIL CRITERION
TA1	Authentication (No username, no password)	Username="" Password=""		"Invalid login credentials"
TA2	Authentication (Correct username, Wrong password)	Username= karoney@gmail.com Password="ewew"		"Invalid Login credentials"
TA3	Authentication (Correct	Username= karoney@gmail.com Password="!Brian768#1"	"Welcome to EPACC Brian"-	

	username, correct password)		Client application switches to next displayable	
TR1	Registration (Missing details)	Full Name="", Email="", Phone="", County=""		"Please enter all details"
TR2	Registration (Missing name)	Full Name="", Email="ka@b.com", Phone="0722140588", County="Uasin Gishu"		"Please enter your full names"
TR3	Registration (Missing email)	Full Name="Brian", Email="", Phone="0722140588", County="Uasin Gishu"		"Please enter a valid email"
TR4	Registration (Missing phone)	Full Name="Brian", Email="ka@b.com", Phone="", County="Uasin Gishu"		"Please enter a valid phone number"
TR5	Registration (Missing county)	Full Name="Brian", Email="ka@b.com", Phone="0722140588", County=""		"Please select your county"
TR6	Registration (Invalid Email)	Full Name="Brian", Email="kab.com", Phone="0722140588", County="Uasin Gishu"		"Please enter a valid email"
TR7	Registration (Correct details)	Full Name="Brian", Email="kab.com", Phone="0722140588", County="Uasin Gishu"	"Hello Brian, welcome to EPACC marketplace. Kindly proceed to login using your email and	

			password V4CEOyxa” (Sent as SMS message to verify phone number)	
TR8	Registration (Duplicate Account)	Full Name=”Brian”, Email=”kab.com”, Phone=”0722140588”, County=”Uasin Gishu”		“Account with this phone number already exists”
TBS1	Buy/Sell Product (Correct details)	Type=”Buy”, Product=”Tomato”, Quantity=”12”, Quality=”Ana F1 Variety”, Delivery date=”29- 03-2016”		
TBS2	Buy/Sell Product (Invalid Selections)	Type=”Not Selected”, Product=”Not Selected”, Quantity=”12”, Quality=”Ana F1 Variety”, Delivery date=”29- 03-2016”		“Please select transaction type and product”
TBS3	Buy/Sell Product (Invalid Date)	Type=”Buy”, Product=”Tomato”, Quantity=”12”, Quality=”Ana F1 Variety”, Delivery date=”29- 03-1908”		“Please provide a valid date”
TBS4	Buy/Sell Product (Invalid Quantity)	Type=”Buy”, Product=”Tomato”, Quantity=”Text”, Quality=”Ana F1 Variety”, Delivery date=”29- 03-1908”		“Please enter valid number for quantity”
TBS5	Buy/Sell Product	Type=” ”, Product=” ”,		“Please fill in

	(Missing details)	Quantity="" , Quality="" , Delivery date=""		all fields appropriately"
TC1	Create Contract (Correct Details)	Type="Buy", Product="Tomato", Quantity="Text", Quality="Ana F1 Variety", Delivery date="29- 03-2016", Price determination="Competitive bidding"	"Successfully created futures market entry for 434 KG of Green Grams"	
TC2	Create Contract (Invalid Selections)	Type="Not Selected", Product="Not Selected", Quantity="12", Quality="Ana F1 Variety", Delivery date="29- 03-2016"		"Please select transaction type and product"
TC3	Create Contract (Invalid Date)	Type="Buy", Product="Tomato", Quantity="12", Quality="Ana F1 Variety", Delivery date="29- 03-1908"		"Please provide a valid date"
TC3	Create Contract (Date 11 days from posting date)	Type="Buy", Product="Tomato", Quantity="12", Quality="Ana F1 Variety", Delivery date="29- 03-2016"		"Contracts are created to mature at some time in the future, please select appropriate delivery date"
TC4	Create Contract (Invalid Quantity)	Type="Buy", Product="Tomato", Quantity="Text", Quality="Ana		"Please enter valid number for quantity"

		F1 Variety”, Delivery date=”29-03-1908”		
TC5	Create Contract (Missing details)	Type=” ”, Product=” ”, Quantity=” ”, Quality=” ”, Delivery date=” ”		“Please fill in all fields appropriately”
TBC1	Bid Contract (Correct Details)	Contract Code=”HDKBKSD”, Bid Amount=”12343”, Member ID=”15”	“Successfully placed bid for purchase of Green Grams”	
TBC2	Bid Contract (Bid Lower than starting bid)	Contract Code=”HDKBKSD”, Bid Amount=”12”, Member ID=”15”		“The lowest you can bid is 130 KES/KG”
TBC3	Bid Contract (Missing details)	Contract Code=””, Bid Amount=””, Member ID=”15”		“Please fill in all details to place the bid”
TBC4	Bid Contract (Invalid Amount)	Contract Code=” HDKKBKSD”, Bid Amount=”ewr”, Member ID=”15”		“Please enter a valid bid amount greater than 130”
TBC5	Bid Contract (Invalid Contract Code)	Contract Code=” HDKKBSD”, Bid Amount=”32323”, Member ID=”15”		“Please enter a valid contract code and try again”
TOC1	Offset Contract (Correct Details)	Contract Code=” HDKKBSD”, Margin=”4500”, Originating Member ID=”15”, Destination Member ID=”23”		“JHF43FID Contract successfully transferred to Joseph Lokishar for 4500KES”
TOC2	Offset Contract	Contract Code=””, Margin=””,		“Please fill in

	(Missing details)	Originating Member ID="", Destination Member ID=""		all details and try again"
TOC3	Offset Contract (Matured Contract details)	Contract Code=" KFBRKSFU", Margin="4500", Originating Member ID="15", Destination Member ID="23"		"Sorry, this contract matured on 20- 03-2016 and cannot be transferred"
TOC5	Offset Contract (Invalid Margin)	Contract Code=" KFBRKSFU", Margin="fdf", Originating Member ID="15", Destination Member ID="23"		"Please enter a valid margin"(Both web and Mobile Client applications prevent editing of margin)
TOC6	Offset Contract (Insufficient Margin)	Contract Code=" KFBRKSFU", Margin="3500", Originating Member ID="15", Destination Member ID="23"		"Insufficient margin paid, please enter the valid amount of KES. 4500" (Transaction rolled back)
TOC7	Offset Contract (Invalid Contract Code)	Contract Code=" KFewKSFU", Margin="fdf", Originating Member ID="15", Destination Member ID="23"		"Please enter a valid contract code and try again"
TWS1	3 rd Party SOAP Web Service (Correct Details)	Username= karoneybrian@gmail.com , API Key="4XDMSNFLMGT2234E	"Successful: 10 Spot transactions were found"	

		R32HFDUR”, Operation=”GetPricesInMarkets ”	(Array object with requested data provided)	
TWS2	3 rd Party SOAP Web Service (Invalid operation)	Username= karoneybrian@gmail.com , API Key=”4XDMSNFLMGT2234E R32HFDUR”, Operation=”GetPricesFromMark ets”		“Invalid Operation, please refer to the WSDL documentation”
TWS2	3 rd Party SOAP Web Service (Invalid credentials)	Username= karoneybrian@gmail.com , API Key=”4XDMR32HFDUR”, Operation=”GetPricesInMarkets ”		“Invalid credentials”

7.5.1.1 CRUD Matrix

This function tested the ability of the system actors to perform create, read, update and delete functions on the core system.

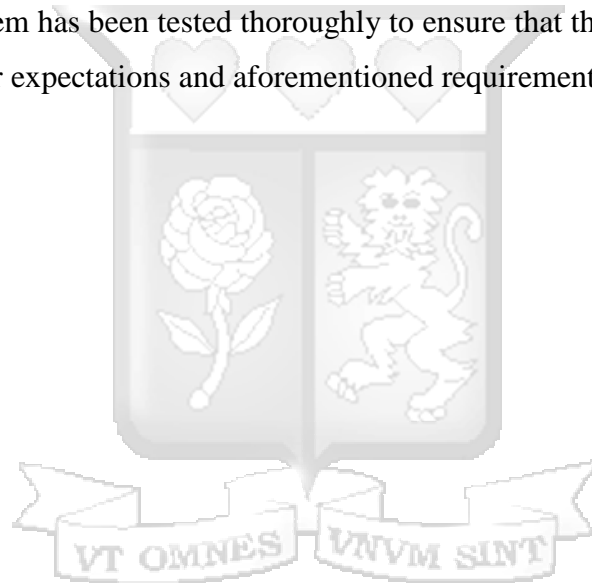
Table 7.2 Crud matrix showing capabilities of system actors

CRUD ACTOR	CREATE	READ	UPDATE	DELETE
BUYERS	YES	YES	YES	NO
FARMERS	YES	YES	YES	NO
SPECULATORS	YES	YES	YES	NO
SYSTEM ADMINISTRATOR	YES	YES	YES	YES
DAEMON	YES	YES	YES	YES

7.6 Summary

This EPACC system provides a specific range of functionality for farmers, buyers and speculators in the agribusiness ecosystem. It is developed to enable buying and selling of agricultural commodities on the spot markets, and also creation of contract farming agreements for future delivery. The system provides functionality for speculators to gain from price fluctuating prices of different commodities by buying and selling contracts before their maturity dates. From its database of spot market transactions, the system provides a web service for querying market prices of commodities across markets in Kenya.

Based on the functionalities demonstrated in the in this chapter, the system requirements defined in chapter 5.3 have been captured and implemented to completion. In addition to this implementation, the system has been tested thoroughly to ensure that the requirements have been met in accordance to user expectations and aforementioned requirements.



CHAPTER 8: CONCLUSIONS AND RECOMMENDATIONS

8.1 Introduction

This chapter provides a summary of the research study findings and results. The evaluation of the research results constituted of the following key research areas in the Kenyan agribusiness sector: marketing information systems, price fluctuations in agricultural commodity prices in Kenya, contract farming and creation of opportunities in the agribusiness value chain. The research also investigated the role of mobile devices in increasing access to pricing information and agricultural investment opportunities. The results of the research shed light on the extent to which price fluctuations in the agribusiness sector have been addressed by existing marketing information systems, the challenges with the existing marketing information systems and justification for the proposed mobile and web based system as the most probable solution.

8.2 Discussion and Key findings

This study sought to investigate the short comings of existing marketing information systems, their inability to mitigate the risk of price fluctuations in the market, and more efficient and effective tools to secure markets and commodity prices. The initial research findings revealed that existing marketing information systems were immensely challenged in protecting farmers from unpredictable price drops, and buyers from price increases. 97% of the sample population has been affected by falling prices of agricultural commodities with the existing MIS; hence there is a need for the proposed system which provides a mechanism to mitigate price fluctuations in the market through contract farming. To ascertain these findings, the researcher administered a questionnaire (see Appendix A) whose main aim was to evaluate the challenges experienced by buyers and sellers with the existing marketing information systems and price fluctuations. The questionnaire required respondents to give information on their usage of current marketing information systems, their knowledge of contract farming agreements and consequently their willingness to enter into a contract before production, their preferred mode of accessing a marketing information system and their willingness to use the proposed solution as a way to protect themselves from unpredictable prices. The research showed that 100% of the respondents were willing to use an MIS, which allows them to secure prices and markets and access contract farming agreements; in addition speculators can also make profit by purchasing and reselling contracts in the system.

8.3 Recommendations

In order to successfully roll out the marketing information system that aims to protect buyers and sellers from price fluctuations, insurance firms need to step in and provide performance bonds. These performance bonds will ensure that buyers and sellers can freely engage in contract farming agreements without the fear of either party defaulting from the contract. As regards to infrastructure, warehousing firms will also be required to register in the system in order to provide for collection and storage points.

8.4 Suggestions for Further Study

This study covered trading in forward contracts which are traded over the counter; governed by contract law. Further studies should investigate incorporation of futures contract which are traded in a formal commodity exchange. The role of futures contract in the agribusiness value chain is a key area for further study which this research was unable to cover. Warehousing receipts systems are also an important area for research as warehouse receipts form the backbone for trading in a formal commodity exchange.

This study was also unable to collect data from a larger sample size due to financial and time constraints. Future studies should incorporate samples from a larger number of respondents.



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APPENDICES

APPENDIX A: Capital Markets Authority (CMA) Interview questions

These interview questions are aimed at identifying the rules and regulations of derivatives trading in Kenya, as defined by the Capital Markets Authority. The information provided on this orally administered interview will assist the researcher in establishing the requirements to integrate trading of contract farming agreements within an electronic trading platform.

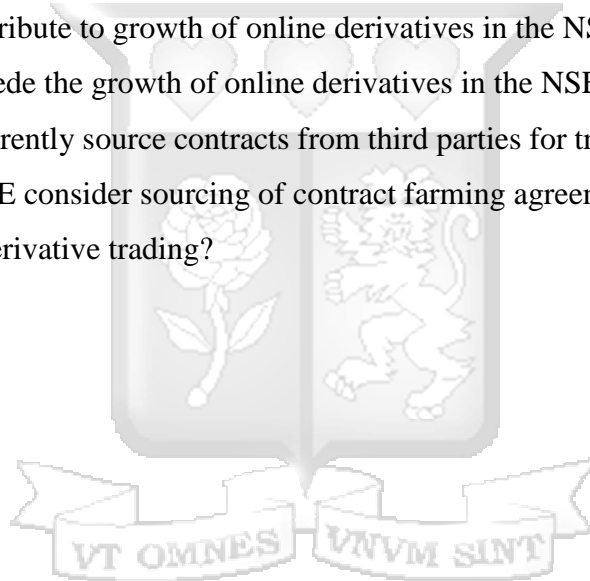
1. What qualifies a farming contract suitable for trading as a derivative?
2. What are the requirements for a private firm to trade derivatives online?
3. What rules are established for derivative price discovery in Kenya?
4. What can you say about the state of derivative trading in Kenya?
5. What factors contribute to growth of online derivative trading in Kenya?
6. What factors impede growth of online derivatives in Kenya?



APPENDIX B: Nairobi Stock Exchange (NSE) Interview questions

These interview questions are aimed at establishing the possibility of providing contract farming agreements for trading as derivatives in the Nairobi Stock Exchange. The information provided on this orally administered interview will assist the researcher in understanding how to provide contract farming agreements from electronic trading platform as financial instruments in the Nairobi stock exchange.

1. What is the state of derivatives trading in NSE?
2. What are the current sources of contracts for the NSE derivatives market?
3. What financial instruments are currently available for trading of agricultural commodities?
4. What factors contribute to growth of online derivatives in the NSE?
5. What factors impede the growth of online derivatives in the NSE?
6. Does the NSE currently source contracts from third parties for trading on the floor?
7. If not, can the NSE consider sourcing of contract farming agreements as financial instruments for derivative trading?



APPENDIX C: Farmers questionnaire

This questionnaire is aimed at establishing the awareness of farmers on existing marketing information systems, level of understanding of contract farming, sensitivity to price fluctuations and the role of mobile technology in marketing of produce. The researcher and research assistants will also record respondent’s demographic data for classification of responses.

1. What agricultural produce do you sell? (If many, separate with commas).....
.....
2. How do you find market for your produce (Tick one or more where applicable)
 - (a) I have a stall in the market
 - (b) I have a shop
 - (c) I sell to marketing agents (Brokers)
 - (d) I supply to hotels/schools/supermarkets/organizations
 - (e) I use a marketing information system (Specify here).....
 - (f) Others (Specify here).....
3. Are you aware of marketing information systems where you can get market for your produce from your mobile phone?
 - (a) Yes
 - (b) No
4. If No. 2 is yes, which market information system do you use?
 - (a) RATIN
 - (b) CEREALMART
 - (c) MFARM
 - (d) KACE
 - (e) Others (Specify here).....
5. If No. 2 is yes, how often do you use the system?
 - (a) Never
 - (b) Frequently
 - (c) Just once

6. Have you been affected by price drops in the market before? (Specify product).....
 - (a) Yes
 - (b) No

7. If No. 6 is yes, severe was it? (Specify consequences).....

.....

8. Are you aware of contract farming agreements?
 - (a) Yes
 - (b) No

9. Would you be willing to enter an agreement with a buyer to guarantee market and price before planting?
 - (a) Yes
 - (b) No (Specify reason)

.....

10. Would you use a marketing information system that helps you guarantee market and price before you produce?
 - (a) Yes
 - (b) No (Specify reason)

.....

.....
 - (c) Yes but

.....

.....

11. If No. 10 is yes, what would be your preferred method to access this information?
 - (a) Smartphone Application e.g. Whatsapp
 - (b) SMS
 - (c) Website

12. Do you have any questions or additions to this?

.....

APPENDIX D: Buyers questionnaire

This questionnaire is aimed at establishing the awareness of buyers on existing marketing information systems, understanding how buyers source for produce, sensitivity to price fluctuations and the role of mobile technology in procurement of produce. The researcher and research assistants will also record respondent’s demographic data for classification of responses.

1. What agricultural produce do you buy? (If many, separate with commas).....
.....
2. How do you find suppliers for your produce (Tick one or more where applicable)
 - (a) Request for quotations
 - (b) Tendering
 - (c) Sending agents to the market
 - (d) I use a marketing information system (Specify here).....
 - (e) Others (Specify here).....
3. Are you aware of marketing information systems where you can get suppliers for your produce from your mobile phone?
 - (a) Yes
 - (b) No
4. If No. 2 is yes, which market information system do you use?
 - (a) RATIN
 - (b) CEREALMART
 - (c) MFARM
 - (d) KACE
 - (e) Others (Specify here).....
5. If No. 2 is yes, how often do you use the system?
 - (a) Never
 - (b) Frequently
 - (c) Just once
6. Have you been affected by price increases in the market before? (Specify product).....

(a) Yes

(b) No

7. If No. 6 is yes, severe was it? (Specify here).....
.....

8. Are you aware of contract farming agreements?

(a) Yes

(b) No

9. Would you be willing to enter an agreement with a farmer to guarantee source of quality produce and price before planting?

(a) Yes

(b) No (Specify reason)

.....

10. Would you use a marketing information system that helps you guarantee desired quality of produce at acceptable prices?

(a) Yes

(b) No (Specify reason)

.....

(c) Yes but

.....

.....

11. If No. 10 is yes, what would be your preferred method to request for suppliers?

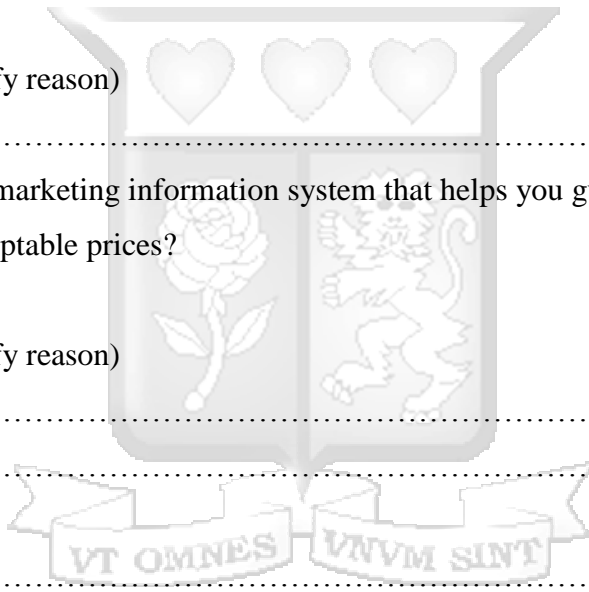
(a) Smartphone Application e.g. Whatsapp

(b) SMS

(c) Website

12. Do you have any questions or additions to this?

.....



APPENDIX E: 3rd Party API

Web Service Endpoints

WSDL URL: http://198.12.159.194/commodity/api/wsd/commodity_exchange.wsdl

ENDPOINT URL: <http://198.12.159.194/commodity/classes/api.php>

i. Sample PHP Client

```
<?php
//Disable caching of WSDL
ini_set("soap.wsdl_cache_enabled", "0");

//Declare System WSDL URL
$SMS_CLIENT = new
SoapClient("http://198.12.159.194/commodity/api/wsd/commodity_exchange.ws
dl");

//Provide required parameters
$params=array();
$params["username"]="karoneybrian@gmail.com";
$params["api_key"]="4XDMSNFLMGT2234ER32HFDUR";

//Invoke requested operations e.g Get Prices in various markets across
Kenya
$response=$SMS_CLIENT->GetPricesInMarkets($params);

print_r($response);
```

?>

ii. GetPricesInMarkets Message

```
<s:element name="GetPricesInMarketsResponse">
  <s:complexType>
    <s:sequence>
      <s:element minOccurs="1" maxOccurs="1" name="status"
type="s:string" />
      <s:element minOccurs="1" maxOccurs="1" name="message"
type="s:string" />
      <s:element minOccurs="1" maxOccurs="1" name="PriceInMarkets"
type="s:string[]" />
    </s:sequence>
  </s:complexType>
</s:element>
<s:element name="GetPricesInMarketsRequest">
  <s:complexType>
    <s:sequence>
      <s:element minOccurs="0" maxOccurs="1" name="username"
type="s:string" />
      <s:element minOccurs="0" maxOccurs="1" name="api_key"
type="s:string" />
    </s:sequence>
  </s:complexType>
</s:element>
```

GetPricesInMarketsRequest request message invokes the operation GetPricesInMarkets which responds with GetPricesInMarketsResponse; an object with a Standard Object of market prices.

iii. GetListOfContracts Message

```
<s:element name="GetListOfContractsResponse">
  <s:complexType>
    <s:sequence>
      <s:element minOccurs="1" maxOccurs="1" name="status"
type="s:string" />
      <s:element minOccurs="1" maxOccurs="1" name="message"
type="s:string" />
      <s:element minOccurs="1" maxOccurs="1" name="Contracts"
type="s:string[]" />
    </s:sequence>
  </s:complexType>
</s:element>
<s:element name="GetListOfContractsRequest">
  <s:complexType>
    <s:sequence>
      <s:element minOccurs="0" maxOccurs="1" name="username"
type="s:string" />
      <s:element minOccurs="0" maxOccurs="1" name="api_key"
type="s:string" />
    </s:sequence>
  </s:complexType>
</s:element>
```

iv. GetProductMargins Message

```
<s:element name="GetProductMarginsResponse">
  <s:complexType>
    <s:sequence>
      <s:element minOccurs="1" maxOccurs="1" name="status"
type="s:string" />
      <s:element minOccurs="1" maxOccurs="1" name="message"
type="s:string" />
      <s:element minOccurs="1" maxOccurs="1" name="ProductMargins"
type="s:string[]" />
    </s:sequence>
  </s:complexType>
</s:element>
<s:element name="GetProductMarginsRequest">
  <s:complexType>
    <s:sequence>
      <s:element minOccurs="0" maxOccurs="1" name="username"
type="s:string" />
      <s:element minOccurs="0" maxOccurs="1" name="api_key"
type="s:string" />
    </s:sequence>
  </s:complexType>
</s:element>
```

APPENDIX F: Web Client

Spot Market

COPY PRINT SAVE ▾			Search:					
#	Type	Product	Quantity	Quality	Location	Offer Price	Total Value	Action
CDS1	BUYING	Tomato	94.500 KG	Ana F1 tomatoes	Uasin Gishu	340.00	0.00	ORDER
CM1373	SELLING	Millet	342.000 KG	dsds	Uasin Gishu	4343.00	1485306.00	ORDER
CM1863	BUYING	Millet	342.000 KG	Havana Cuba	Uasin Gishu	434.00	148428.00	ORDER
CM3540	SELLING	Millet	543.000 KG	Handkbsds	Uasin Gishu	4343.00	2358249.00	ORDER
CM38	BUYING	Maize	54354.000 KG	434	Uasin Gishu	434.00	23589636.00	ORDER
CM41	SELLING	Maize	43434.000 KG	Hybrid	Uasin Gishu	434.00	18850356.00	ORDER
CM44	SELLING	Maize	4343.000 KG	4353		4343.00	18861649.00	ORDER

Figure F. 1 Spot Market

Average prices in markets

COPY PRINT SAVE ▾			Search: Uasin Gishu	
#	Product	Market	Average Price	
3	Fresian Cows	Uasin Gishu	4,343.00/COW	
4	Green Grams	Uasin Gishu	2,388.50/KG	
5	Maize	Uasin Gishu	434.00/KG	
6	Millet	Uasin Gishu	3,040.00/KG	
7	Potato	Uasin Gishu	30.00/KG	
8	Rice	Uasin Gishu	54,656.00/KG	
9	Sheep	Uasin Gishu	434.00/COW	
10	Tomato	Uasin Gishu	340.00/KG	

Market prices of products in Kenya

Showing 1 to 8 of 8 entries (filtered from 10 total entries)

← Previous 1 Next →

Figure F. 2 Prices In markets

Available Tenders

.....

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Search:

#	Type	Product	Quantity	Quality	Maturity	Action
CCMFS13K	BUYING	Millet	43434.000 KG	353453	03-12-2016	PLACE BID
CHGRLLJRN	BUYING	Green Grams	434.000 KG	dsfsd	03-16-2016	PLACE BID

Available Contracts

Showing 1 to 2 of 2 entries (filtered from 6 total entries)

← Previous 1 Next →

Figure F. 3 Available tenders

Available Forward Contracts

COPY PRINT SAVE ▾

Search:

#	Product	Quantity	Quality	Maturity	Total Value	Margin	Action
CVHM	Tomato	13.680 KG	ANA F1 Green house-non GMO	3/10/2016	323232.00	3232320 ↓	BUY VIEW TRENDS
CVHM	Tomato	13.680 KG	ANA F1 Green house-non GMO	3/10/2016	323232.00	3232320 ↑	BUY VIEW TRENDS

Available Contracts

Showing 1 to 2 of 2 entries (filtered from 7 total entries)

← Previous 1 Next →

Figure F. 4 Available forwards

I will

Select Product

Quantity in Units

Price determination Competitive Bidding Set fixed price

Set minimum bid in KES/unit

Quality

To be delivered

I agree [Terms and Conditions](#)

[CREATE REQUEST](#) [CANCEL](#)

Figure F. 5 Create contract web form

Buy/Sell in Spot Market

I want to

Select Product

Quantity in Units

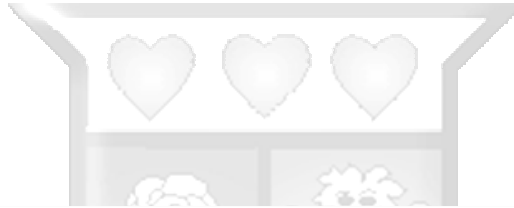
Offer price in KES/unit

Quality

To be delivered on

I agree [Terms and Conditions](#)

Figure F. 6 Buy/Sell Item Web



Product margins

COPY PRINT SAVE

Search:

#	Product	Opening price(KES)	Closing price (KES)	Date	Trend
1	Tomato	120	320	28-Mar-16	200 ↑
2	Potato	430	140	28-Mar-16	-290 ↓
3	Tomato	78	120	27-Mar-16	42 ↑
4	Tomato	120	320	26-Mar-14	200 ↑

Product margins

Showing 1 to 4 of 4 entries

← Previous 1 Next →

Figure F. 7 Product Margins

Available Tenders

.....

COPY PRINT SAVE

Search: Buyin

#	Type	Product	Quantity	Quality	Maturity	Action
CCMFS13K	BUYING	Millet	43434.000 KG	353453	03-12-2016	<input type="text" value="Bid in KES/Unit"/> <input type="button" value="BID"/> <input type="button" value="CANCEL"/>
CHGRLJRN	BUYING	Green Grams	434.000 KG	dsfsd	03-16-2016	<input type="button" value="PLACE BID"/>

Available Contracts

Showing 1 to 2 of 2 entries (filtered from 6 total entries)

← Previous 1 Next →

Figure F. 8 Place bid on tender

Contract for supply of 342.000 KG of Maize

THE LIST BELOW SHOWS BIDDERS INTERESTED IN THIS TENDER

COPY PRINT SAVE ▾

Search: _____

#	Member	Contact	Location	Amount	Action
1	Brian Karoney	254722140588	Uasin Gishu	6600	AWARD

Contract Bids

Showing 1 to 1 of 1 entries -- Previous 1 Next --

Figure F. 9 Award tender

My Farming Contracts

COPY PRINT SAVE ▾

Search: _____

#	Product	Quantity	Quality	Maturity	Action
CCWUSSFQ	Wheat	100000.000 KG	Hybrid grass	11-16-2016	OFFSET FOR KES. 0

Available Contracts

Showing 1 to 1 of 1 entries -- Previous 1 Next --

Figure F. 10 Sell Forward Contract web



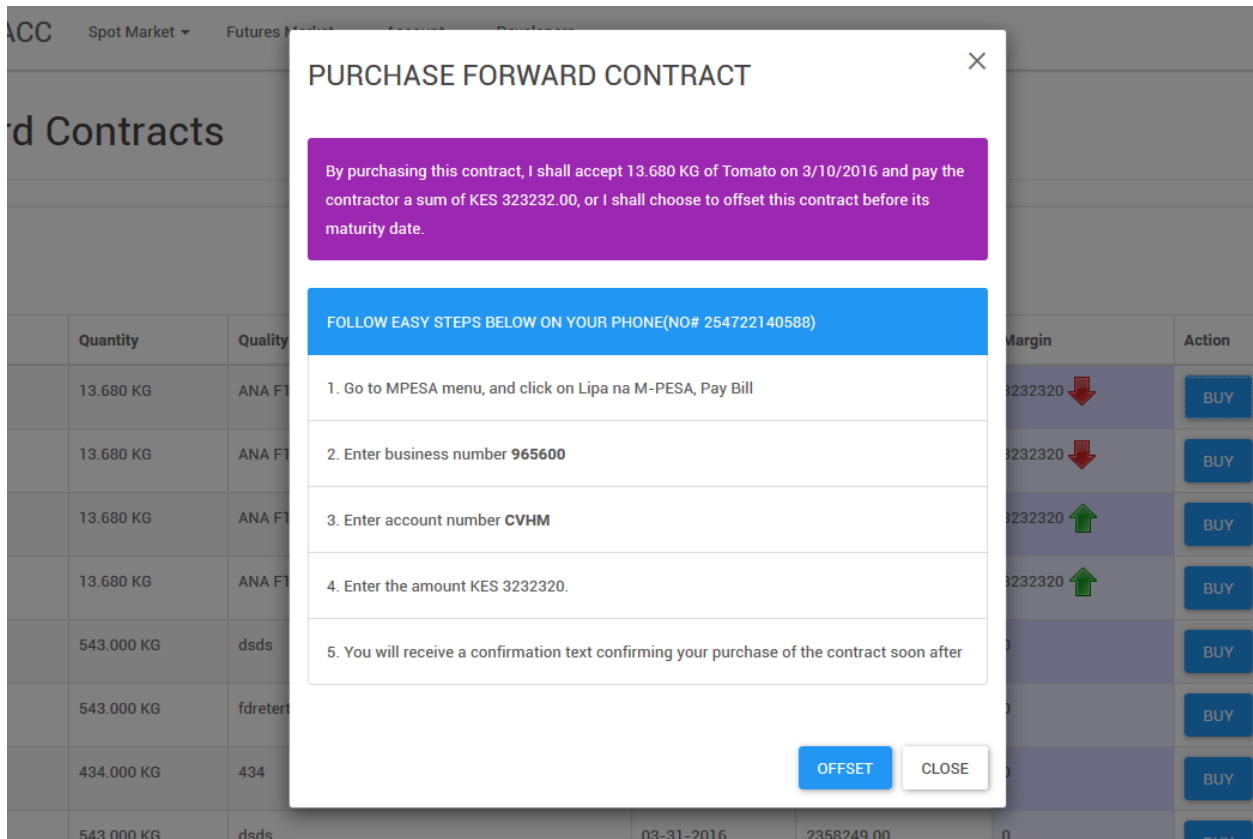


Figure F. 11 Buy Contract Web

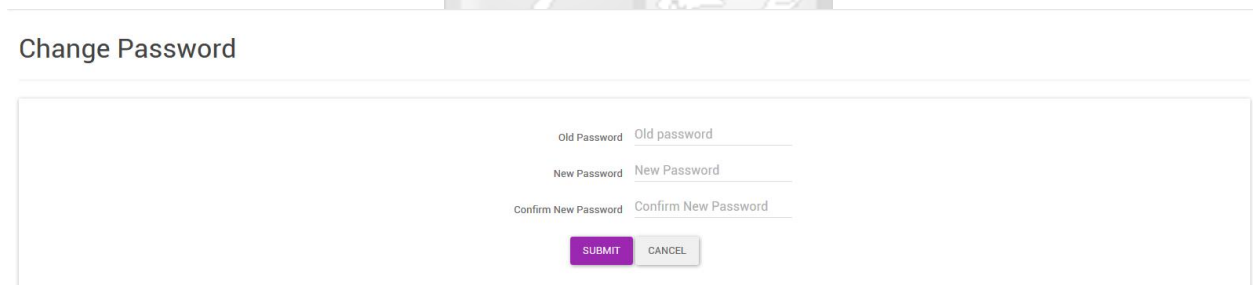



Figure F. 12 Change password web

APPENDIX G: Turn It In Report



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Figure G. 1 Turn it in Report

APPENDIX H: Pictures



Figure H. 1 Electronic Tickers on ECX building

