UNIVERSITY OF NAIROBI
SCHOOL OF COMPUTING AND INFORMATICS

A PRODUCE-BASED CREDIT SERVICE MODEL: CASE FOR LIMURU FARMERS DAIRY COOPERATIVE

BY

JORAM NDUATI KINUTHIA

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DECLARATION

This research project, as presented on this report is my original work and to the best of my knowledge has not been presented for any other university award.

Joram Nduati Kinuthia

P58/62274/2010

Signed: …….

Date: ……..

This project has been submitted as part of fulfillment of the requirements for the award of Masters of Science in Computer Science of the School of Computing and Informatics of the University of Nairobi, with my approval as the University Supervisor.

Prof. Peter Waiganjo Wagacha

Signed: …….

Date: ……..

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My family, for believing in me.

May God bless you.

DEDICATION

For my wife Fidelis Muthoni.

For my son Ethan Kinuthia.

ABSTRACT

For many years, Kenya has relied on coffee, tea and horticulture for empowerment of small holder farmers in the rural areas. This trend is changing as dairy farming has taken a key role complementing the traditional cash crops in many rural households. The dairy industry is a major source of income and employment to an estimated 1.5 million people mainly in rural Kenya.

Small scale farmers face several challenges some of which include difficulties in accessing credit, in-ability to build milk produce with economic value, marketing, and quality assurance. To overcome these challenges, the farmers have formed dairy cooperative societies, which facilitate milk collection, bulking, processing and marketing for the more advanced ones. In these cooperatives, the small holder farmers benefit from economies of scale, access to credit, and also access to markets.

Dairy cooperatives - the business units - are faced with several challenges and key among those is providing access to credit against milk delivery. Farmers often run into arrears, and spend money and time that could have been spent on other activities such as travelling to cooperative's head office to access information. Suppliers, service providers and shop owners are unable to accurately determine credit to be advanced to farmers. The cooperative management incurs overheads each month from manually reconciling credit information before making payments to members, resulting in delays. The credit process is offline, largely manual, prone to errors and fraud.

Limuru Dairy Cooperative was selected as a case in this research. Focusing on the small holder dairy farmer, the credit process was analyzed and a mobile phone based solution developed using evolutionary prototyping.

Farmers were able to use SMS to access credit information. Shop owners and cooperative management were able to use a smart phone application to advance merchandise to farmers against value of milk delivered.

From the pilot data analysis, the solution showed that if adopted, service delivery at the cooperative would be enhanced, efficiency enhancement in the credit process, and the livelihoods of Limuru Dairy small holder farmers improved.

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TERMINOLOGY

AGRA	Alliance for Green Revolution in Africa
API	Application program interface
App	Application
BI	Behavioural Intention
CCK	Communications Commission of Kenya
CDE	Center for Development Enterprise
FGD	Focus Group Discussion
GIS	Geographical Information System
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communication
HTML	Hypertext Markup Language
HTTP	Hypertext Transfer Protocol
HQ	Headquarters
ICT	Information and Communication Technology
ICT4D	ICT for Development
IDE	Integrated Development Environment
IDRC	International Development Research Center
J2ME	Java 2 Platform, Micro Edition
JSON	JavaScript Object Notation
KDB	Kenya Dairy Board
KDSC	Kenya Dairy Sector Competitive Program
M4D	Mobile for Development
MIS	Management Information System
OS	Operating System
PDU	Protocol Data Unit
RDBMS	Relational Database Management System
SDP	Small holder Dairy Project
SMPP	Short Message Peer to Peer Protocol
SMS	Short Message Services
SQL	Structured Query Language
TAM	Technology Acceptance Model
UNICEF	United Nations Children Fund
USSD	Unstructured Supplementary Service Data
WAP	Wireless Application Protocol
WWW	World Wide Web
XML	Extensible Markup Language

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1 INTRODUCTION

1.1 BACKGROUND

1.1.1 Dairy sector in Kenya

The dairy industry plays a key role in the Kenyan economy. Milk production increased from 2.8 billion litres in 2002 to 4.2 billion litres in 2007, valued at Kshs 84 billion. Kenya exported 22 million litres of milk equivalent of dairy products to the regional markets between 2003 and 2007. (Ministry of Livestock and Development, Strategic Plan 2008-2012).

The dairy industry is a major source of livelihood to many Kenyans, contributing about 4% of Kenya's GDP. The industry has created 500,000 direct jobs in milk transportation, processing and distribution and a further 750,000 in related support services. For years, the country relied on coffee, tea and horticulture for empowerment of rural economy. Today the dairy industry is rising as the cornerstone in rural development (KDB, 2012).

1.1.2 Dairy Value Chain

The value chain of both formal and informal milk market is fragmented with a large number of players at each step. In the formal value chain, the milk is usually transported to chilling and bulking centers, then to a processing facility. Once milk is processed, agents or distributors deliver it to a point of sale.

Informal market connects producers to consumers via brokers. At the farm gate level, informal marketing channels dominate with most farmers using this channel. These channels include hawkers, brokers, self-help groups as well as neighbours and business establishments like hotels. In total, the informal market channel is estimated to control 60% of the total marketed milk.

1.1.3 Dairy Cooperatives

Small scale farmers face several challenges some of which include difficulties in accessing credit, in-ability to build milk products with economic value, and quality assurance. To overcome the above challenges, small scale farmers have formed dairy cooperative societies.

At the minimum, the cooperatives provide milk collection and bulking. ??spaceAdvanced cooperatives also provide processing, marketing, credit access, and veterinary services. Cooperatives allow small holder farmers to benefit from economies

of scale, access to credit, reliable markets, and stronger linkages with other service providers.

1.1.4 Case: Limuru Dairy Farmers Cooperative Society

In this study, Limuru Dairy Farmers Cooperative Society (Limuru Dairy) was used as a case because of its accessibility, openness, and its business model that goes beyond milk collection, processing and marketing. The members of Limuru Dairy are mainly small holder farmers in Kikuyu, Limuru, Ndeiya, and Ngarariga divisions. As of April 2012, there were 24 contracted shops/stores spread across the milk catchment divisions. These stores act as collection points as well as provisional stores.

Through the stores, Limuru Dairy provides animal feeds, clinical services and human food to its members on credit. This service has endeared the cooperative to its members as they are able to access credit against milk delivered, and the difference paid out at the end of the month.

Limuru Dairy maintains a custom-made computer based information system that keeps information about members (farmers), milk collection, payment processing, credit sales, veterinary services, and stores inventory. Through the e-dairy project by the Kenya Dairy Board, Limuru Dairy introduced proximity smart cards (*maziwa* card) to replace paper-based milk journals. However, the major challenge identified in this new system was handling of cards. The memory chips on the cards are sensitive and required proper care.

1.1.5 Popularity of the mobile phone in Kenya

There are an estimated 26 million mobile subscribers in Kenya as of January 2012. This represented a penetration rate of 67 per 100 inhabitants (CCK, 2012). The reasons for high penetration include but not limited to affordability of mobile handsets, cheaper calling rates, extensive coverage of mobile network, and convenience of services like mobile money transfer, short messaging and mobile internet access. There are also a variety of third party applications and value added services that make the mobile phone a useful tool in the day-to-day lives of Kenyans.

1.2 PROBLEM STATEMENT

Based on data captured in Limuru Dairy management Information System (MIS), 90% of the members accessed goods and services on credit from appointed shops in the milk catchment area.

The shops run a paper-based credit sales journal for each farmer that captures membership and transaction details. A copy of the journal is sent to the head office for update onto the MIS at frequent intervals within the monthly payment cycle. At the end of each month, Limuru Dairy has to process the payments.

This method poses several challenges. Farmers often run into arrears and at times get advances that are more than the value of their milk delivery. Often, some farmers have to make trips to the head office whenever they feel that there were computational errors against the milk delivered. Farmers spend time and money that could have been spent on other activities. It is also not possible o know the pay rate per litre of milk unless the farmer calls or travel to the cooperative's head office.

Shop owners face similar challenges. In addition, it is not possible to accurately determine the credit to be advanced to a farmer.

Limuru Dairy management incurs a lot of overhead each month when they have to manually reconcile credit information for its members.

If the manual system is left unchecked, the overall capital base of the cooperative would be undermined in the long term. In summary, this system is offline, largely manual, prone to errors and fraud.

There is therefore a need to provide farmers, cooperative management, and provisional stores with near real time information about the amount of credit that can be advanced to farmers using accessible and affordable mobile phone technology.

1.3 **JUSTIFICATION**

1.3.1 Credit access utility on the mobile phone

Tapping on the wide usage and acceptance of the mobile phone, it was feasible to develop a mobile application that address challenges identified in section 1.2. Using affordable mobile handsets, farmers can conveniently access information about the current pay rate per liter of milk, total milk delivered, total credit advanced and the net amount of money expected from the comfort of their farms.

The mobile phone based technology also allows the cooperative management to enforce policy where a member cannot borrow in excess of his/her value of milk delivery. The application is also able to keep track of sales and inventory in the different shops within the milk catchment area which spans Limuru and Kiambu districts.

1.3.2 Value addition

The cooperative management can effectively manage the credit risk while gauging their performance against their competitors. In this way, the technology will enable management committees to identify their strengths, weaknesses and modify their service and product mix to meet the needs of their members in their localities. The application will enable the cooperative to enforce policy where members cannot borrow more than their value of milk delivery.

The value proposition to the small holder farmers who form the majority of the members is that it will enable them access credit using a convenient, fast, and low cost tool against delivery of their key agricultural produce. The members will save time, transport cost, and have peace of mind by being able to access information on milk deliveries, selling price per liter, and credit information from their mobile phones.

Shop owners and contracted service providers using the application will be able to check members' cash balance before transacting. This eliminates overdrafts while resolving operational costs. They will be able to manage credit limits, monitor demand for particular products or services and manage risk.

The application provides a fast and reliable financial information access channel to members and thus accelerates financial inclusion of agricultural producers.

1.4 OBJECTIVES

The objectives of the research are;

a) To establish the processes involved in credit advancement and payment to farmers at Limuru Dairy
b) To identify challenges faced by farmers, agro-vets/shop keepers, and cooperative management in the credit process.
c) To design and develop a mobile based technology that can address the challenges identified using appropriate technology adoption and development methods.

1.5 SCOPE

The study covered the credit and payment processes at Limuru Dairy. It was important to note that the milk collection processes are highly automated in many dairy cooperatives including Limuru Dairy and were therefore not be part of this study.

The first section of the study involved a feasibility study, analyzing the credit system A prototype was then developed to address the identified challenges. Finally, the prototype was tested in terms of the interface, functionality and user perception.

1.6 EXPECTED PROJECT OUTCOMES

The expected outcome was a mobile phone-based application that facilitated farmers to access inputs, merchandise, and services on credit against value of milk delivered. Specifically the mobile application was to;

- Provide a faster, reliable, and accurate way of doing business at an affordable cost (cheaper compared to deployment of wide area networks).
- Enable store keepers and members to check the cash balance before transacting therefore eliminating overdrafts.
- Resolve operational challenges in cooperatives i.e. introduces operational efficiency
- Provide a fast and reliable financial information access channel to members.
- Reduce operational costs and fraud (enhances transparency)
- Accelerate financial inclusion of agricultural producers.

1.7 ASSUMPTIONS

This project assumed that shopkeepers had access to a smart phones based on the Android technology. It is also assumed that the milk catchment areas had adequate mobile network coverage.

The farmer cooperative society was expected to have a computer based information system that facilitated storage of farmer, transaction and produce records.

2 LITERATURE REVIEW

2.1 DAIRY SECTOR IN KENYA

2.1.1 Milk production

In Kenya, two main types of cattle are kept for milk production and other purposes. These are the exotic breeds and their crosses, collectively referred to as dairy cattle and indigenous zebu cattle. It is estimated that dairy cattle contribute about 60% of the national milk production while the other indigenous breeds contribute the rest 40%. Rift Valley and Central Provinces are the main dairy zones accounting over 80% of the total dairy cattle population in the country (SDP Survey, 2005).

Dairy production in Kenya is undertaken under three main production systems. These are smallholder zero grazing, smallholder open grazing and large-scale open grazing.

Estimating the size of the dairy industry, however, is a challenge. Most of the sector is informal, and the official statistics capture only a small portion that is formal.

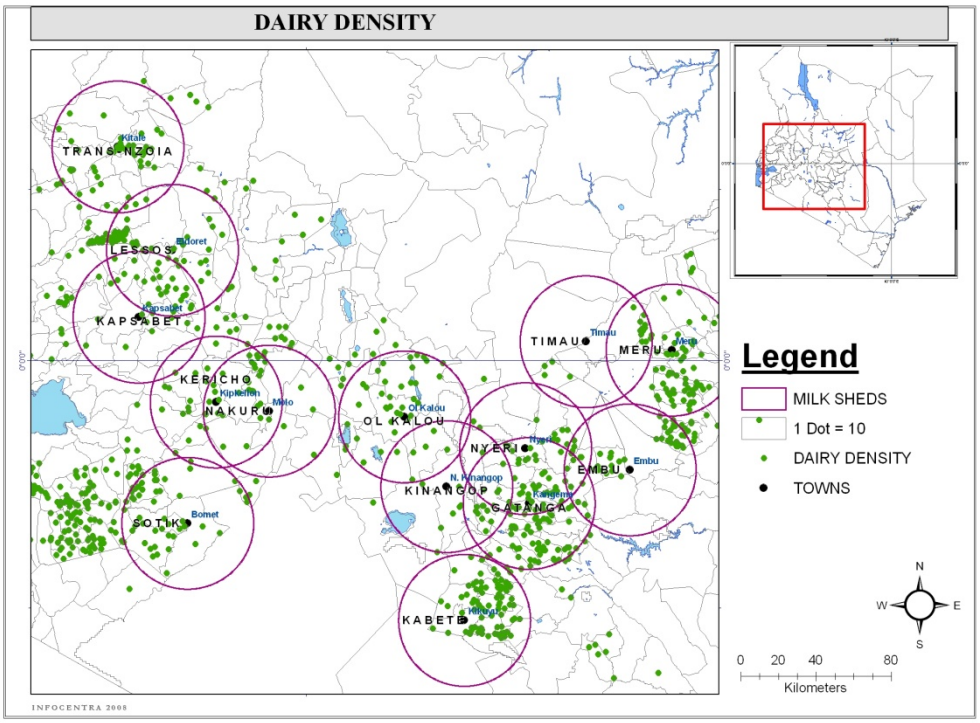


Figure 1: Dairy density (Source: ILRI/infocentra 2008)

Apart from milk, dairy animals also provide manure, other marketed products such as calves and cullings as well as other intangible benefits such as insurance and status symbol.

2.1.2 Sector Regulation

The main regulatory body is the Kenya Dairy Board (KDB) established under the Dairy Industry Act, Cap 336 of the Laws of Kenya. KDB has the responsibility of developing, promoting and regulating the dairy Industry. The main functions of KDB are the enforcement of National Standards for the Dairy Industry, training for the industry, facilitation of stakeholders' activities, and maintenance of a databank for the dairy industry and regulation of imports.

Several programs driven by the government and Non Governmental Organizations (NGOs) are currently supporting farmer cooperatives through farmer training, milk setting up infrastructure, organizing farmer into business groups, and marketing of milk products. These include Center for Development Enterprise (CDE), Technoserve, Agritrace, Land O'lakes, Heifer International, among others.

2.1.3 Milk Value Chain

In most of the dairy producing areas, milk collection is organized along collection routes. Individual farmers deliver the milk to the pick-up point or marketing agents collect the milk directly from the farms. These agents include brokers, hawkers, transporters, co-operatives and processors. The informal market outlets are the most dominant, accounting for over 76% of the total milk sold. The co-operatives, self-help groups and direct sales to processors are the formal milk marketing channels, which absorb around 24% of the milk sold. The informal milk market in Kenyan cities and towns is concentrated in the low income areas primarily due to the lower prices charged to the consumers (Karanja 2002).

Four main categories of traders are recognized by the KDB. These are producers, milk bars, mini-dairies and cottages. These traders pay an annual license fee ranging from Ksh 1,000 to Ksh 5,000. They also pay milk cess at 20cts per liter as at 2010.

The demand in both informal and formal market channels is unsophisticated. Milk is consumed either raw or as its processed equivalent of fresh milk. In the informal market only about 16% of milk undergoes home or artisanal processing and is sold as home-made sour milk or yogurt. Very similar dynamics prevail in formal market. 85% of processed produce is sold as fresh milk either as short life pasteurized milk or long life UHT milk. Yoghurt makes another 3%, fermented milk 7% and powder milk 3%, with

value-added products such as cheese and butter making less than 2% of produce sold (Industry Survey, 2005).

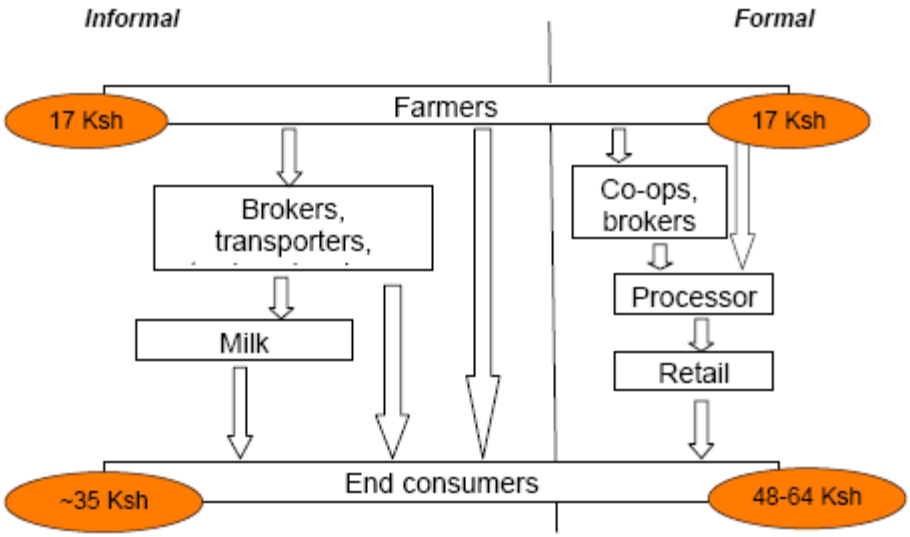


Figure 2: Market map (Source: Technoserve 2008)

Informal prices range from 30 to 40 Ksh, depending on seasonal availability of milk and distance to market. Formal market prices are based on 500ml pouch and 500ml pyramid Tetra Pack packaging of pasteurized fresh milk. The value chain of both formal and informal market is fragmented with a large number of players at each step, and a low level of vertical integration. In the formal value chain, the milk is usually transported to chilling and bulking centers, then to a processing facility. Once milk is processed, agents or distributors deliver it to a point of sale. Informal market connects producers to consumers normally via a number of brokers. In total, the informal market channel is estimated to control 60% of the total marketed milk.

2.1.4 Challenges in the dairy supply chain

The dairy sector in Kenya is characterized by lack of co-ordination between production, processing and marketing. This lack of vertical co-ordination impacts negatively on performance and efficiency.

The dominant informal milk traders who have emerged after market liberalization are also found to be ill-equipped to handle milk as a perishable commodity. This has led to heavy and unnecessary losses along the value chain.

Almost all Kenyan dairy statistics are only estimates, at best. The last cattle census was conducted in the 1960's. The current official cattle population statistics come from the Ministry of Livestock and Fisheries Development, through its field reports compiled by extension officials. The official statistics place the number of milking cattle at 3.5 billion. The survey conducted by Smallholder Dairy Project (SDP) asserts that the actual cattle number might be double the official figure (SDP Policy Brief 10). The unreliability of data makes it difficult to draw concrete conclusions about the milk production, consumption and marketing patterns (Technoserve, 2008).

Remoteness of most of the producers and the poor state of the infrastructure makes milk transportation difficult and expensive.

A major component missing on the ground is a basic system for data gathering and analysis, both on the farm and chilling plant level. Some chilling plants interviewed had a data gathering function in place, i.e. they were producing a basic set of financial data. However, the data was not used proactively to make strategic decisions (Technoserve, 2008).

2.1.5 Information systems in the dairy sector

Different stakeholders in the dairy sector have attempted to introduce computer based information systems particularly in automation of the dairy value chain. Other attempts have been made at developing operational systems for use by the dairy cooperatives.

E-dairy

E-dairy project is a Public Private Partnership initiative between the Kenya Dairy Board and Agritrace. The objective was to automate the dairy sector through infrastructure development and policy mechanisms to ensure that all the stakeholders across the value-chain work more efficiently while meeting international transactions and traceability standards. The eDairy project stakeholders cuts across the farmer, their dairy business units, the processor, the regulations as well as line industry players involved in the sector. Efficient information management was expected to overall reduce transactional costs and pass these savings onto the farmer and other stakeholders while at the same time creating new market opportunities for the country's (regions) products beyond the borders. The main implementation veins for this project included custom-built industry-specific software with a combination of highly customized hardware with a very low total cost of ownership and a most reasonable return of investment on the part of the stakeholder. The e-Dairy System was meant to

create a virtual eco-system for the whole dairy sector in whereby the industry's stakeholders would have a vibrant, secure and efficient platform to exchange information on demand (KDB, 2011).

Kenya farmer and livestock e-portal

The Kenya farmer and livestock e-portal was developed under the Kenya Dairy Sector Competitiveness Program (KDSC) program run by Land'O Lakes, an international NGO. The web based application serves as a complete dairy and livestock Management Information System (MIS) for the dairy and livestock Industry. The system initial and subsequent data collection, retrieval and analysis which are meant to meet all the needs of the stake holders pertaining to the dairy industry. The system was to achieve farmer registration, cattle and livestock census, breed and pedigree information, milking status, veterinary services and disease control information, and online training. The system also aimed to integrate with mobile Short Message Services (SMS) and access via smart phones.

2.1.6 Challenges facing current information systems

The objectives of setting up the information systems in the dairy value chain are well intended. Automating data collection, transmission from the field to central location, analysis and providing quick access to dairy information is useful. However, there are challenges that include;

- High initial cost of hardware, software, training.
- Sustainability of the systems at the dairy cooperatives especially after withdrawal of donor support.
- Lack of envisaged adoption. In some cases, immediate needs of the farmers/cooperatives are not necessarily information systems addressing the value chain (Mburu, B., 2009).
- Repetition of effort. Different organizations are re-doing the same systems but focusing on same cooperatives.
- Traceability of milk from the farmer is not properly addressed.
- System integration. The systems do not interface with each other, or at least the regulator. Processors treat most of their market data as confidential due to competition.
- These systems focus on the formal market, which only accounts for 30% of total milk production.

2.2 MOBILE TECHNOLOGIES FOR DEVELOPMENT (M4D)

2.2.1 Introduction

Mobile for Development (M4D) refers to using mobile technologies to create practical and sustainable mobile solutions and services that enable social development. M4D assists organizations to increase the effectiveness of their social programs by integrating them with mobile technology (www.m4dev.org, retrieved April 2011).

M4D can be applied in various development sectors as outlined in this table.

SECTOR	THEMES
Healthcare	Awareness, training, remote data collection, remote monitoring, patients tracking, disease monitoring, diagnostic and treatment support
Education and Training	m-learning, games, training, examinations and testing
Livelihood solutions	skills development, rural enterprise, business exchange solutions
Rural Finance	microfinance, client service delivery tools, monetary transactions, insurance and remittance, surveillance
Agriculture	alerts and communication to farmers, agro-advisory services, market price information, soil and crop management, sales and business platforms
Sustainable development and environment	awareness, training, disaster management, relief monitoring, weather forecast alerts, remote data capturing, GPS, surveillance

Table 1: M4D sectors. Source: www.m4dev.org

In 2010, UNICEF commissioned a research study to help the organization understand the global mobile telephony landscape and the relationship to advancing development, and as an area of significant future opportunities (UNICEF, Mobiles for Development 2010). From the study, the following were the key findings;

- M4D programmes carry advantages in terms of accessibility, speed, empowering women and complimenting other forms of technology.
- M4D projects can be either transformative – offering a service that previously did not exist – or offering improvement – improving the delivery of a service in terms of speed, cost , reliability and efficiency.
- The majority of projects are regarded as either pilots or in the early stages of development. Many have conducted limited small sample research in order to prove the concept. Half of these had clear intentions to expand.
- 5 of the 10 case studies had achieved national reach as their services were distributed through national mobile operators. Certain projects only had local relevance and would require duplication of many cost components to increase their reach.
- Challenges to expansion included technical training, both in terms of data collection and processing. Obviously the extent of training depends on how quickly people can grasp the concepts involved. Furthermore, in certain cases users struggled to understand the potential of services.
- Simplicity of concept is key to achieving scale.
- The sustainability of M4D projects very much depends on the ability to provide a return on investment.
- The case studies reveal four broad ways this can be achieved: Consumer pays; Company pays; Service provider pays; community pays.
- Mobiles are particularly effective in reaching women, due largely to the fact that women can use mobiles at times and in locations that are convenient to them

2.2.2 M4D application development Model

The M4D development organization suggests the following generic stages in developing an M4D application.

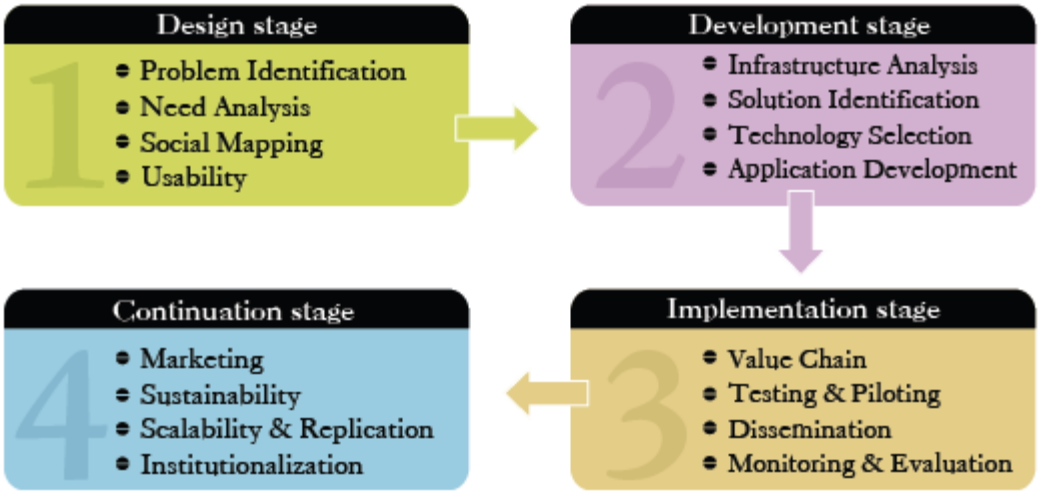


Figure 3: M4D application development stages. Source: www.m4dev.org

Design Stage: The problem is identified at the host organization e.g. in-efficiency within a business process. The various needs of the stakeholders are also identified. Needs analysis focuses on the requirements related to the goals, aspirations and needs of the users and/or the user community and feeds them into the system requirement analysis process. The main purpose of needs analysis is the user's satisfaction (Karwowski W, Soares M., Stanton, N. A, 2011). Social mapping involves looking at the people's social amenities, roads, market centers, communication, settlement, economic activities, etc and putting this on a geographical map. This allows for a deeper understanding of the organization's eco-system.

Development Stage: M4D projects are dependent on the cellular network of the service provider. Backend systems have to be in place as these will host the database and perform processing of instructions. Appropriate mobile client solution has to be selected e.g. SMS based, web-browser, Unstructured Supplementary Service Data (USSD), or installable applications. Upon selection, the next step will involve developing the application using available mobile development platforms.

Implementation Stage: This involves porting the application to the organization. Tests can then be conducted, preferably on pilot basis. The organization can then transition from old processes to the new mobile-enabled processes.

Continuation Stage: This involves ensuring the application meets the set expectation, ensuring continuous changes are made, and system monitoring and evaluation of the application. The application can be scaled to meet growing demands, or replicated to other organizations.

2.2.3 Mobile applications in the agricultural sector in Kenya

With high penetration rate of about 67 for every 100 inhabitants, mobile phones are an important tool for a larger part of the population in Kenya. Kenya is largely an agricultural based economy, with the majority of farmers practicing small scale farming. Challenges faced by these farmers provides mobile application developers with various opportunities to develop mobile phone applications that can provide services such as disseminating up-to-date information, support access to training materials and facilitate linkage between farmers and markets as well consultancy services (Mlab Research, 2011).

NokiaLife Tools

In 2009 Nokia launched a mobile service in Kenya to offer prompt weather and agriculture related information to farmers to enhance their preparedness in ensuring optimal food production. The objective of this initiative was to enable rural based communities and persons living in small towns to receive regular updates on climatic changes; farm input and farm produce prices on their mobile phones, empowering them to make quick and informed decisions that will enhance their productivity. Through partnerships with Nokia, Kenya Meteorological Department could send regular tips to farmers, through NokiaLife Tools, on changing weather patterns, while agro-based organizations could provide information to help farmers update farming techniques or indicate prevailing market conditions that could help prevent future food shortages.

M-Farm

M-Farm is a transparency tool for Kenyan farmers where they simply SMS the number 3555 to get information about the retail price of their products, buy their farm inputs directly from manufacturers at favorable prices, and find buyers for their produce. Using M-Farm, farmers can inquire current market prices of different crops from different regions/markets, aggregate orders, get connected to farm input suppliers, and sell collectively to a ready market (mfarm.co.ke, retrieved April 2012).

Kilimo Salama

One of the recent attempts is to provide insurance services to farmers through the mobile technology. Farmers insure some of the costs of growing crops against bad weather through mobile telephony that links solar-powered weather stations to an insurance company. The crop insurance named '*Kilimo Salama*' - Swahili for safe farming, covers only variability of rain and not crop failure due to pests or disease. The objective of the partnership between UAP Insurance and Safaricom was to ease the process of buying insurance products. On purchase, dealers use a camera phone to scan a barcode that automatically registers the policy with Kenyan insurance provider UAP over Safaricom's mobile phone network. Confirmation of the policy is then sent to the farmer on his mobile phone through short text messaging (Mlab Research, 2011), (GSMA, 2012).

AGRA and Voxiva

The Alliance for a Green Revolution in Africa (AGRA) teamed with Voxiva to develop a market information service for farmers. In this project, agro-dealers (stockists) would place requests for inputs through the web-based application using web-enabled mobile phones or computers. This linkage was to achieve a seamless flow of information between suppliers and stockists. According to Mr. Mutonye, managing director at AGMARK, the challenges with the system was not necessarily the technology, but unwillingness of the stockists to embrace the system, and mainly the cultural issues involved. For example, stockists relationship with the suppliers may be 'personal' and therefore the stockist may not necessarily buy from the cheapest supplier. His view was that at current, the best approach for such ICT applications was to adopt a 'push' approach where information flows from the manufacturer/supplier downwards to stockists and farmers, and not vice versa. His main reason was that farmers prefer to make a phone call rather than send Short Messages Services (SMS) or use mobile applications.

In 2010, a group of developers launched an application that availed instant information to farmers on relevant seeds and potential markets for their produce. In this project, a farmer sends a text message with the word '*agcommons*' from his/her mobile phones to 368674; enter the name of his or her city, village or place one is located. The system would then return an SMS message with nearest location where the farmer can get the service requested. The objective of the service was to furnish farmers with information

that allows them to plan and decide more effectively which crops or livestock will perform best on their farms, anticipate and manage disease outbreaks and rainfall shortfalls, and make decisions where to sell the produce (Agcommonsplatform, 2010).

2.2.4 Mobile data collection technologies

Information systems are primarily concerned with collection, transmission, processing, and dissemination of data.

Mobile data collection systems have several components that facilitate for data collection, transmission, storage and retrieval. Each component has several technology options, appropriate for different situations.

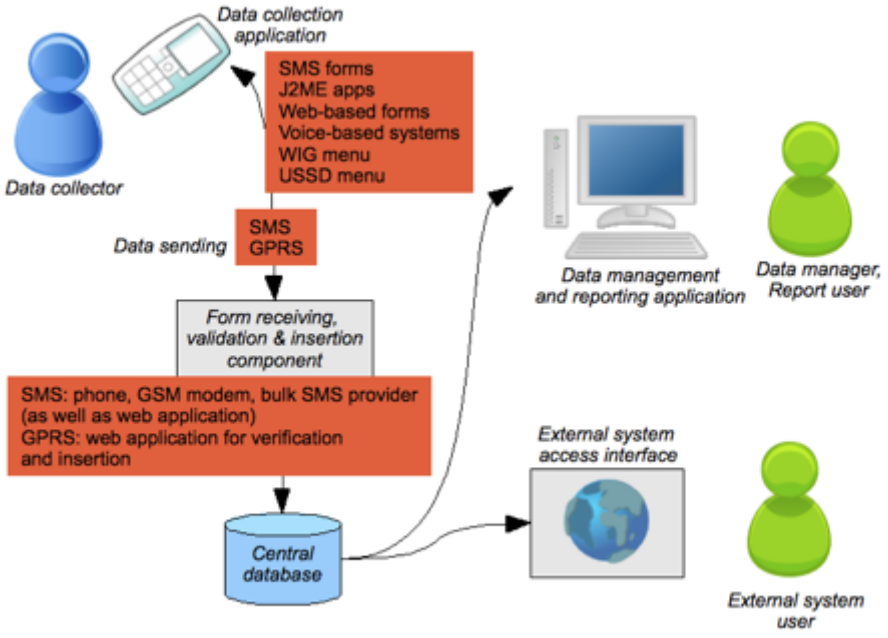


Figure 4: Mobile data collection technologies. Source: M. Loudon, mobileactive.org

The components can be categorized as:

- The data collection client interface, which the user interacts with to accomplish data collection and transmission
- The data transfer method, which dictates how the information input on the phone is transmitted to a central server for storage and retrieval.
- Server-side components to receive and store the data, and allow users to display and manage the database.

Below is a table showing common mobile data collection methods

Technique	Description
Short Message Services (SMS)	Most popular where user sends data in using inbuilt SMS functionality on the phone
	Compatible with all mobile phones
Smart Applications (Apps)	A programming language is used e.g. java and loaded on a phone that can support the application
	Usually developed for smart phones, and are platform specific.
Web-based forms	The client uses phone's web browser to access the application. The user browses to a website, where the form is published in an optimized format for mobile browsers
In voice-based	User dials a number and then chooses from options on a menu ("to record the answer to this question, press 1 for yes, 2 for no, etc).
	Useful when there are low levels of literacy among data collectors, or when a system is needed that caters for both landline and mobile phones
Unstructured Supplementary Service Data (USSD)	This is a real-time question-response service, where the user initiates a session and is then able to interact with the remote server by selecting numeric menu options.
	e.g. *544# and following text responses via menus
	The main limitations of USSD is the requirement for a continuous connection during the session, a limited length of USSD menus, and expensive acquisition and licensing constraints in the Kenyan market

Table 2: Mobile data collection methods

2.2.5 Mobile application development tools

Mobile application development refers to the process of developing application software for mobile gadgets e.g. mobile phones, iPods, personal digital assistants, etc. There are several tools and platforms available. Some are full end-to-end systems, whereas others are client application components only. The choice of tools depends with specific needs, resources available, and the skills to do system customization or development (M. Loudon, 2010).

The table below shows a summary of popular tools/platforms.

	Programming language	**Integrated Development Environment (IDE)**	**Cross-platform deployment**	**Development tool cost**
Android	Java, C,C++	Eclipse,IntelliJ IDEA,NetBeans	Android only	Free
BlackBerry	Java	Eclipse	BlackBerry only	Free
iOS SDK	Objective-C	Xcode,AppCode	iPhone, iPad, iPod Touch	Free & commercial licenses
Java ME	Java	Eclipse, NetBeans	Yes	Free
.NET Compact Framework	C#, VB.NET,Basic4ppc	Visual Studio 2008, 2005, 2003,Basic4ppcIDE	Windows Mobile, Windows CE, Symbian	Free & commercial licenses
Palm OS	C, C++, Pascal	(Eclipse),CodeWarrior,PocketStudio, HB++, Satellite Forms	Palm OS handhelds, or Windows Mobile with StyleTap emulator	Free & commercial licenses
Python	Python	Several, including plugins forEclipse	Nokia Series60, desktops	Free
Qt SDK	C++, QML	Qt Creator	Symbianplatform, Maemo, MeeGo, Linux,Windows, Mac OS X	Free & commercial licenses
Symbian	C++	Many choices	Compile per target	Commercial and free tools
Windows Mobile	C, C++	Visual Studio 2010, 2008, 2005, eMbedded VC++ (free), Satellite Forms	Windows Mobile, Windows FU, Windows CE	Free & commercial licenses

Table 3: Mobile application development tools

2.3 TECHNOLOGY ADOPTION IN RURAL COMMUNITIES

This study sought to develop a mobile based solution that was to be deployed for use by a rural community in Limuru, Kenya. In this section, two technology adoption models are described and one adopted for use. An adoption model will aid in evaluating and identifying factors that contribute to farmers accepting and using the mobile based solution.

2.3.1 Technology Acceptance Model (TAM)

The model suggests that when users are presented with a new technology, the following factors are critical in determining whether the technology will be adopted:

- Perceived usefulness - The degree to which a person believes that using a particular system would enhance his or her job performance
- Perceived ease-of-use - The degree to which a person believes that using a particular system would be free from effort

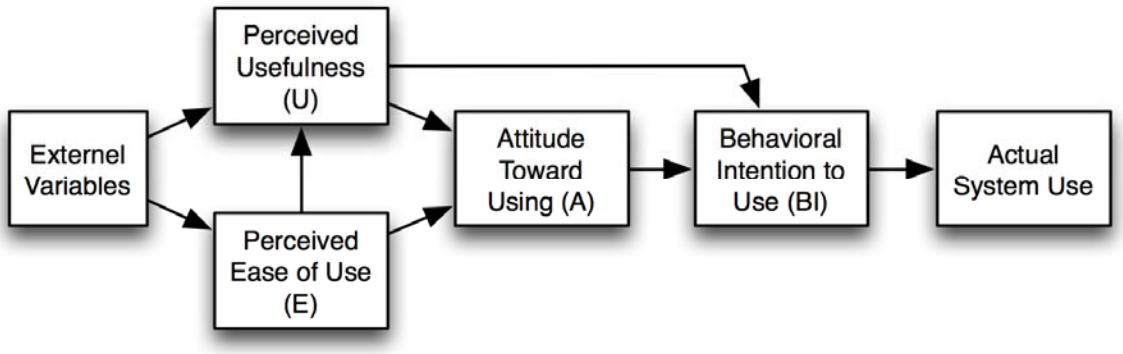


Figure 5: Technology Acceptance Model (TAM). Source: Davis, 1985

The purpose of the model is to predict the acceptability of a tool and to identify the modifications which must be brought to the system in order to make it acceptable to users.

Limitations of the TAM

In general TAM focuses on the individual user of a computer, with the concept of perceived usefulness, with extension to bring in more and more factors to explain how a user perceives usefulness, and ignores the essentially social processes of information

systems development and implementation, without question where more technology is actually better, and the social consequences of IS use (Bagozzi, 2007).

2.3.2 Unified Theory of Acceptance and Use of Technology (UTUAT)

This is a technology acceptance model formulated by Venkatesh and others in "*User acceptance of information technology: Toward a unified view*" (Venkatesh et al, 2003). The UTAUT aims to explain user intentions to use an information system and subsequent usage behavior.

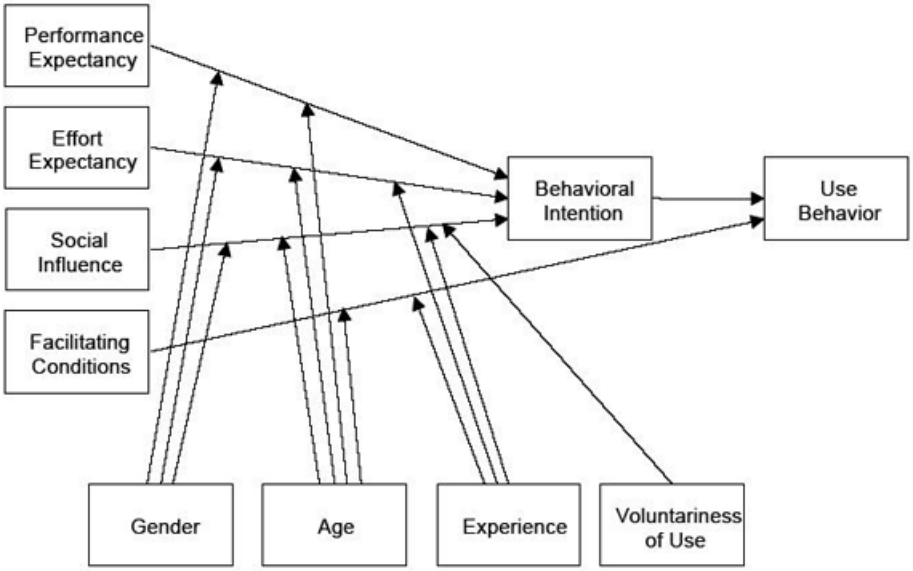


Figure 6: Unified Theory of Acceptance and Use of Technology. Source: Venkatesh, 2003

The theory holds that four key constructs (performance expectancy, effort expectancy, social influence, and facilitating conditions) are direct determinants of usage intention and behavior. Gender, age, experience, and voluntariness of use are posited to mediate the impact of the four key constructs on usage intention and behavior.

Relevance of UTUAT

Many user acceptance models with different determinants exist to measure the user agreement of information systems which is an important factor to indicate a system success or failure. These theories have been widely tested to predict user acceptance.

However, no comprehensive instrument to measure the variety of perceptions of information technology innovations had existed until Venkatesh et al. (2003) attempted to review and compare the existing user acceptance models with an ultimate goal to develop a unified theory of technology acceptance by integrating every major parallel aspect of user acceptance determinants from those models (Sundarajev, 2009).

The four key constructs of performance expectancy, effort expectancy, social influence, and facilitating conditions can be applied to this study. This makes UTUAT a more relevant model to this study as compared to TAM.

2.4 SUMMARY

Based on the literature review and discussions with key stake holders, the following key success factors for mobile based applications in the Kenyan context were identified;

- The application should be mobile phone based since this is largely available and in use in most rural set-ups.
- There should be existing formal structures in the farmer cooperatives. This makes it easy to introduce technology that will improve on existing business process.
- The technology has to address a persistent problem that can easily be addressed by a technology.
- If possible, the problem should have an element of credit services for small holder farmers who do not readily have access to cash.

Limuru Dairy provided a good case study because of its accessibility (located near Nairobi), amicable staff, and its business model that includes provision of goods and services on credit to members against value of milk delivered.

The M4D model in section 2.2.2 captures features that are important for development and deployment of mobile based applications. The model has practical steps covering design, development, implementation and continuity. In the continuity phase, this model addresses scalability, sustainability and replication. These are not available in the UTUAT model, which has also been used in this study.

The UTUAT model introduces performance expectancy which is a farmer's belief that the mobile technology will improve his/her execution of tasks. Effort expectancy will measure the ease associated with executing tasks using the mobile technology where as the social influence indicates whether someone important to the farmer influences his/her decision to use the new mobile technology.

3 METHODOLOGY

3.1 OVERVIEW

This section describes the various data collection tools that were used in identifying and analyzing the challenges faced by Limuru Dairy. The prototyping software development model was used and reasons given for its adoption in this research project.

3.2 DATA COLLECTION TECHNIQUES

The M4D application development model (figure 5) was largely adopted. A range of techniques were used as described below.

3.2.1 Literature survey

Relevant literature was reviewed to gain an understanding of the dairy industry, mobile technologies, adoption, and a review of existing mobile applications in the agricultural sector. Sources of the literature included the internet, journals, newspaper articles, and industry publications.

3.2.2 Field Visits

Several field visits at Limuru Dairy were conducted in order to gain a deeper understanding of Limuru Dairy business model. Discussions were held with staff at the head office, stores, and farmers.

During field research, several stakeholders were consulted with an aim of gaining clear understanding of the dairy industry, attempts at introducing different ICTs, the success or failure, and lessons learnt. This approach was informed by the need to have an innovative solution that will address a real problem in the dairy sector.

3.2.3 Interviews/Consultations

Experts in the dairy and to a wider extent the agricultural sector were consulted. This helped in giving deeper insight into the dairy sector, and specifically Information and Communications Technology (ICT) interventions. Limuru Dairy farmers and management were extensively consulted during the problem identification phase, and subsequent phases. Mobile application developers were also consulted, especially with regards to choice of mobile technology and mobile landscape in Kenya.

3.2.4 Focus Group Discussions (FGD)

This was conducted to obtain qualitative data on the perceptions, opinions, beliefs, and attitudes towards the mobile-based application. The FGD was conducted on two

groups; management staff of Limuru Dairy, and farmers. The discussions were recorded on video to allow playback at a later date.

3.2.5 Questionnaires

Quantitative data on usability, perception, attitude, and functionality of the mobile application were collected using questionnaires. The data was collected after product demonstration.

3.2.6 Immersion sessions

This involved spending time at Limuru Dairy head office operations staff, getting involved with the shop keepers at Limuru Agro-vet stores, and finally participating in milk collection at the stores. These provided a rich firsthand experience at Limuru Dairy.

3.3 EVOLUTIONARY PROTOTYPING MODEL

Prototyping is the rapid development of a system. The principal use is to help users and developers understand the requirements for the system. Users can experiment with a prototype to see how the system supports their work and the prototype can reveal errors and omissions in the requirements (Sommerville, I., 2000).

In this research project, an evolutionary prototyping model was adopted. In this approach of system development, the initial prototype is produced and refined through a number of stages to the final system.

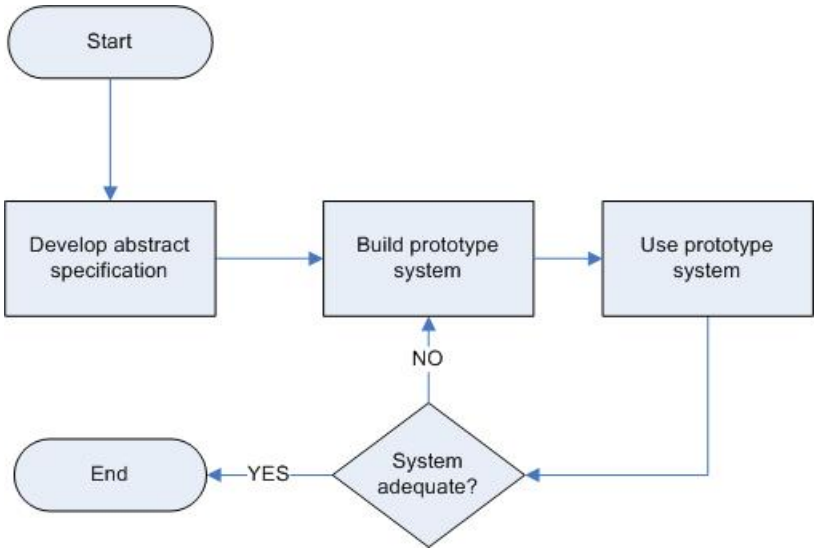


Figure 7: Evolutionary prototype. Source: Sommerville. I, 2000

The prototype developed consisted of the following modules;

- mobile application (app) client that runs on a smart phone
- SMS system
- Backend system

Each module was developed and tested independently. These were later integrated then tested. The integrated system was extensively evaluated during the focused group discussions at Limuru Dairy.

The following are reasons for adopting evolutionary prototyping approach for in the research project:

- Users at Limuru Dairy were able to engage with the system at an early stage. This enhanced the likelihood of meeting user requirements and commitment.
- Allowed accelerated delivery of the system where a working system was available early in the process.
- Misunderstandings between software users and developers are exposed
- Missing and/or confusing services were likely be detected

4 SYSTEM ANALYSIS AND DESIGN

4.1 ANALYSIS

The current business model at Limuru Dairy was mapped out. Information flows, users, and processes were identified. The focus was on the credit access process which is analyzed in detail in this chapter.

4.1.1 Current business model at Limuru Dairy

This figure shows the current set-up and information flow at Limuru Dairy.

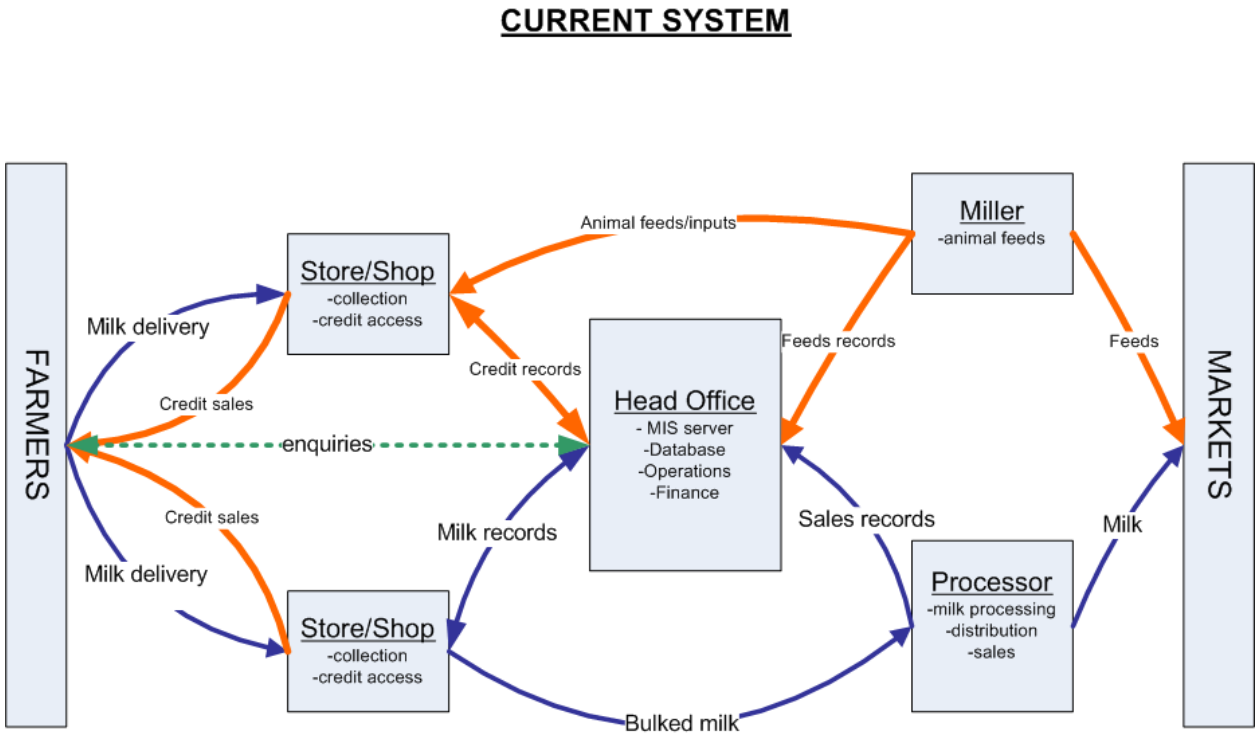


Figure 8: Limuru Dairy business model

Limuru Dairy has four business units namely:

- Head office – hosts the cooperative's headquarters. Management, finance, and ICT staffs are hosted here. All other units are coordinated from this location.
- Milk Processor – Daily milk collection is delivered here for processing and distribution to the market.
- Feeds milling plant – a relatively new installation. Animal feeds are milled and sold to members and the public and a cheaper price.

- Farmer stores/shops – these are distributed across the milk catchment areas. There are a total of 31 shops/stores, which primary function is milk collection, and stores provision to members. The inputs are sourced from the feed miller.

Milk collection is organized around routes, where each route has several stores/shops. Every morning and evening, farmers deliver their milk to the stores, where Limuru Dairy staff will assess the quality before weighing. Weighing is done using digital meters. The quantity of milk delivered is then recorded on a milk journal. A copy of the journal is left with the farmer. On some routes, the *maziwa* electronic card (described in section 1.1.4) system is used.

4.1.2 Review of current credit process

Each shop maintains a paper-based credit sales journal where transaction and membership details are recorded. A copy of the journal is sent to the head office for update onto the MIS at frequent intervals within the monthly payment cycle. At the end of each month, Limuru Dairy has to process the payments.

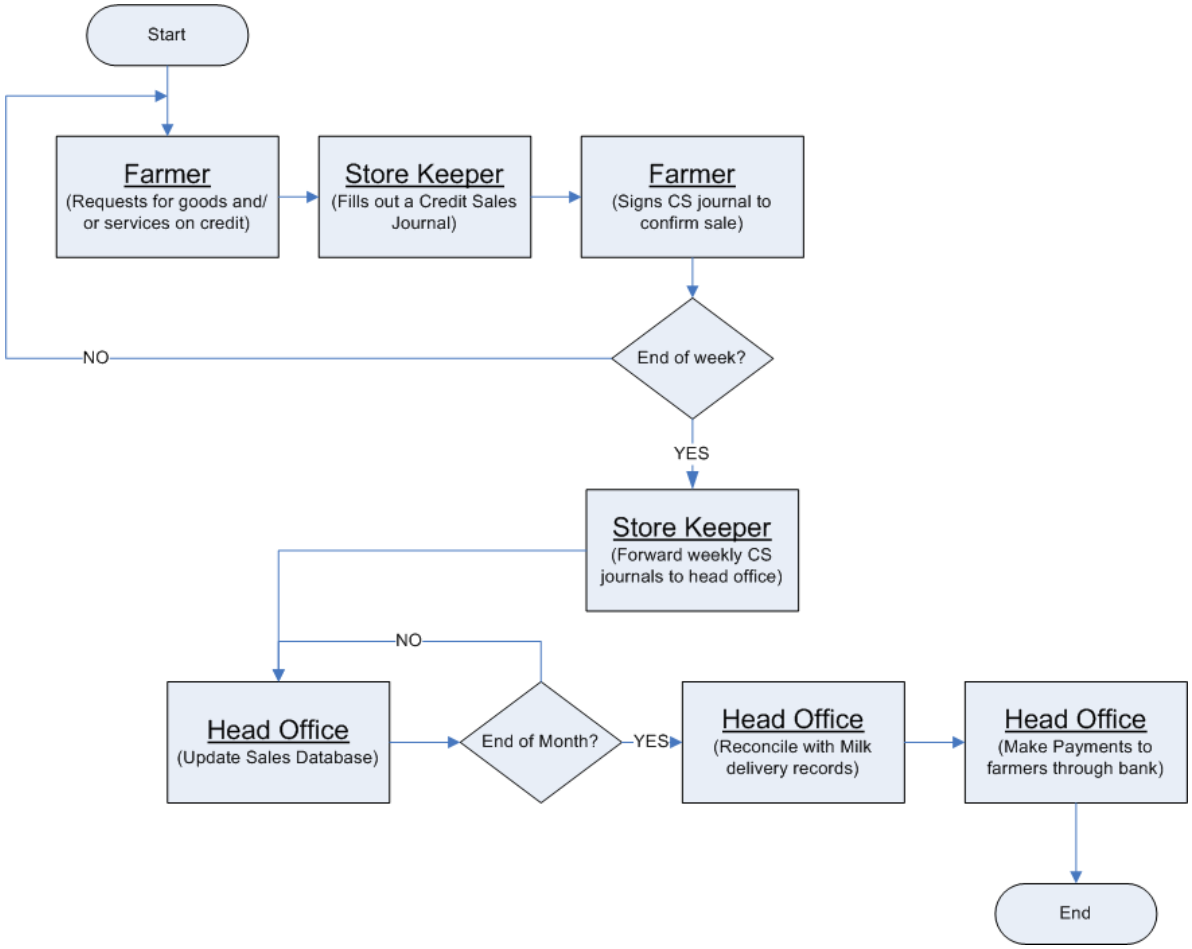


Figure 9: Credit process at Limuru Dairy Cooperative

Challenges

- Farmers often run into arrears and at times get advances that are more than the value of their milk delivery.
- Often, some farmers have to make trips to the head office whenever they feel that there were computational errors against the milk delivered. Farmers spend time and money that could have been spent on other activities.

- It is also not possible to know the pay rate per liter of milk unless the farmer calls or travel to the cooperative's head office.
- Shop owners face similar challenges. In addition, it is not possible to accurately determine the credit to be advanced to a farmer.
- Limuru Dairy management incurs a lot of overhead each month when they have to manually reconcile credit information for its members.
- Results in payment delays to farmers.
- If the manual system is left unchecked, the overall capital base of the cooperative would be undermined on the long term.

In summary, this method is offline, largely manual, prone to errors and fraud.

4.1.3 User requirements

Faced with challenges identified in section 4.1.2, the following were identified as requirements by the stakeholders at Limuru Dairy.

- An appropriate technology should be introduced to allow for almost real time credit transaction, as is the case with milk delivery. Using *maziwa* proximity cards the milk records are updated daily onto the MIS.
- Farmers should be able to access credit information from their localities, without the need of travelling to the head office.
- Shopkeepers should be able to check credit limits for farmers before committing transaction.
- A policy should be enforced where a member cannot access goods or services above the value of milk deliveries
- Transactions should be captured directly onto the MIS in the head office, to eliminate manual updates and data capture errors.
- The system should be able to calculate daily credit balances for each farmer, and relay the same to the farmer on request.

Based on the above requirements, and the taking into account farmer technical literacy, affordability of proposed technology, and geographical spread of the members, this project adopted a mobile phone based solution to integrate with existing back-end systems at Limuru Dairy.

4.1.4 Requirements for a mobile solution

The following were identified as challenges that need to be addressed when designing mobile based solutions.

- Unlike desktop computers, mobile phones have lower processing and memory capacities. This means minimum processing function at the phone.
- Mobile gadgets have small screen and keyboards making it unfriendly to use (Kiplagat D., 2006).
- Cross platform compatibility issues for diverse models. Different versions have to be availed for mobile applications that are designed for installation.
- Usability has to be keenly observed due to constraints in the size of the phone for installable mobile applications.
- Network reliability of service providers may limit transmission of data between mobile gadgets and the backend systems at the head office.
- Security of data is critical, and controls have to be put in place to ensure confidentiality, and authorized access, authentication, integrity of data, and non-repudiation.

From the above challenges, the following items were considered as critical and incorporated in the prototype.

- Taking into account the farmers, and shop keepers as different user groups, provide a platform independent technology for farmers through SMS, and platform specific installable application for shopkeepers.
- Platform specific installable mobile application for shop keepers' guarantees security of information held on the device and data transmission.
- Mobile numbers of farmers must be registered in the backend system to ensure only registered farmers are able to use the SMS service.
- Limit amount of data transmitted between mobile phone and backend system. This was achieved by sending coded information.
- Easy steps to execute transactions on the mobile application. Ensure minimal data input by providing select menus.

4.2 DESIGN

4.2.1 Proposed mobile based system

This figure shows the overall proposed mobile application.

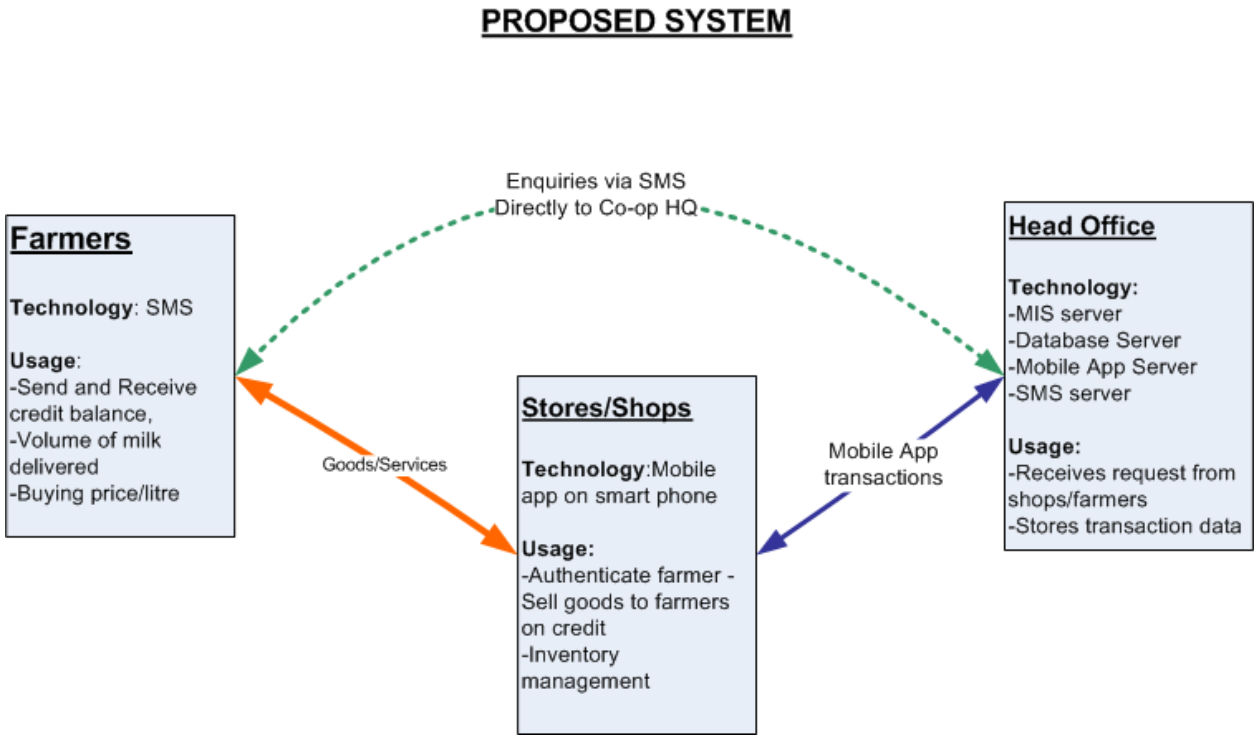


Figure 10: Proposed mobile based system

The proposed system introduces mobile technologies to replace existing manual and paper based credit process.

4.2.2 Short Messages Service (SMS)

At the farmer level, an SMS service allows the farmer to send an SMS request that returns the volume of milk delivered for the month, provisional buying price, value of goods and services procured on credit for the month, and the balance thereof. This will drastically reduce frequent travels of the farmers to the Cooperative head office, increase transparency, and empower the farmers by providing necessary information before making credit purchases.

4.2.3 Mobile application (Mobile App)

The mobile app is used at the stores and replaces the current sales journals. With the app, the store keeper is able to check the credit worthiness of a member farmer before commencing any transaction. The app has controls that prevent advancing goods to

farmers who do not qualify for credit, as well as placing limits of the value of items vis-a-vis the credit available.

The store keeper has more control of the inventory as the app allows him to order and receive goods. When an order is placed, the request is automatically sent to the head office.

4.2.4 Hosted database and online information servers

The database server, management information system (MIS), mobile app server and SMS server are located at the head office of the cooperative. The mobile app and SMS server must be online to allow querying of data from the field over the mobile network.

A key advantage of this system is that credit transactions are posted directly onto the MIS and hence eliminates the arduous task of manual updates thus saving Limuru Dairy time and money.

4.2.5 Revised credit process

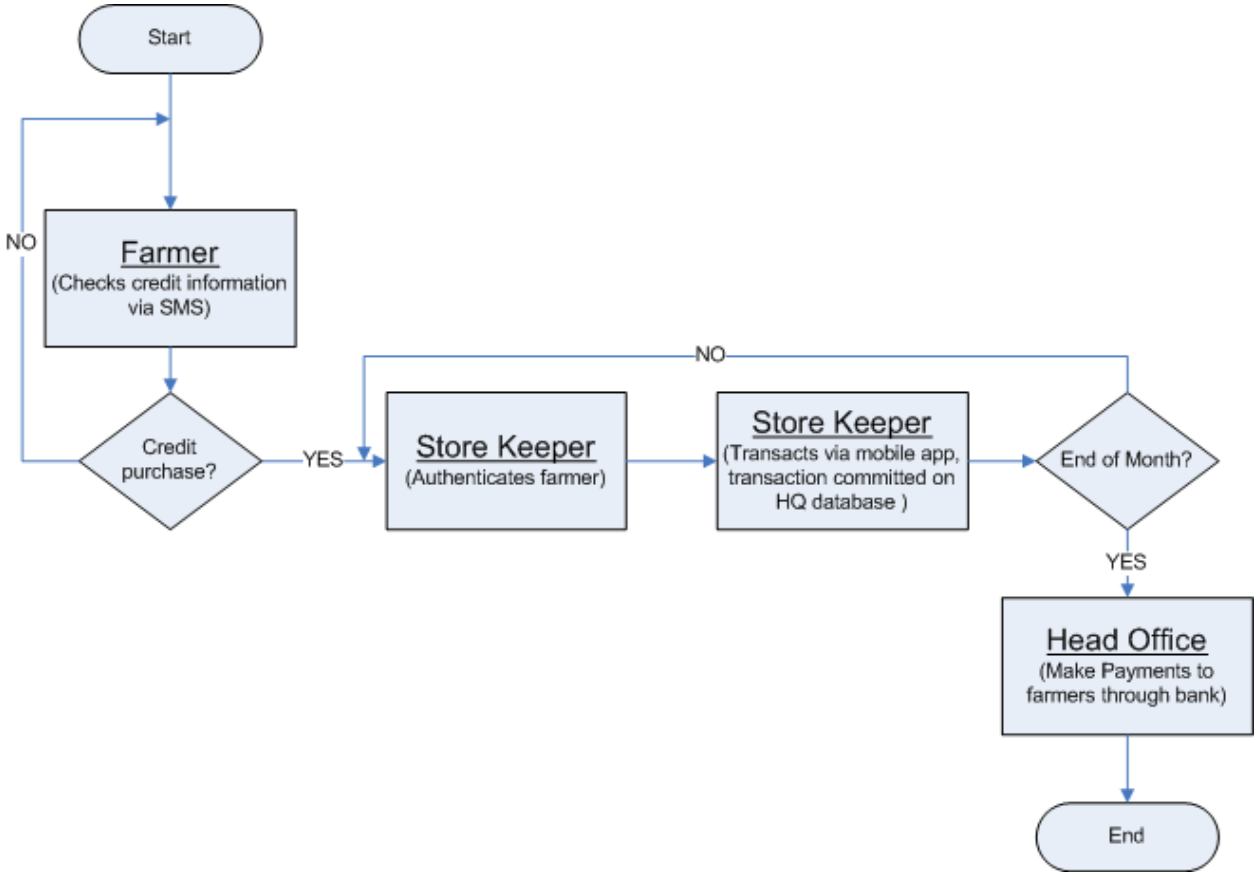


Figure 11: Revised credit process

The revised model is highly automated using mobile technology. First, a farmer can check the amount of credit he can access from his/her mobile. Before the actual sale transaction, a farmer is first authenticated. Next, using the mobile app, the shopkeeper will execute the transaction. This eliminates the paper based credit journals. The transaction is automatically committed on the database at the head office. Therefore, the weekly delays experienced when sales journals are picked and transferred to the head office are eliminated. Lastly, manual reconciliations at the head office are eliminated as the database has scripts that update members' balances after every transaction.

4.2.6 Database design

The tables are modeled on the existing database at Limuru Dairy. This is to allow the new system to integrate seamlessly with existing database. The milk collection and payment records are reconciled at the database level.

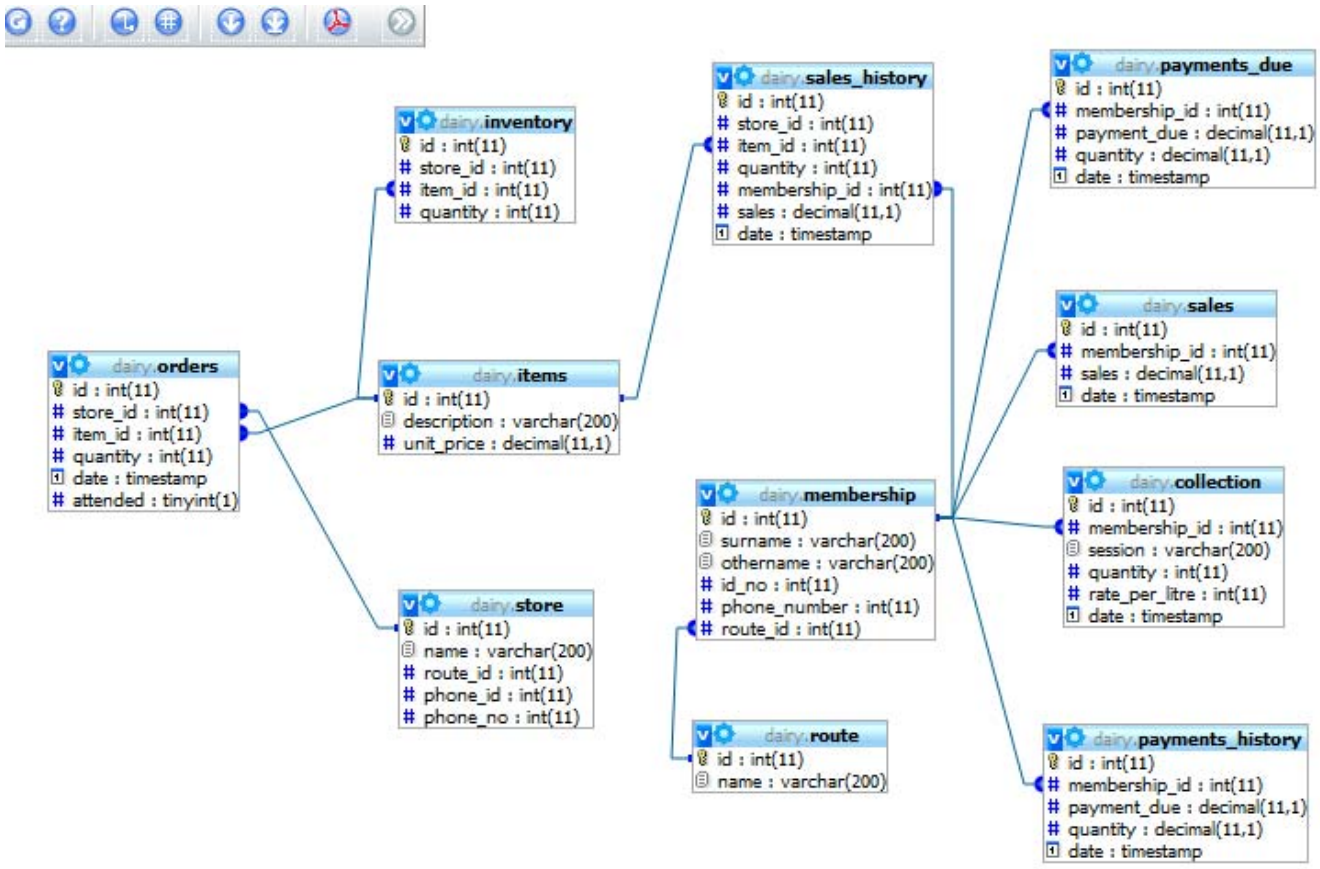


Figure 12: Database schema

4.2.7 User Interface design

This involved designing the mobile user interfaces, clearly showing interactions and sequence of events as experienced by the user.

The agro-vet/shop keeper first checks the member/farmer balance. The system will then respond by displaying the member status (active or otherwise), available balance, milk quantity delivered, credit incurred so far, and the balance thereof.

If the balance is positive, a sell transaction can then be initiated. This is executed as shown in the figure.

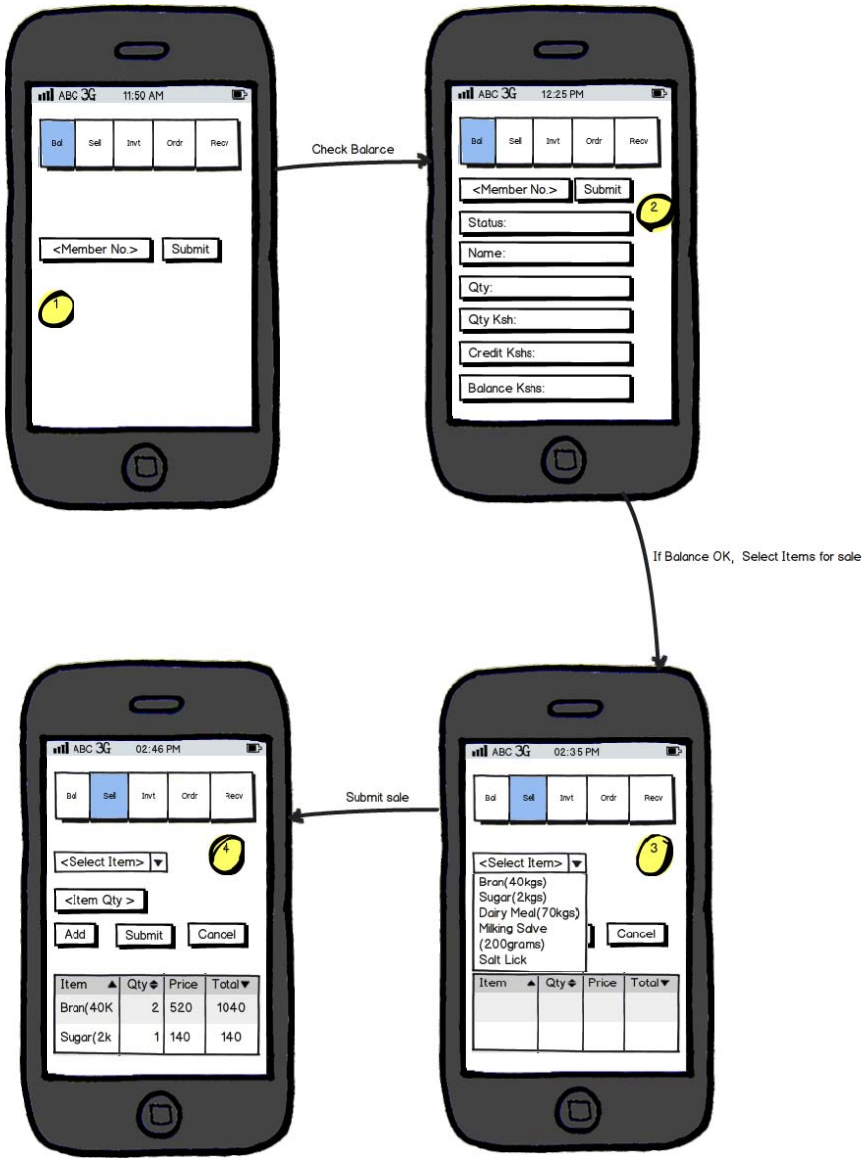


Figure 13: Screen mock up for *balance* and *sell* functions

Additionally, the system allows for inventory control. The application allows the shopkeeper to check inventory levels, request and also receive stock.

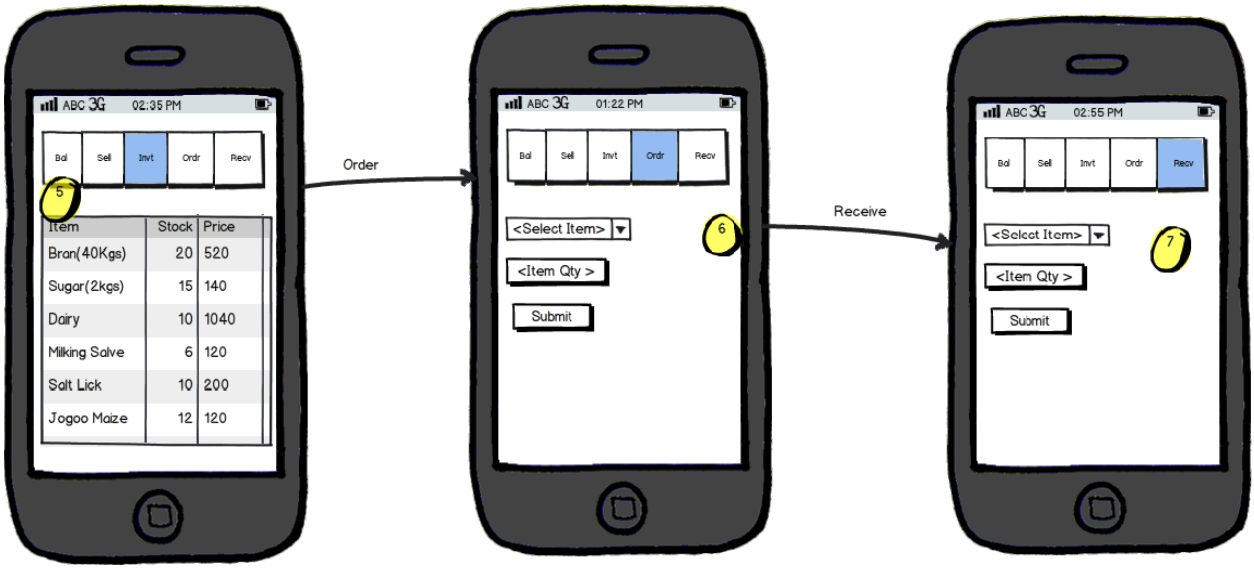


Figure 14: Screen mock up for inventory, order and receive functions

5 PROTOTYPE IMPLEMENTATION

5.1 OVERVIEW

This chapter describes in details the implementation of the prototype. First, the different modules and supported technologies are presented in a technical model. Next, the modules are described in detail, including choice of technology, coding, testing, and integration. The user documentation is attached at the end as an appendix.

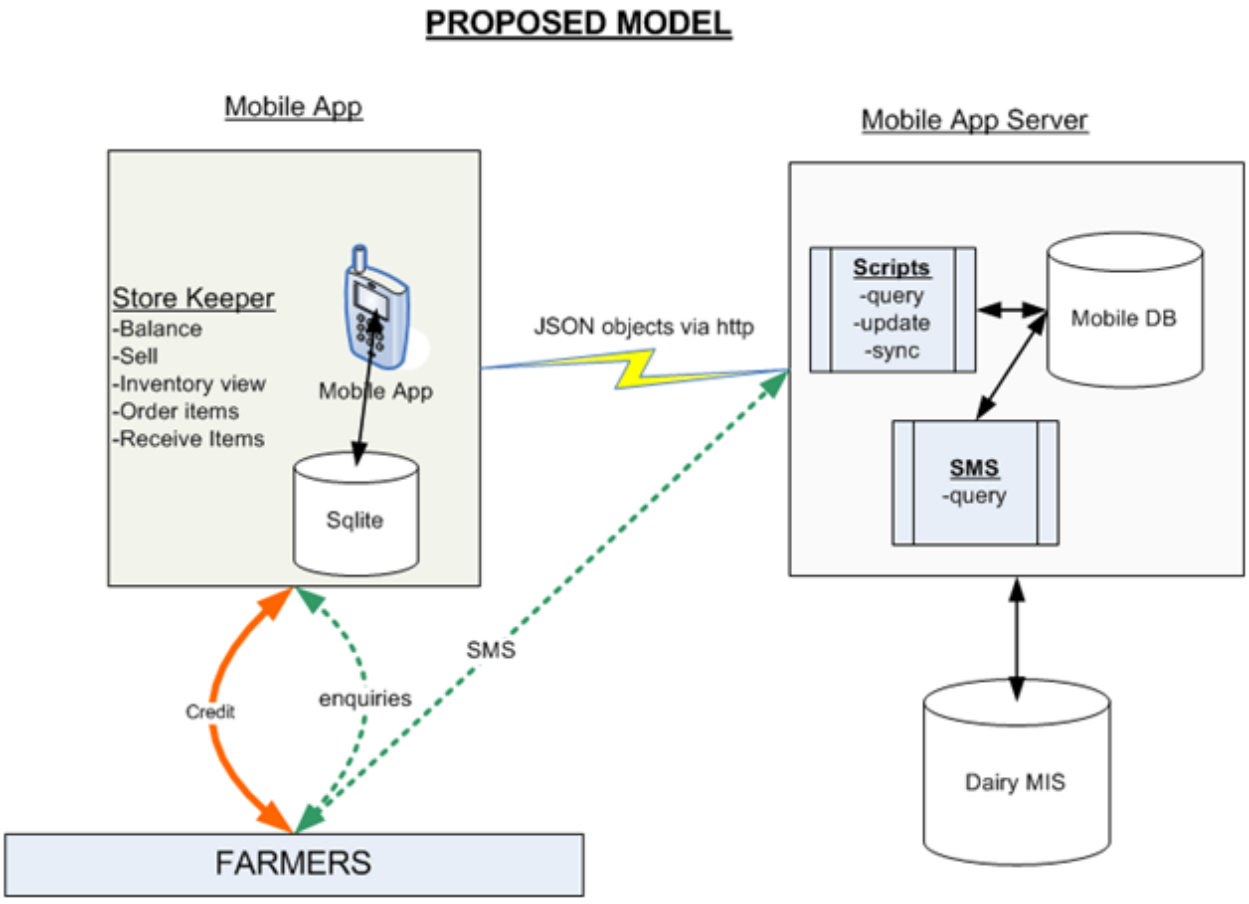


Figure 15: Model showing mobile technologies interaction

5.2 CHOICE OF TECHNOLOGIES USED

5.2.1 Android

The mobile application is based on the android platform that runs on smart phones. Android is a Linux-based operating system for mobile devices such as smart phones and tablet computers. The android software stack includes an operating system, middleware and key applications. The dairy application sits on the android operating system (OS), and taps services such as communication and storage from the OS.

By providing an open development platform, Android offers the ability to build rich and innovative applications. Secondly, android smart phones are becoming cheaper and latest trends show falling prices for android handsets.

Android allows developers take advantage of the device hardware, access location information, run background services, and others since they have full access to the same framework APIs used by the core applications. The application architecture is designed to simplify the reuse of components (deloper.android.com, retrieved May 2012).

5.2.2 Java and Eclipse Integrated Development Environment (IDE)

The dairy app is built using the Java programming language. Eclipse Integrated Development Environment (IDE) for Java developers provides superior Java editing with validation, incremental compilation, cross-referencing, code assist; and XML Editor.

5.2.3 Short Messages Services Library (SMSLib)

SMSLib is a Java library which allows send/receive of SMS messages via a compatible GSM modem or GSM phone. Some of the functionality supported by SMSLib includes:

- Supports GSM phones and GSM modems connected via serial port interfaces or IP interfaces.
- Works with PDU/TEXT protocols.
- Supports Inbound & Outbound simple text messages.
- Works with 7bit, 8bit and UCS2 (Unicode) message encodings.
- Supports Inbound & Outbound big (multipart) messages.
- Flash messaging.
- Outbound messages with port information / addressing.

- Outbound WAP PUSH SI messages.
- Status (Delivery) Report messages.
- Basic GSM information available: Modem, Manufacturer, software revision, Signal level, etc.
- Supports a few bulk operators, using http/https protocols.
- Support the SMPP protocol.
- Handles multiple gateways at the same time

The SMS server allows farmers to send SMS to the system and get information such as quantity of milk delivered during the month, amount of goods taken on credit, and the balance thereof.

5.2.4 MySql database server

MySQL is a relational database management system (RDBMS) that runs as a server providing multi-user access to a number of databases, and distributed under the open source and proprietary licenses.

The Mysql database holds information on the membership, inventory, milk collection, credit sales, payments to farmers, and stores. This database is designed to synchronize with the main MIS system run by Limuru Dairy.

5.2.5 Scripting

A script is a set of instructions that is executed automatically upon trigger by a program or event. Several of these scripts are implemented in the mobile application and database. These include:

- A script that allow the mobile app to synchronize information on the phone memory with the *Mysql* database on the server.
- A script that updates the member balances upon update of milk collection or credit transaction

The scripts are written using the *php* language and Structured Query Language (SQL) statements e.g. a script that clears monthly records after payments are done

```
CREATE EVENT clear_payments_due
  ON SCHEDULE  EVERY 1 MONTH STARTS CURRENT_TIMESTAMP + INTERVAL 13 DAY
  COMMENT 'Clears out payments_due table each month.'
  DO
    DELETE FROM dairy.payments_due;
```

5.2.6 Communication between the mobile apps

Communication between the mobile app and the mobile server is achieved through JavaScript Object Notation (JSON) over hyper text transfer protocol (http). JSON is a lightweight data-interchange format that is easy for humans to read and write. It is also easy for machines to parse and generate. JSON is built on two structures:

- A collection of name/value pairs.
- An ordered list of values.

In this project, this has been implemented as an array.

5.3 PROTOTYPE DEVELOPMENT

5.3.1 Mobile Application

Mobile app implemented the following functions;

- Balance check – Allows the shopkeeper to check a farmer's balance before commencing a transaction

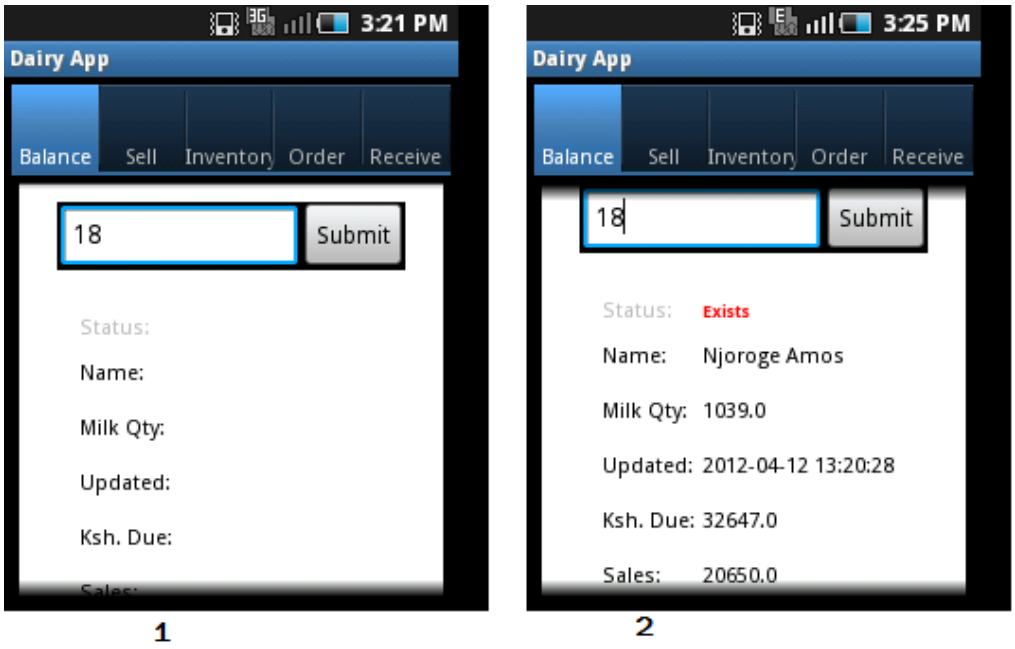


Figure 16: Check balance function

- Sell – If credit balance is adequate, the sell tab allows the shopkeeper to perform a sale transaction.

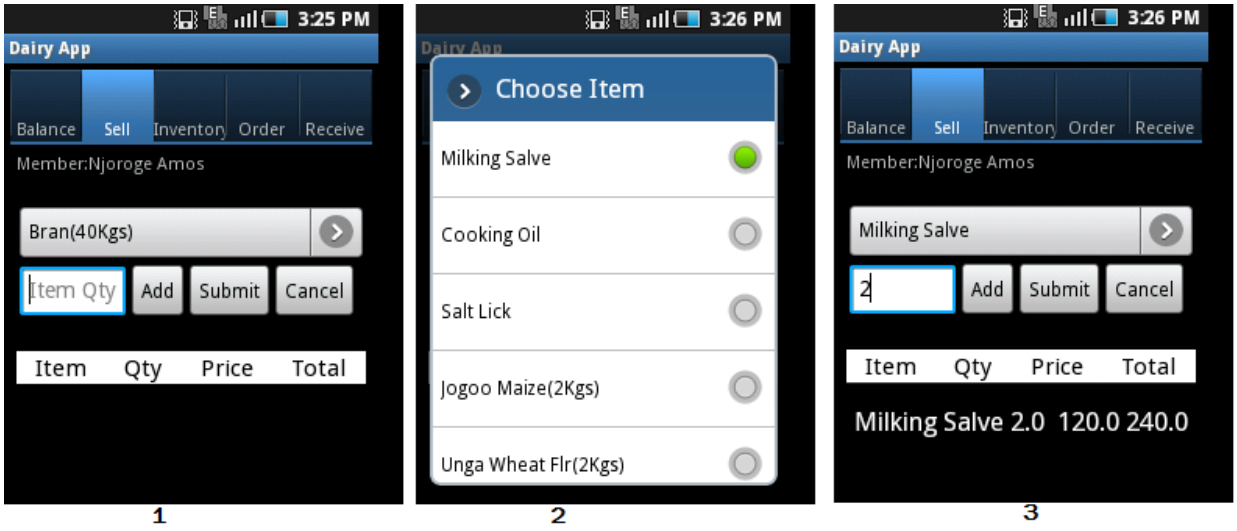


Figure 17: Sell process

- Inventory – This allows the shopkeeper to view list of items on stock, quantities, buying price and any re-ordered items. The shopkeeper can also synchronies the inventory with the head office, especially to reflect prices of items which are fluid.

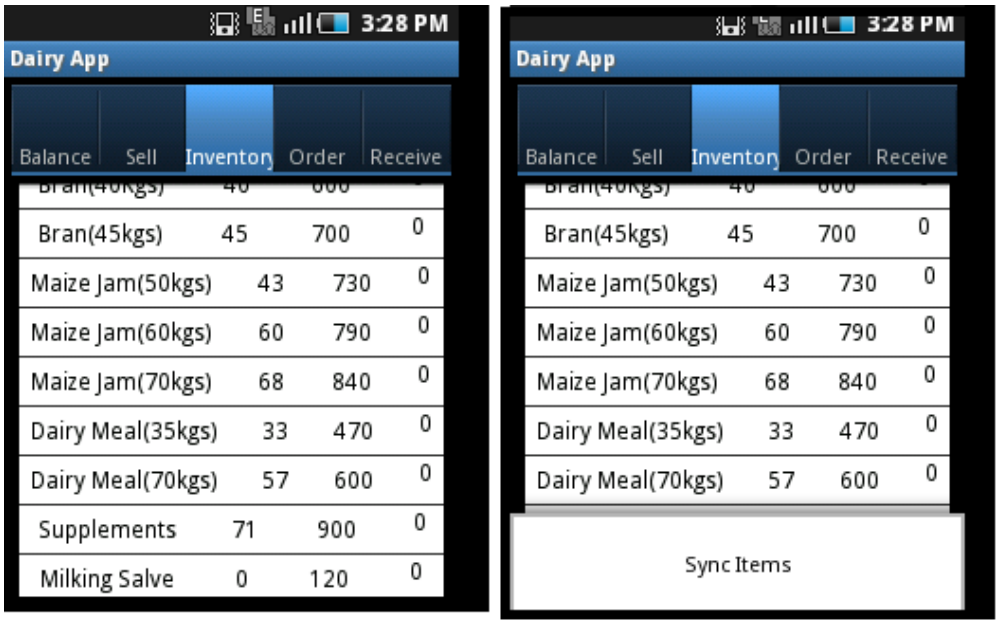


Figure 18: Inventory screen showing Sync function

- Order – Allows the shopkeeper to order for items that are running low on stock form the head office.
- Receive – Allows the shopkeeper to receive items from the suppliers.

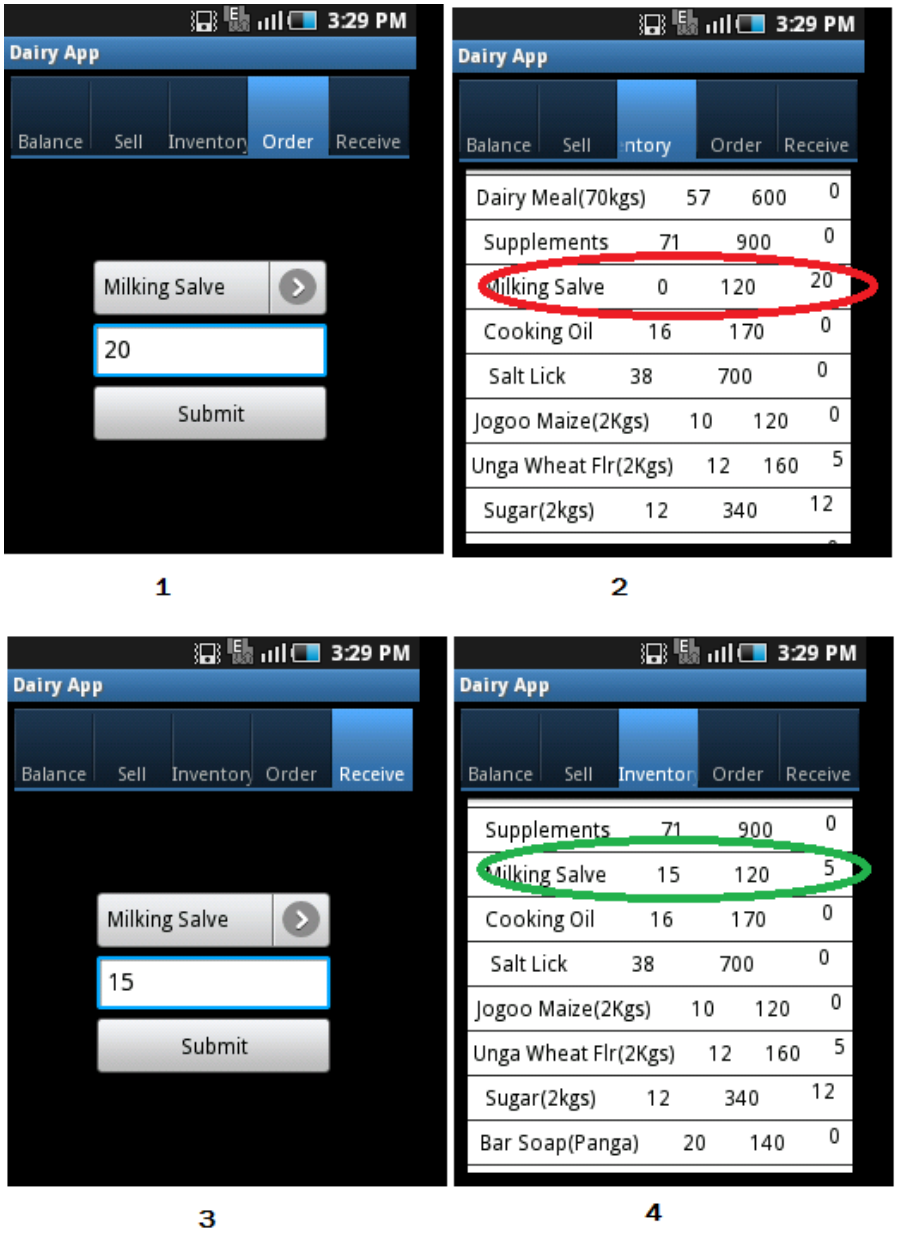


Figure 19: Order and receive goods

5.3.2 SMS module

This was implemented using the SMSLib library collection. A Global System for Mobile Communication (GSM) modem was used as the SMS gateway. The functions include:

- Receive SMS
- Authenticate SMS source. A source mobile number must be registered on the database prior to using the service. This is a simple but effective way of authentication. Each member is associated with a single mobile number.
- Read corresponding member details, quantity of milk delivered for month, credit sales, and balances.
- Send an SMS containing the above information to the originating mobile number.

Netbeans was used as the development environment.

Any handset can be used to send and receive the SMS. This figure shows sample SMSs from the system.

Figure 20: Sample sms on a Samsung handset and a simulator.

5.3.3 Integration and server installation

The MySQL database was installed on a Linux server hosted at the ICT Center in University of Nairobi. The server had the following specifications:

- 4 GB Random Access Memory
- 120 GB hard disk
- Gigabit Ethernet network card
- Connection to the internet
- GSM modem (SMS gateway)

Integration of the components was achieved at the database level. The mobile app will send *http* requests that are received by a web service. The web service will then query the database and return results.

Similarly, the SMS gateway will receive an SMS that is captured into the database. This triggers an authentication function. If positive, member balance is queried from the database and results returned to the SMS gateway for relay to the originating mobile number.

5.4 PROTOTYPE EVALUATION

In this research, a field test was conducted with the intended users of the system who were drawn from the head office technical staff, store/shop keepers and selected farmers. The tests were video recorded during the focus group discussions. The users also filled in questionnaires after the test runs.

To allow access from any GSM network, the back-end system was hosted on a server that had internet connection. The mobile app was installed on smart phones that run android operating system only. The app was tested on Huawei Ideos, and Samsung Galaxy Mini smart phone. The SMS service could be accessed on any handset that supports the SMS protocol.

The objective was to:

- Get the users' view of the application's interface and functionality
- Get the users' perception in terms of performance and effort required in operating the system.

- Get the users' attitude towards using the system
- Get the users behavioral intention to use the system

5.4.1 Technology acceptance model

The above factors were derived from the technology acceptance model that models how users come to accept and use a technology.

The research questions were constructed based on the TAM framework above. The questionnaire is found in appendix G.

5.4.2 Test process

For the farmers, their mobile numbers were initially captured on the database. This was to facilitate authentication before sending a reply sms.

1. Register mobile number with cooperative management
2. Send an sms (blank or otherwise) to predefined mobile number e.g. 0737 775 408
3. Wait for a reply.
    a. Reply SMS shows member id, volume and value of milk delivered, credit access amount, and balance expected

For shop keepers and cooperative management;

1. Launch the Dairy Sacco App from the mart phone
2. Authenticate farmer
3. Check the membership status using farmer ID (as supplied by the farmer)
4. Sell
    a. Select item
    b. Enter quantity
    c. Add to the cart
    d. Submit sale (commits transaction)
5. Optional: check inventory level
    a. Order items
    b. Receive item

5.4.3 Results

Qualitative results

The following were key issues noted after review of the recording of the focus group discussions

- The SMS application was simple to use, and provided instant access to credit and other information
- The mobile application made it easy for shop keepers to advance goods on credit to farmers, order for new stock, monitor current stock.
- The mobile application made it easy for cooperative management to track credit transactions and inventory across all shops, make farmer payments in time since the system automates reconciliations.

The group also noted the following

- The application does not capture cash sales
- They need some time to get accustomed to touch screen phones.
- Introduce receipts print out or sms confirmation after transactions

Results of the survey

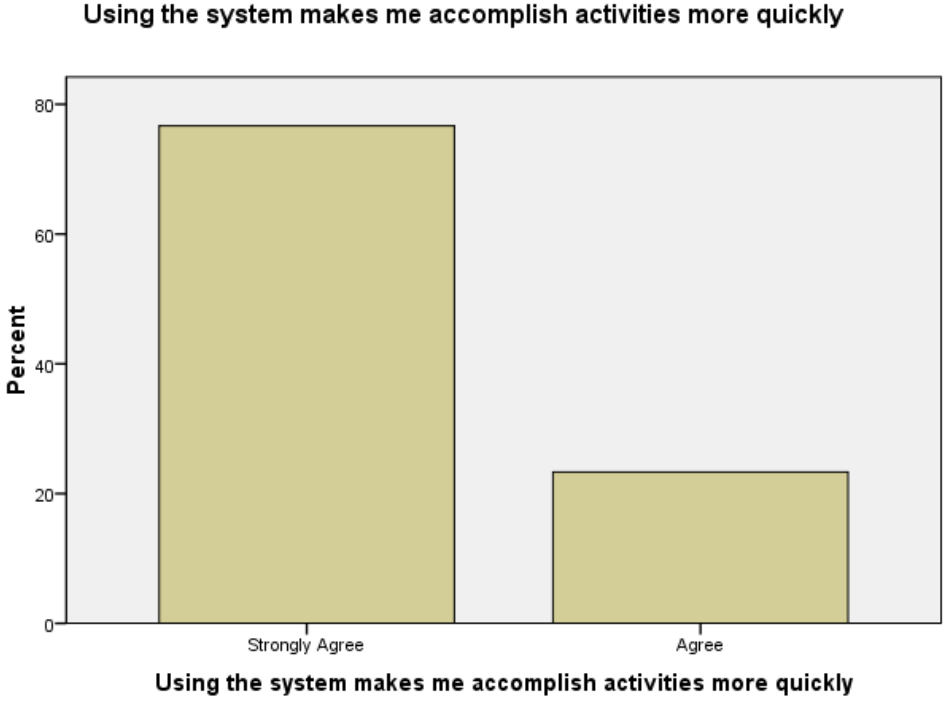
The final results were captured on SPSS and analysed.

Performance Expectancy

100% of the respondents reported the system makes them accomplish their work quickly.

Using the system makes me accomplish activities more quickly

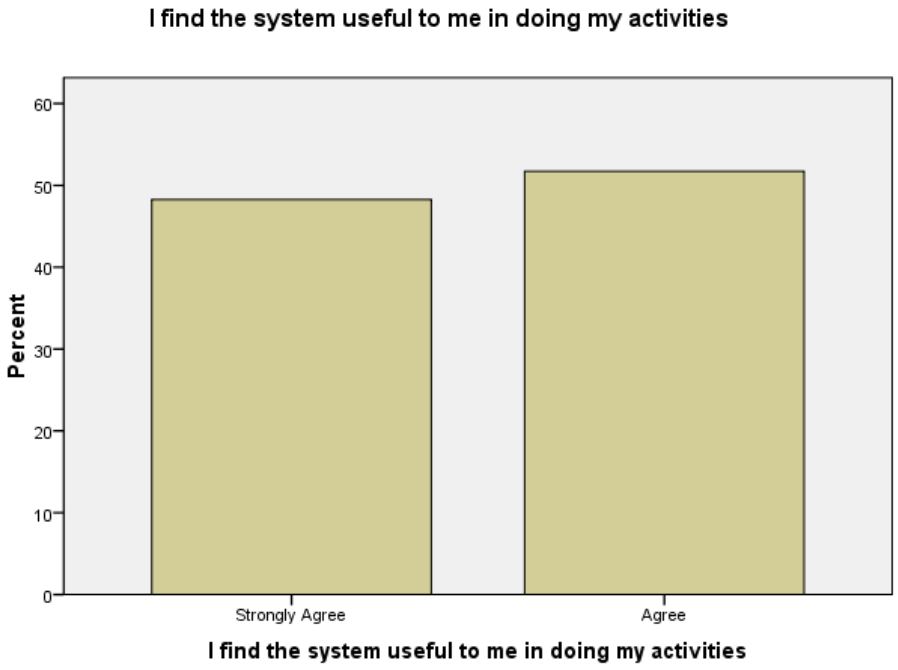
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	23	76.7	76.7	76.7
	Agree	7	23.3	23.3	100.0
	Total	30	100.0	100.0	



Asked whether they found the system useful in doing their activities, 97% responded positively.

I find the system useful to me in doing my activities

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	14	46.7	48.3	48.3
	Agree	15	50.0	51.7	100.0
	Total	29	96.7	100.0	
Missing	System	1	3.3		
Total		30	100.0		

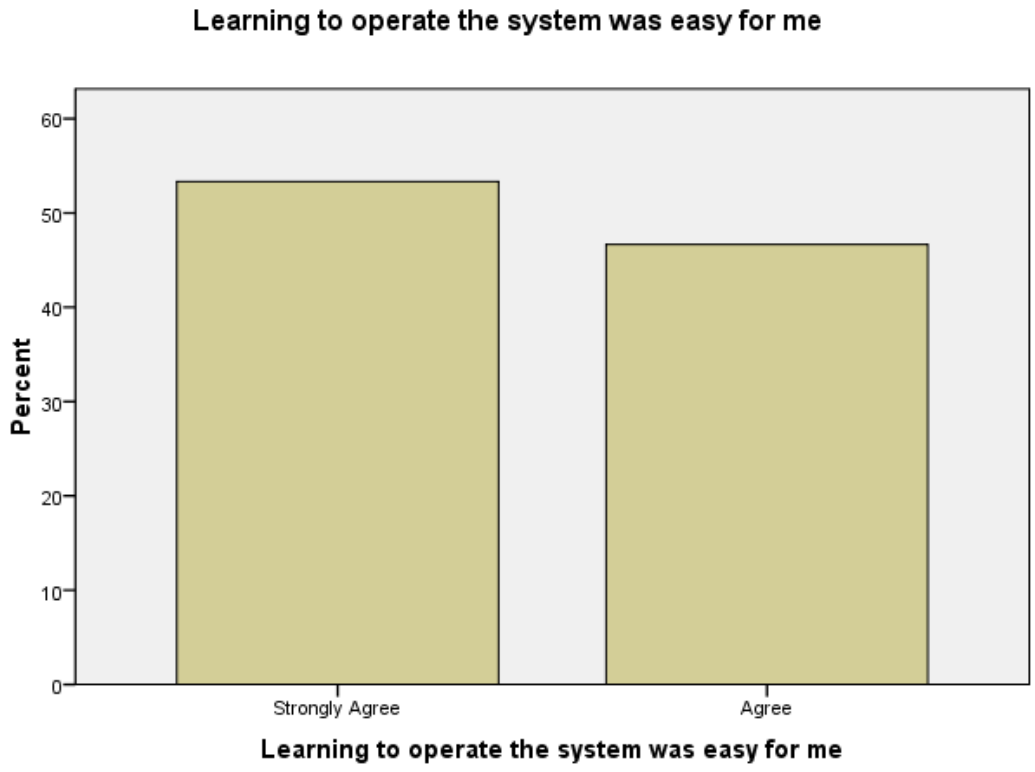


Effort Expectancy

100% of the respondents found learning to operate the system easy.

Learning to operate the system was easy for me

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	16	53.3	53.3	53.3
	Agree	14	46.7	46.7	100.0
	Total	30	100.0	100.0	

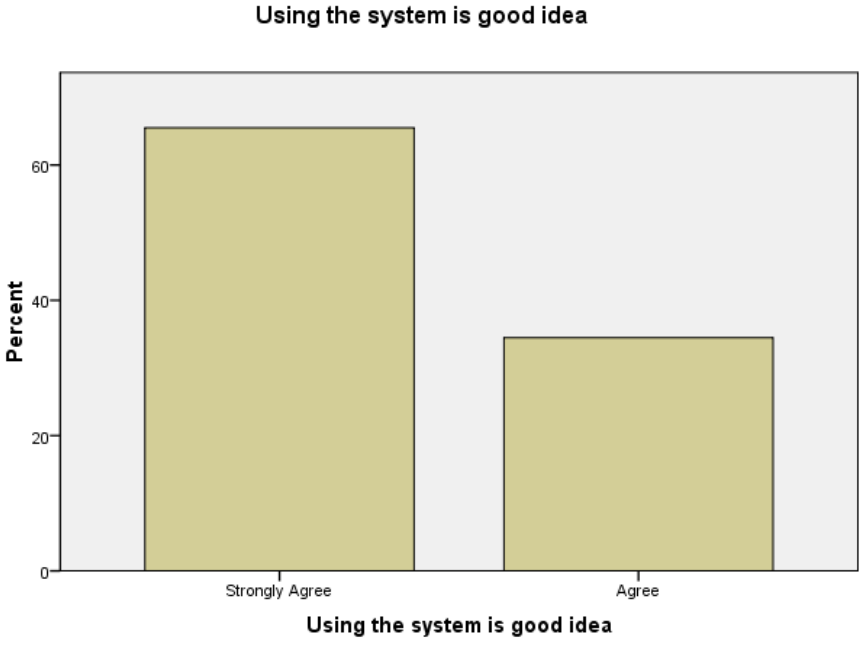


Attitude towards using the system

97% of the respondents agreed that using the system is a good idea.

Using the system is good idea

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	19	63.3	65.5	65.5
	Agree	10	33.3	34.5	100.0
	Total	29	96.7	100.0	
Missing	System	1	3.3		
Total		30	100.0		

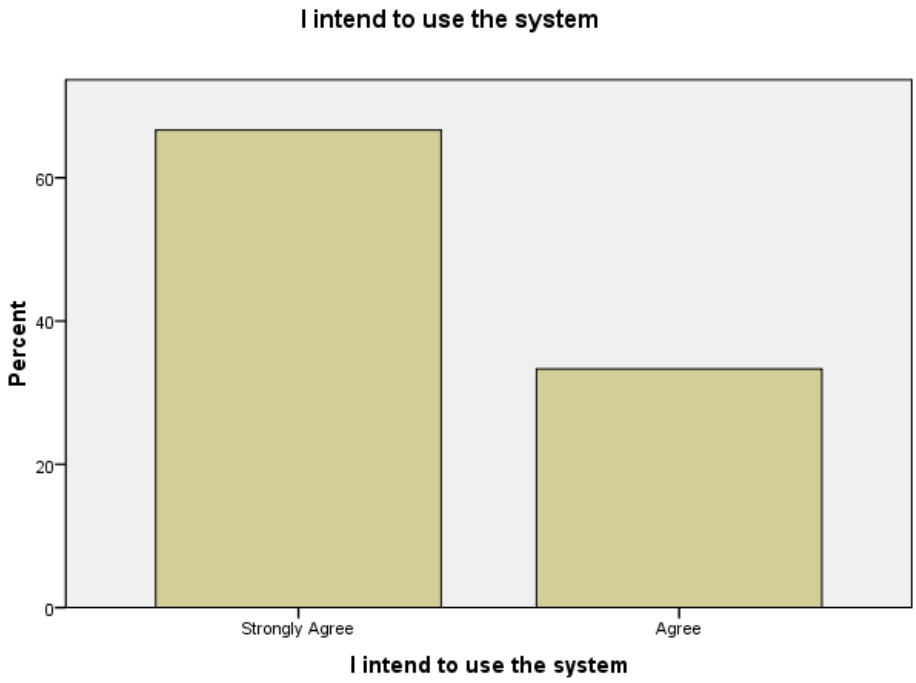


Behavioral intention to use the system

100% of the respondents intended to use the system

I intend to use the system

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	20	66.7	66.7	66.7
	Agree	10	33.3	33.3	100.0
	Total	30	100.0	100.0	



6 DISCUSSION

6.1 ACHIEVEMENTS

The following were achieved as per the objectives set out in chapter one.

Objective 1: To establish the processes involved in credit advancement and payment to farmers at Limuru Dairy

Field visits and interviews were conducted at Limuru Dairy's head office, processing plant and stores/shops. This was to help gain a deeper understanding of the back office operations, milk collection, credit advancement, and payment processes. It was also important to appreciate the relationship among the processes. The business model and the credit process were analyzed and mapped out as shown in section 3.4.

Objective 2: To identify challenges faced by farmers, agro-vets/shop keepers, and cooperative management in the credit process.

The following were identified as challenges in the credit process:

- Farmers often run into arrears and at times get advances that are more than the value of their milk delivery.
- Farmers have to make trips to the head office whenever they feel that there were computational errors against the milk delivered therefore spending time and money that could have been spent on other activities.
- It is also not possible to know the pay rate per liter of milk unless the farmer calls or travel to the cooperative's head office.
- Shop owners are not able to determine the credit to be advanced to a farmer.
- Limuru Dairy management incurs a lot of overhead each month when they have to manually reconcile credit information for its members before payment.
- If the manual system is left unchecked, the overall capital base of the cooperative would be undermined on the long term.
- The credit process is offline, largely manual, prone to errors and fraud.

Objective 3: To design and develop a mobile based technology that can address the challenges identified using appropriate technology adoption and development methods.

A prototype was developed using affordable and accessible mobile technology to address above challenges. Field tests were done at Limuru Dairy head office, and at a store. Focused group discussions were also held, where product demonstrations were held. Usage data was collected. The participants' views were collected using

questionnaires. From the usability analysis, the solution showed that if adopted the solution would greatly enhance service delivery, introduce efficiency in the credit process, and improve the livelihoods of Limuru Dairy small holder farmers.

The application was able to:

- Send and receive SMS
- Facilitate checking member balance
- Facilitate buying/selling goods on credit
- Transfer transaction data to head office
- Inventory control
- Introduce controls to check fraud.

6.2 LIMITATIONS AND CHALLENGES

The initial challenge was access to farmer cooperatives that were willing to share their processes and data, and also entertain the idea of adopting suitable mobile technology based solutions. This was mainly due to trust issues, competition and previous experiences that did not have a direct benefit to the cooperative.

The dairy sector is complex, with varying challenges along the value chain. Sometimes, the challenges are specific to the cooperatives and also geographic areas. The impact of this on small holder farmers would also be subject for debate, considering the theme of the study was to fall under the ICT for Development (ICT4D) theme.

Mobile application development is platform dependent. For example, the mobile app was based on android. This means the application can only be installed on smart phones running the android operating system. However, smart phones on android are the cheapest in the market today.

The reliability of the GSM mobile network in some of the milk catchment areas of Limuru Dairy was wanting. The transactions would get disrupted at areas with weak signal coverage.

It would have been best to pilot the solution at Limuru Dairy. However, due to Limuru Dairy internal regulations and procedures for approval, this was not possible during the short research project period.

6.3 CONCLUSION

The research approach for this project was to identify and understand a need facing a small holder farmer cooperative in a rural set-up in Kenya. The second step was to suggest an information technology enabled solution to address the needs.

The project was able to identify a problem, analyze, and develop a mobile phone based solution. From the results, the solution showed great potential of use and adoption. If adopted the system would greatly enhance service delivery by the cooperative, introduce efficiency in the credit process, and improve the livelihoods of Limuru Dairy small holder farmers.

6.4 SUGGESTED FURTHER RESEARCH

A pilot can be conducted to allow extensive use and tests. This will help in evaluating the application in terms of data transfer speeds, user experience, evolving user needs, user interface design, and stability of back-end processes e.g. are the monthly scripts refreshing monthly collection and credit data?

The application can also be extended to cover cash and credit sales, artificial insemination, veterinary services, personalized services e.g. payment of school fees, and hospital bills which are common needs amongst farmers in rural Kenya. Portable thermal printers can also be introduced to print receipts after each sale transaction.

A research study to evaluate the impact of the solution amongst the small holder farmers, the operations at the cooperative's head office and shops/stores can be done.

The system can also be extended to other agricultural commodity cooperatives.

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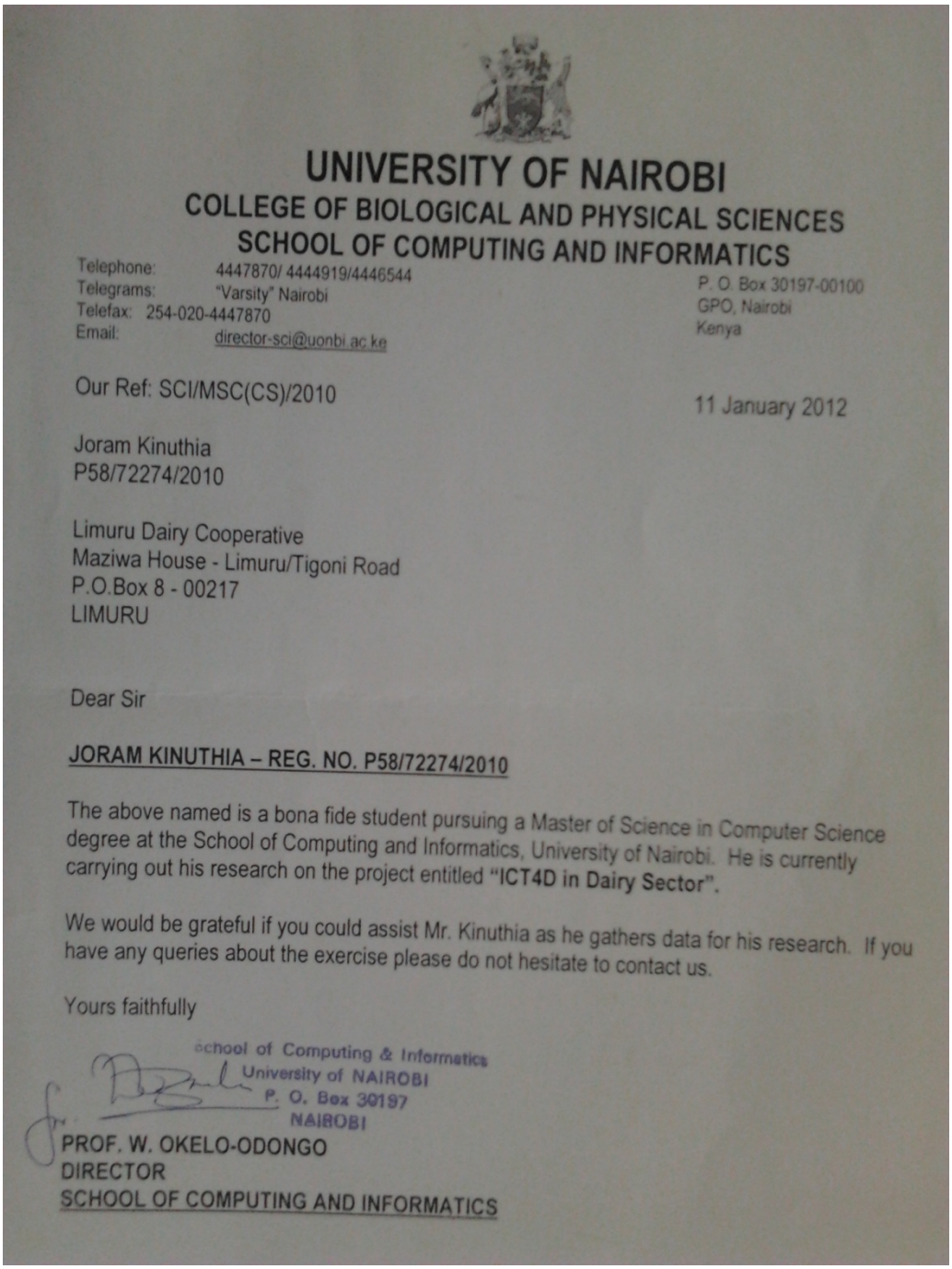
APPENDIX A: LETTER OF AUTHORITY TO CONDUCT RESEARCH



UNIVERSITY OF NAIROBI
COLLEGE OF BIOLOGICAL AND PHYSICAL SCIENCES
SCHOOL OF COMPUTING AND INFORMATICS

Telephone: 4447870/ 4444919/4446544
Telegrams: "Varsity" Nairobi
Telefax: 254-020-4447870
Email: director-sci@uonbi.ac.ke

P. O. Box 30197-00100
GPO, Nairobi
Kenya

Our Ref: SCI/MSC(CS)/2010

11 January 2012

Joram Kinuthia
P58/72274/2010

Limuru Dairy Cooperative
Maziwa House - Limuru/Tigoni Road
P.O.Box 8 - 00217
LIMURU

Dear Sir

JORAM KINUTHIA – REG. NO. P58/72274/2010

The above named is a bona fide student pursuing a Master of Science in Computer Science degree at the School of Computing and Informatics, University of Nairobi. He is currently carrying out his research on the project entitled **"ICT4D in Dairy Sector".**

We would be grateful if you could assist Mr. Kinuthia as he gathers data for his research. If you have any queries about the exercise please do not hesitate to contact us.

Yours faithfully

School of Computing & Informatics
University of NAIROBI
P. O. Box 30197
NAIROBI

PROF. W. OKELO-ODONGO
DIRECTOR
SCHOOL OF COMPUTING AND INFORMATICS

APPENDIX B: FGD MATERIALS

A MOBILE BASED CREDIT FACILITY FOR A DIARY COOPERATIVE

CASE OF LIMURU FARMERS DAIRY COOPERATIVE

CONSENT FORM

Date: 20/04/2012

Thank you for agreeing to participate in this research. We are very interested to hear your valuable opinion on how technology and associated application may be made more useful and user-friendly to you the farmer and also cooperative management.

- *The purpose of this research is to learn how we can best design an application running on mobile phones targeting farmers, and mostly access to credit services.*
- *The information you will give us is highly confidential and your name will not be associated with anything you say in the focus group or any other time during the research process*
- *We will be video-recording the focus group discussions so that we can make sure we capture all your thoughts, opinions, ideas and suggestions from the group. Once again no names will be attached to the tapes and the recordings will be erased once we transcribe the information*
- *You do not have to answer any question if you do not feel like doing so and you may withdraw from the study at any time*
- *As part of the research we will also be asking you some questions individually. If you are not sure about a question please feel free to ask any one of us or you can contact the researcher through telephone number below this form*

Joram Kinuthia
School of Computing and Informatics, University of Nairobi
Email: kinuthianj@uonbi.ac.ke
Tel 0737 775 408

FOCUS GROUP DISCUSSION GUIDE

Preparation

Consent forms will be distributed to all users prior to the FGD sessions. The consent form is reproduced here for completeness.

Introduction – 5 to 10 Minutes

Welcome

Will introduce myself and my research assistant
Ask the group members to say their names
Describe briefly who we are and what we do
Inform the participants why we are carrying out the research and what we will do with the information we collect
Explain to them why they are participating in the FGD

Explanation of the process

Find out how many have participated in an FGD before
Explain that FGD are about
learning from them (positives and negatives)
gathering information not achieving consensus
looking for priorities not long winded lists
explain that we will also use questionnaires

Logistics and Ground Rules

The FGD will last about one hour
Feel free to move around
Ask them to suggest some ground rules such as
Everyone should participate
Stay with the group
Ask if anyone has a question before beginning

Turn on the Camcorder remembering to give people time to answer questions before moving in with probes.

FGD Guide – 50 to 60 Minutes

We would like the discussion to be informal, so there's no need to wait for us to call on you to respond. In fact, we encourage you to respond directly to the comments other people make. If you don't understand a question, please let us know. We are here to ask questions, listen, and make sure everyone has a chance to share

Demonstration of the Dairy Sacco App to the audience (20 Minutes)

What is your general feeling about the Dairy Sacco App? Do you like it? If not what don't you like? (the appearance, interface, Language, functionality)

Probes for discussion

What do you like about it? Why?

What don't you like about it? (Why?)

What changes would you like made in order for you to like it?

What functionality would you like added?

What functionality do you find most useful? Some-what Useful? Least useful?

What was the most exciting thing you learnt?

Probes for discussion

- *What was exciting about it?*
- *How did you learn about it?*
- *What have you been able to use with what you learnt?*
- *Can you repeat it again another time?*
- *Can you show someone who does not know how to do it? (Show)*
- *What can we do to make the learning process better?*

- *Was there someone ready to help?*
- *Did the help make you able to accomplish the task? (Depends on previous probe)*

- Would you use the system if it was availed to you on mobile phone? Why (probe the perceived benefits)?
- What individual factors could limit the use of the application? Put probes, e.g. lack of knowledge, no appropriate mobile phone, no credit, etc
- What community factors could limit the use of the application? Put probes, e.g. no Internet access in community, other people are not using the application; there is no one to consult in case of problems, etc.
- What national factors could limit the use of the application? Put probes

Probes for discussion

- *Besides Calling and SMS, what other uses do they currently have?*
- *Would you pay for accessing the information? How much?*

That concludes our FGD. Thank you very much for coming and sharing your thoughts and opinions with us. If there is additional information that you think of later on please feel free to contact us and we shall get in touch with you.

Joram Kinuthia

University of Nairobi

School of Computing and Informatics

Box 30197-00100 Nairobi Kenya

Email: kinuthianj@uonbi.ac.ke

APPENDIX C: MOBILE APP USER MANUAL

User Manual

Dairy Sacco App

| kinuthianj@uonbi.ac.ke |

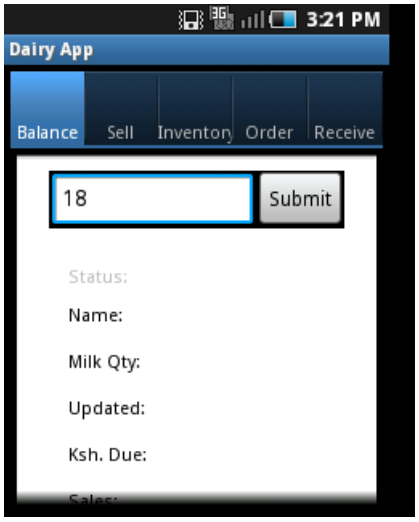
| Phone: 0737 775 408 |

The Dairy Sacco App has two user interface modules; the App module that runs on an android smart phone, and the SMS module that can use any mobile phone.

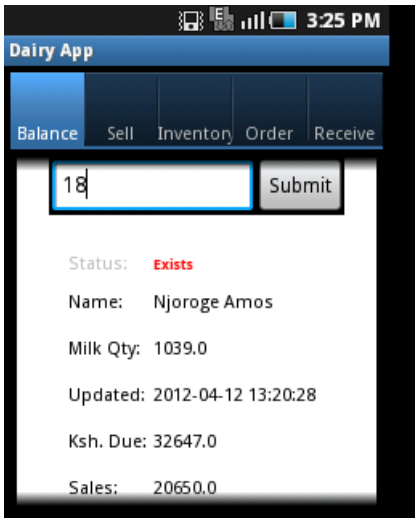
The app is designed for use by a shop keeper/store owner. To begin a transaction, the shop keeper first queries the member balance using a member ID. If the farmer has enough money, the app allows a credit sale to be effected.

1. Launch the Dairy App

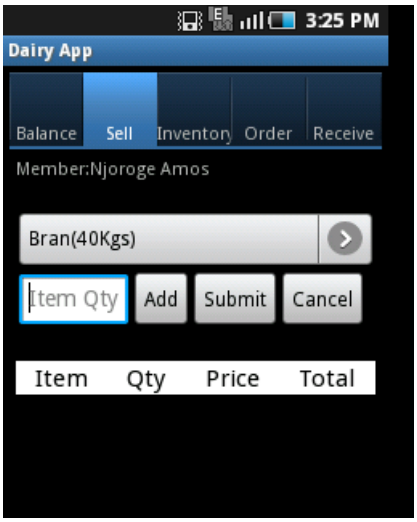
2. Enter the member number and click on submit



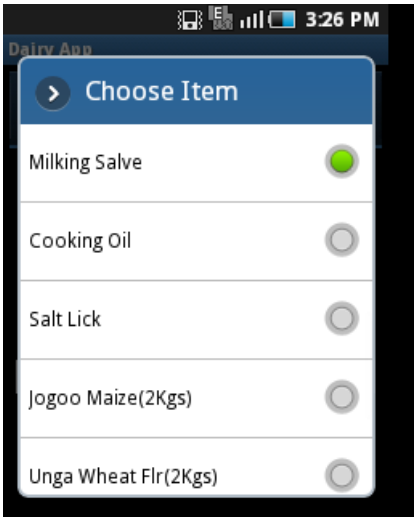
3. View farmer information (Milk delivered during the month, value of the milk, credit sales, and balance)



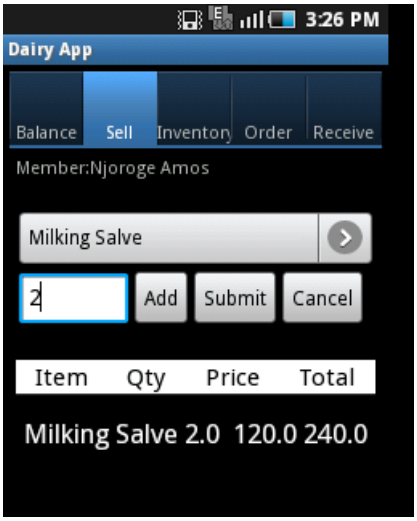
4. If balance is positive, the shop keeper can proceed with to the credit sale.



4.1. Sales items can be selected from a list of available items on sale

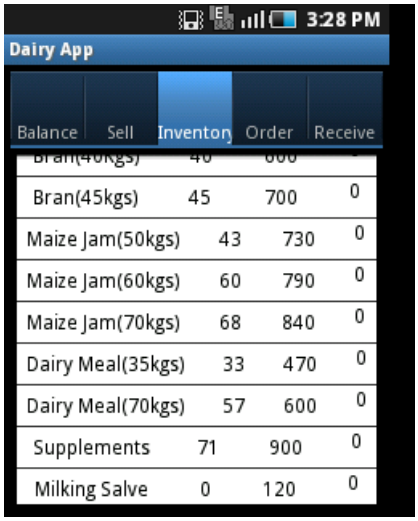


4.2. Up to 5 items can be sold per transaction. App will not allow the credit limit to be exceeded. Click on submit to commit the transaction.

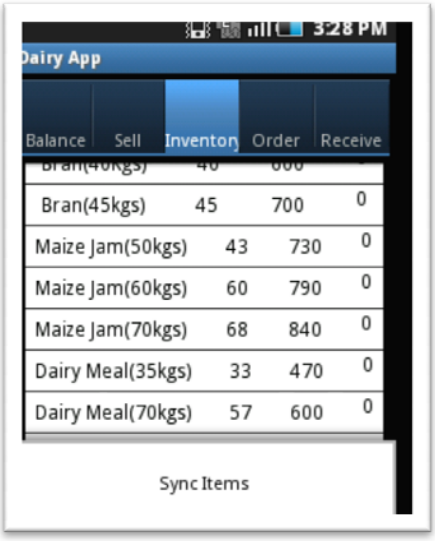


Shop/Store keeper can be able to control stock levels; which are synchronized to a master database at the cooperative head office. All transactions must be done using the app.

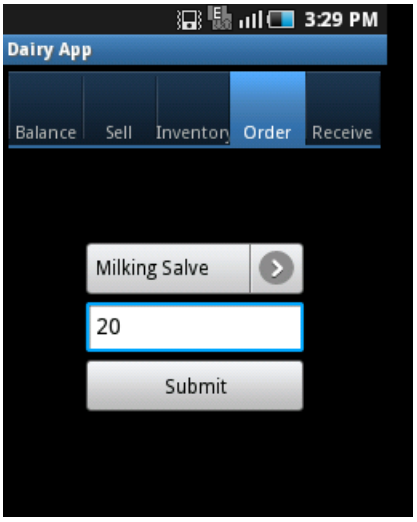
5. Check inventory levels



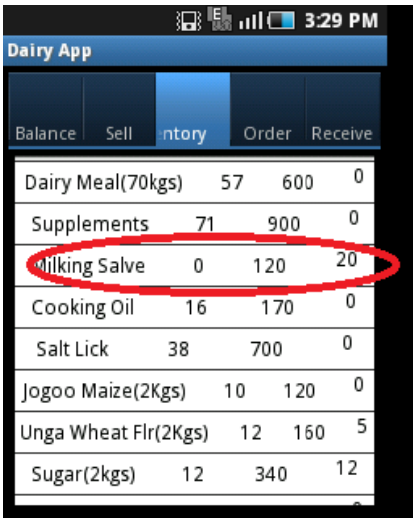
6. Automatically synchronize stock levels. This will update new items or price adjustments.



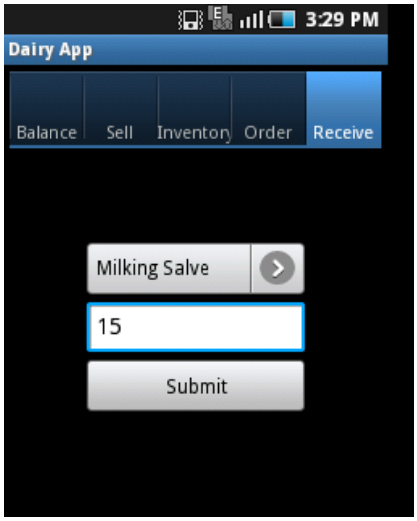
7. If an item is running to low levels, it is possible to make an order to the head office.



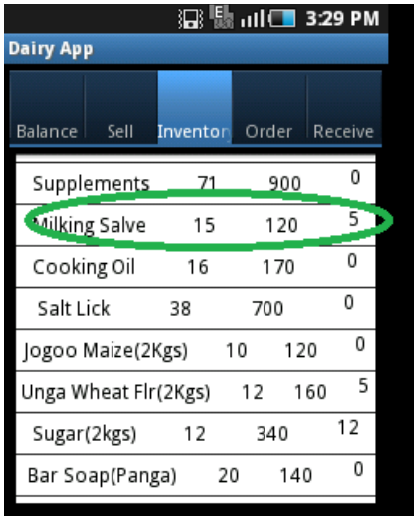
7.1. This is reflected in the Inventory



8. The items should be checked-in through the app upon receipt from the suppliers.



8.1. New status of inventory



SMS System

Farmers do not need to go to designated shops to access information on milk deliveries and credit balance.

1. Using any handset, send an SMS to a predefined number e.g. 123456

2. You will get a reply with above information.

----END----

APPENDIX D: SAMPLE CODE

Netbeans Integrated Development Environment (IDE)

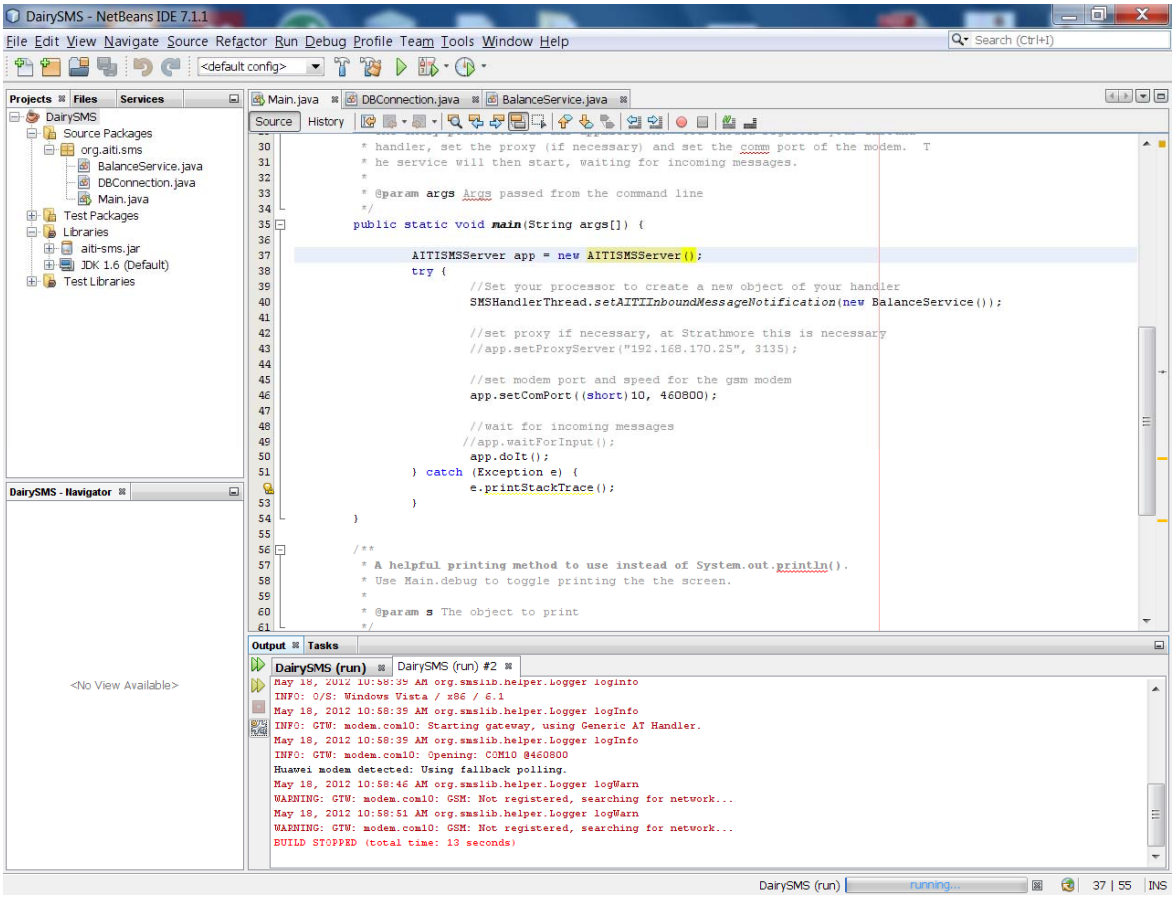


Figure 21: Netbeans IDE for sms module development

Function to update inventory items

```
public class InventoryUpdateService extends Service{

        private static final String TAG = InventoryUpdateService.class.getSimpleName();
        private Timer timer;
        private List<NameValuePair> rows;


         private TimerTask updateTask = new TimerTask() {
           @Override
           public void run() {
             Log.i(TAG, "Timer task doing work");
             try {
                                List<NameValuePair> records= getInventory();
                           HttpClient httpclient = new DefaultHttpClient();
```

```
                    HttpPost httppost = new HttpPost("http://41.204.186.141/dairy/update_inventory.php");
                    httppost.setEntity(new UrlEncodedFormEntity(records));
                    httpclient.execute(httppost);
                        } catch (Throwable t) {/* you should always ultimately catch
                                                                    all exceptions in timer tasks, or
                                                                    they will be sunk */
                                Log.e(TAG, "Failed to retrieve the results", t);
                        }
                }
               };
            @Override
            public IBinder onBind(Intent arg0) {
                    // TODO Auto-generated method stub
                    return null;
            }
            @Override
              public void onCreate() {
                //code to execute when the service is first created
                    super.onCreate();
                    Log.i(TAG, "Service creating");
                    timer = new Timer("InventoryUpdateTimer");
               timer.schedule(updateTask, 1000L, 86400 * 1000L);
              }

              @Override
              public void onDestroy() {
                      super.onDestroy();
                      Log.i(TAG, "Service destroying");
                //code to execute when the service is shutting down
              }

              @Override
              public void onStart(Intent intent, int startid) {
                //code to execute when the service is starting up
              }

              public List <NameValuePair> getInventory() throws JSONException, UnsupportedEncodingException{
                            rows= new ArrayList<NameValuePair>();
                            StringEntity se;
                            JSONArray jArray = new JSONArray();
                            String                                                                    []
projection={InventoryDatabaseHelper.COLUMN_ID,InventoryDatabaseHelper.COLUMN_ITEM,InventoryData
baseHelper.COLUMN_QTY,InventoryDatabaseHelper.COLUMN_ORDERED};
                            Cursor                                    c                               =
getContentResolver().query(InventoryContentProvider.CONTENT_URI,projection,null, null, null);
                    c.moveToFirst();
                    while (c.isAfterLast() == false) {
                        JSONObject jObject = new JSONObject();
                      jObject.put(InventoryDatabaseHelper.COLUMN_ID,c.getString(0));
                      jObject.put(InventoryDatabaseHelper.COLUMN_ITEM, c.getString(1));
                      jObject.put(InventoryDatabaseHelper.COLUMN_QTY, c.getString(2));
                      jObject.put(InventoryDatabaseHelper.COLUMN_ORDERED, c.getString(4));
```

```
                jArray.put(jObject);
                    c.moveToNext();
                }
                se = new StringEntity(jArray.toString());
        se.setContentType("application/json;charset=UTF-8");
                rows.add(new BasicNameValuePair("jsondata", se.toString()));
                rows.add(new BasicNameValuePair("store_id", getStoreID()));
                c.close();

                            return rows;
                    }

            public String  getStoreID(){
                    Context mContext = this.getApplicationContext();
                SharedPreferences myPrefs = mContext.getSharedPreferences("dairyPrefs", 0);
                int storedIdNumber =  myPrefs.getInt(BalanceTab.STORE_ID, 0);

                return storedIdNumber+"";
            }

}
```

Function to sends sms

```
package org.aiti.sms;

import java.sql.Connection;
import java.sql.DriverManager;
import java.sql.ResultSet;
import java.sql.ResultSetMetaData;
import java.sql.Statement;

/**
 *
 * @author sam
 */
public class DBConnection {
    static Connection conn;
    static Statement stmt;

    public static void connect() {
        try {
            //load the drivers
            Class.forName("com.mysql.jdbc.Driver").newInstance();
            conn = DriverManager.getConnection("jdbc:mysql://localhost:3306/dairy", "root",
"xxxxxx");
            stmt = conn.createStatement();
        } catch (Exception e) {
            e.printStackTrace();
        }
    }

    public static void close() {

        try {
            if (conn != null) {
                conn.close();
                stmt.close();
            }
        } catch (Exception e) {
            e.printStackTrace();
        }
    }

    public static int authenticate(String phoneNumber){
```

```
        int id=-1;
        ResultSet rs;
        connect();
        String search;
        //phoneNumber.trim();
        search = "select membership.id,membership.phone_number from membership where membership.phone_number='"+phoneNumber+"';";
        try {
            rs =stmt.executeQuery(search);
            if (rs.next())//record exists
            {
                int temp=rs.getInt("membership.id");
                System.out.print(temp);
                String acNo=rs.getString("membership.phone_number");
                if(phoneNumber.equals(acNo)){
                  id=temp;
                }
            }
        } catch (Exception e) {
            e.printStackTrace();
        }
        close();
        return id;
    }

    public static String getBalance(int no){

        String bal="";
        ResultSet rs;
        ResultSetMetaData meta = null;
        connect();
        String query;
        query="SELECT membership.id, membership.surname,membership.othername,payments_due.payment_due,payments_due.quanti ty,payments_due.date,sales.sales"
                + " FROM membership,payments_due,sales WHERE ( membership.id = '" + no + "' ) AND ( payments_due.membership_id = '" + no + "' ) AND ( sales.membership_id = '" + no + "' ) ";
        try {
            rs =stmt.executeQuery(query);
            meta = rs.getMetaData();
            if (rs.next())//record exists
```

```
        {
          int balance=rs.getInt("payments_due.payment_due") - rs.getInt("sales.sales");
          bal+= "Id:"  + rs.getInt("membership.id")+ "\n" +
               "Name:"      +      rs.getString("membership.surname")      +      "      "      +
rs.getString("membership.othername") + "\n" +
               "Milk Qty:" + rs.getFloat("payments_due.quantity") + "\n" +
               "Updated:" + rs.getString("payments_due.date") + "\n" +
               "Ksh. Due:" + rs.getFloat("payments_due.payment_due")  + "\n" +
               "Ksh. Sales:" +rs.getFloat("sales.sales") + "\n" +
               "Ksh. Balance:" + balance;

        }
      } catch (Exception e) {
        e.printStackTrace();
      }
      close();
      return bal;
   }
}
```

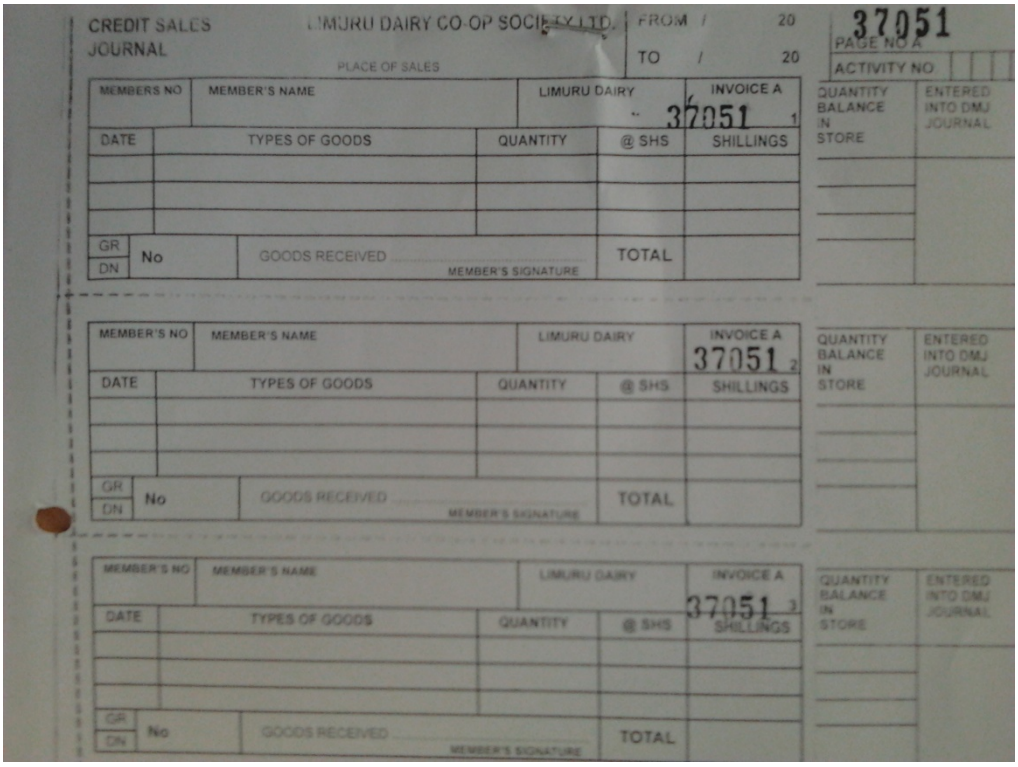
Database scripts

```
CREATE TRIGGER insert_payments_due AFTER INSERT ON collection
FOR EACH
ROW BEGIN
IF EXISTS (SELECT * FROM payments_due WHERE membership_id = NEW.membership_id)THEN
UPDATE payments_due SET payment_due = ( payments_due.payment_due + NEW.quantity * NEW.rate_per_litre ) ,
quantity = ( payments_due.quantity + NEW.quantity ) ;
ELSE INSERT INTO payments_due(membership_id,payment_due,quantity)VALUES (NEW.membership_id, NEW.quantity * NEW.rate_per_litre, NEW.quantity);
END IF ;
INSERT INTO payments_history(membership_id,payment_due,quantity)VALUES ( NEW.membership_id, NEW.quantity * NEW.rate_per_litre, NEW.quantity);
END ;$$

CREATE TRIGGER insert_sales_history_on_insert
AFTER INSERT ON sales
FOR EACH ROW BEGIN
 INSERT INTO sales_history (store_id,item_id,quantity,membership_id,sales)VALUES(NEW.store_id,NEW.item_id,NEW.quantity,NEW.membership_id,NEW.sales);
END;

CREATE TRIGGER insert_memid_sales AFTER INSERT ON collection
FOR EACH
ROW BEGIN
IF EXISTS (SELECT * FROM payments_due WHERE membership_id = NEW.membership_id)THEN
 UPDATE payments_due SET payment_due = ( payments_due.payment_due + NEW.quantity * NEW.rate_per_litre ) ,quantity = ( payments_due.quantity + NEW.quantity ) ;
ELSE INSERT INTO payments_due(membership_id,payment_due,quantity)VALUES (NEW.membership_id, NEW.quantity * NEW.rate_per_litre, NEW.quantity);
    INSERT INTO sales(membership_id,sales) VALUES (NEW.membership_id,0);
END IF ;
INSERT INTO payments_history(membership_id,payment_due,quantity)VALUES (NEW.membership_id, NEW.quantity * NEW.rate_per_litre, NEW.quantity);
END ;$$
```

APPENDIX E: CREDIT SALES JOURNAL



CREDIT SALES JOURNAL

LIMURU DAIRY CO-OP SOCIETY LTD.

PLACE OF SALES

FROM / 20

TO / 20

37051

PAGE NO A

ACTIVITY NO

MEMBERS NO | MEMBER'S NAME | LIMURU DAIRY | INVOICE A 37051 1

DATE | TYPES OF GOODS | QUANTITY | @ SHS | SHILLINGS

GR / DN No | GOODS RECEIVED ..... MEMBER'S SIGNATURE | TOTAL

QUANTITY BALANCE IN STORE | ENTERED INTO DMJ JOURNAL

MEMBER'S NO | MEMBER'S NAME | LIMURU DAIRY | INVOICE A 37051 2

DATE | TYPES OF GOODS | QUANTITY | @ SHS | SHILLINGS

GR / DN No | GOODS RECEIVED ..... MEMBER'S SIGNATURE | TOTAL

QUANTITY BALANCE IN STORE | ENTERED INTO DMJ JOURNAL

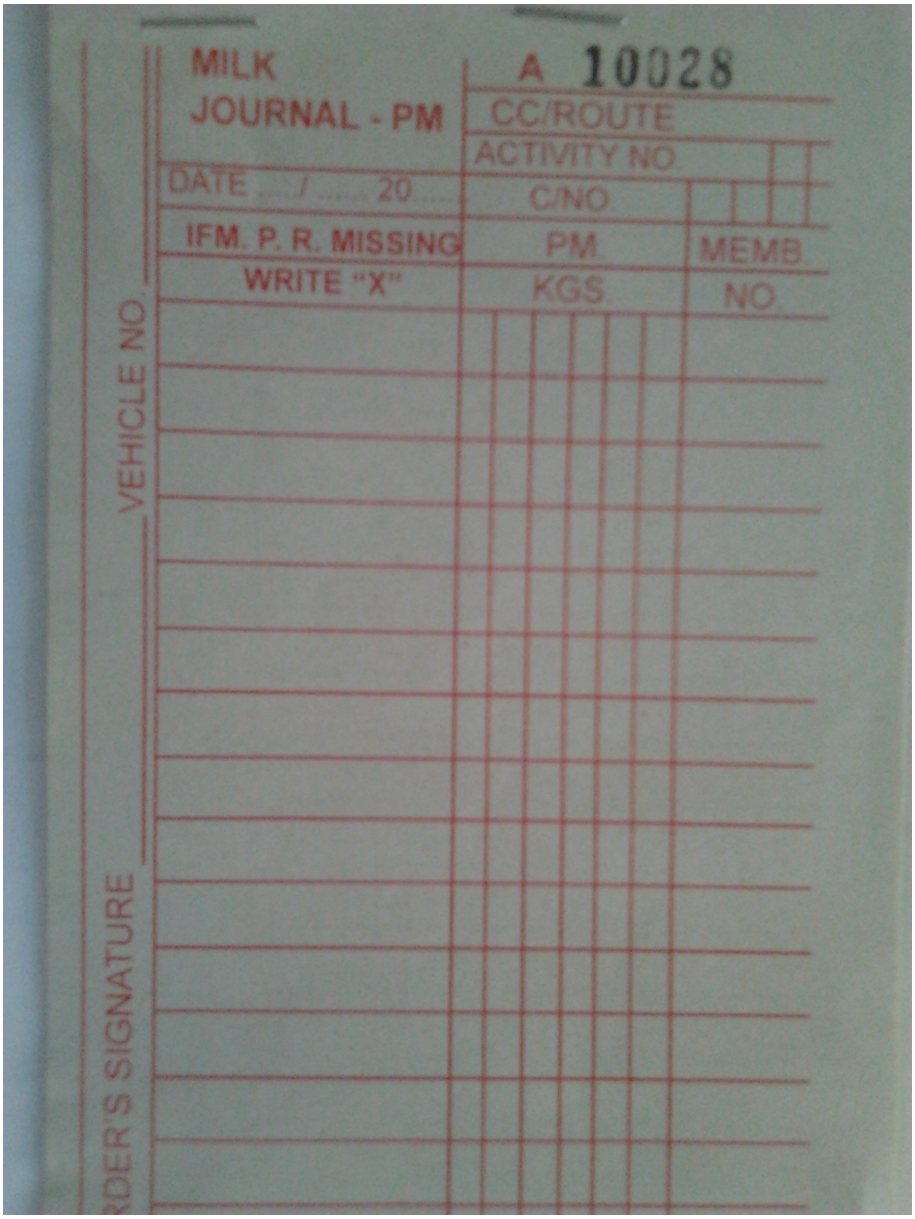
MEMBER'S NO | MEMBER'S NAME | LIMURU DAIRY | INVOICE A 37051 3

DATE | TYPES OF GOODS | QUANTITY | @ SHS | SHILLINGS

GR / DN No | GOODS RECEIVED ..... MEMBER'S SIGNATURE | TOTAL

QUANTITY BALANCE IN STORE | ENTERED INTO DMJ JOURNAL

APPENDIX F: MILK JOURNAL



APPENDIX G: QUESTIONAIRRE

A MOBILE BASED CREDIT FACILITY FOR A DAIRY COOPERATIVE

CASE OF LIMURU FARMERS DAIRY COOPERATIVE

QUESTIONAIRE

Date: 20/04/2012

Dairy Sacco App - Interface and functionality

(i) Interface

(a) Do you think the prototype interface is easy to use? Yes No

- If yes, what did you find easiest to do?

_____

_____

- If no, what do you think made the interface not easy to use?

_____

_____

(b) Is the interface appealing? Yes No

- What do you think is most appealing?

_____

_____

- What do you think is least appealing?

_____

_____

(c) Is the language used in the prototype useful to you? Yes No

If no, what language would you consider useful to you?

_____

(d) What features of the prototype interface did you find most useful to you?

_____

(e) What would you want to add to the interface to make it better for you?

(f) What would you want to remove from the interface to make it better for you?

(ii) Functionality

(a) Do you think this application is relevant/ useful to you? No Yes Somewhat

- If it is relevant, do you think you would use it frequently? Yes No
- If it is not relevant what do you think can be added to it to make it more relevant?

(b) What do you think can be removed from it to make it more relevant?

(c) In which ways do you think this application will be useful to you?

(d) Is there something about this application that you think is useless? Yes No

- If yes, what part of the application do you think is useless?

(e) Do you think this application will change your life in any way? Yes No

I. If yes, in which way?

User's Perception Evaluation

Use the following Scale in Rating the Application

1: Strongly Agree; **2:** Agree; **3:** Neither Agree nor Disagree; **4**: Disagree; **5**: Strongly Disagree

(a) Performance Expectancy (PE)

Item Construct	Rating (Please Tick One)				
	1	**2**	**3**	**4**	**5**
Using the system makes me accomplish activities more quickly					
I find the system useful to me in doing my activities					

(b) Effort Expectancy (EE)

Item Construct	Rating (Please Tick One)				
	1	**2**	**3**	**4**	**5**
Learning to operate the system was easy for me					
My interaction with the system is clear and understandable					
Working with the system is complicated, it is difficult for me to understand what is going on					
It takes long to learn to use the system to make it worth the effort					

(c) Effect of Opinion Leaders

Item Construct	Rating (Please Tick One)				
	1	**2**	**3**	**4**	**5**
People who are important to me think I should use the system ***(Specify below whom these are…e.g. Peers, Teachers, age mates, business men, parents etc)***					
People who influence my behavior think I should use the system (***Specify below who these are…e.g. Peers, Teachers, age mates, business men, etc***					

(d) Effect of Cultural Practices

Item Construct	Rating (Please Tick One)				
	1	2	3	4	5
Some cultural practices or beliefs in my community discourage me from using the system					

(e) Social Influence (SI)

Item Construct	Rating (Please Tick One)				
	1	2	3	4	5
My status in society does not encourage me to use the system					
Using the system enhances my image within the community					

(f) Facilitating Conditions

Item Construct	Rating (Please Tick One)				
	1	2	3	4	5
I have control over using the system					
I have the resources necessary to use the system (equipment and money)					
I have the knowledge necessary to use the system					
I get help whenever I am in need to know more on using the system					

(g) Attitude towards using the system

Item Construct	Rating (Please Tick One)				
	1	2	3	4	5
Using the system is good idea					
I like the idea of using the system					
I enjoy using the system, it's fun					
I always look forward to going to use the system					

(h) Behavioral Intention to use the system

Item Construct	Rating (Please Tick One)				
	1	2	3	4	5
I intend to use the system					
I will always use the system to do my activities					
I feel anxious using the system					
I am scared of doing something wrong while using the system					

5: Demographic details

(a) Names: _____

(b) Telephone Number:_____

(c) Age (Years) _____(d) Gender (Male/Female) _____

(e) Marital Status_____

(f) Location/Area _____

Thank you for taking your time to provide your feedback.

For any further information please get in touch with

Joram Nduati Kinuthia

University of Nairobi, School of Computing and Informatics, Box 30197-00100 Nairobi

Email: kinuthianj@uonbi.ac.ke

Tel 0737 775 408