Improving Customer Shopping Experience using an Android Barcode Reader Application

Kizi Dimira Othuon

091775

A Dissertation Submitted in Partial Fulfilment for the Requirements for the Degree of Master of Science in Mobile Telecommunication and Innovation

Faculty of Information Technology

Strathmore University

Nairobi, Kenya

April 2018

Declaration

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

Name: Kizi Dimira Othuon

Student No: 091775

Signature: ……..

Date: …….

Approval

The thesis of Kizi Dimira Othuon was reviewed and approved by the following:

Dr. Vitalis Gavole Ozianyi,

Senior Lecturer, Faculty of Information Technology,

Strathmore University

Dr. Joseph Orero,

Dean, Faculty of Information Technology,

Strathmore University

Professor Ruth Kiraka,

Dean, School of Graduate Studies,

Strathmore University

Dedication

I dedicate this work to the Almighty God who gave me the favour and opportunity to pursue my master's degree, Safaricom and @iLabAfrica for the opportunity, support and training they offered for the attainment of this master's degree.

Acknowledgements

First, I give thanks to the Almighty God for patience, knowledge, strength and wisdom bestowed to me that immeasurably contributed to completion of this dissertation.

I would like to express gratitude to my supervisor Dr. Vitalis Ozianyi for the remarks and engagement through the learning process of writing this dissertation and not forgetting the participants of my survey, who willingly shared their views and sacrificed precious time during the interview process.

I thank Safaricom Academy and @ILab Africa for granting me this Scholarship. The opportunity to acquire the knowledge, skills and expertise necessary to complete this work is priceless.

Finally, to my family, friends and colleagues who assisted me, I give heartfelt regard and gratitude

Thank you all!

Abstract

Queues continue to grow in spite of exhaustive methods done at the supermarkets to reduce it. There has been a rising interest in fast and simple shopping in supermarkets. In the ordinary shopping framework, check-out counters are distributed to minimise the queues yet at the same time it is said to be tedious. This created an exceptional opportunity that the researcher used to improve the current way of managing check-out queues and improve customer shopping experience. A review on consumer shopping behaviour and existing solutions was done to get an understanding of consumer's reaction to queues. Several theoretical models were extracted and combined in order to facilitate the study of queues and discovery of retail solutions. The literature shows that queues are an extremely complex phenomenon, and many of the drivers and pointers to customer satisfaction with queuing cannot be measured simply in terms such as the length of queue or wait time. Improving queues and satisfying customers required considerable understanding and more sophisticated responses.

A mobile and web application was developed to make the management of check-out queues easier and efficient and to improve customer shopping experience. Agile methodology was adopted as the software methodology for the development of the application. *Scan It*, a mobile barcode scanning application was developed as a tool to offer an interactive platform where customers can scan and purchase supermarket products. It was developed for better improvement of shopping experience. The final prototype was tested to verify if the requirements were met.

Keywords: Barcode, Self-Check-Out System, Consumer Behaviour

Table of Contents

List of Figures

List of Tables

List of Abbreviations/Acronyms

ADT	Android Development Tool
EPC	Electronic Product Code
ERD	Entity Relationship Diagrams
JSON	JavaScript Object Notation
NFC	Near Field Communication
OS	Operating System
PC	Personal Computer
PDA	Personal Digital Assistant
POS	Point of Sale
PSA	Personal Shopping Assistance
RFID	Radio Frequency Identification
SDK	Software Development Kit
TAM	Technology Acceptance Model
TRA	Theory of Reasoned Acceptance
UML	Unified Modelling Language
URL	Uniform Resource Locator

Chapter 1: Introduction

1.1 Background of the Study

The vision of technology is to connect the gap between the virtual world and the physical world of digital information. Over the last years this vision has been applied to enhancing supply chain in retail and improving the handling of goods in logistics with Radio Frequency Identification (RFID) as the driving technology. More recently, its worth for everyday users has been gradually recognised (Ropraz, 2008).

Mobile applications and mobile devices offer retailers more than just the chance to reach out to consumers. Mobile devices particularly offer opportunities to associate phone functionality, interaction and information search while using a product or shopping in-store. A mobile device is a persistent companion to a customer, an access to the relationship between the retailer and the consumer. This makes a mobile device a complementary channel for physical retailing and distance selling (Shankar et al., 2010).

Arvidson (2011) stated that the Internet has intensely transformed the face of retail, empowering consumers with huge amounts of information to make buying decisions and creating a platform for consumers to give feedback to retailers and brands on the quality of their products and services. Consumers can evade a brick-and-mortar retail store completely by associating prices and reading other users' reviews online before making a purchase. Consumers are said to be using mobile devices and social networking sites to help impact their decisions. Each of these trends has made it more challenging for physical retail stores to survive unless they adapt and learn to use the Internet (Lee, 2017).

Amazon recently advertised a state of the art self-check-out system that uses computer vision, deep learning algorithms and sensor fusion. The company envisions customers at the Amazon Go being able to pick whatever they want off the shelves and walking out with it and the items are automatically billed to their Amazon accounts (Kennedy, 2016). Labour is the biggest cost supermarkets face besides the products sold, and grocers are already taking steps to make cashiers obsolete through self-checkout stands. Amazon has changed the retail labour market by minimising labour force (Jake , 2018).

The major impacts of Internet on retailing are reduced search costs for the consumer, a growing variety of products offered (Brynjolfsson & Smith, 2000), allowing consumers to make better

choices for themselves and increasing the relationship with the purchased brand (Edelman, 2010). For example a study done by Daugherty, Li and Biocca (2008) and also by Court, Elzinga and Mulder (2009), shows that almost 60% of consumers of facial skin care products do more research after purchase but the use of Internet falls short of expectations when consumers want a direct interaction with the supermarket in-store attendants or staff. The additional value created by mobile phone services for consumers is derived from the fact that these services are accessible independent of location and time (Balasubramanian & Peterson, 2002).The real business drivers for mobile technology were customer interaction and functional efficiency this in turn increases retailer effectiveness and efficiency (Kumar & Zahn, 2003).

Shopping within the present day customarily integrates ready in queue to get your product scanned for checkout and billing. This usually results in a deal of misused time for customers. A study done by Visa in 2005 features out an astonishing reality that 70% customers walk out of a queue if they find the queue too extensive, and 10% of the customers were found to have been totally disappointed and immediately walked out of a queue (Chaure & Jain, 2016). Moreover, an evaluation done by CISCO Internet Business Solution, showed that the prime reasons clients utilised innovation were to: save time (47%), find most affordable cost (63%), find an outstanding combination (26%) and find value and the best quality (25%).

1.2 Problem Statement

One of the greatest challenges people face in supermarkets is long queues at the check-out. A survey of 2500 people done by Cox (2015) to figure out their supermarket shopping habits shows that long queues at the check-outs was a big issue and there is no efficient technology that aims to deal with this issue in Kenya.

Customers usually end up abandoning the queues and some are put off immediately by the long queues when entering the supermarkets (Barclays, 2015). Some of the issues that bring about long queues during check out are the payment methods that are offered in the supermarket like cash, use of credit card and mobile money. There is usually some delays either on the customer part or supermarket that facilitate these delays.

1.3 Research Objectives

i. To identify the challenges faced by customers due to a slow check-out system,
ii. To determine the existing technologies that assist in shopping in retail supermarkets,
iii. To design, develop and test a mobile application that can enable customers to scan and check-out their purchases at the supermarket,
iv. To validate the efficiency and effectiveness of the mobile application.

1.4 Research Questions

i. What are the challenges faced by customers due to a slow check-out system?
ii. What are the current technologies that assist in shopping?
iii. How can the mobile application be used to scan items and check out purchases at the supermarket?
iv. What are the findings of testing and evaluation of the developed application?

1.5 Research Justification

A survey of people's shopping habits was done to determine the list of things customers hate at the supermarket. One of the top issue was long queues at the check-outs. 62% people surveyed stated this to be their main issue and most of them leave without buying anything (Cox, 2015). There is need for a solution that will help minimize the long queues during busy shopping periods. The solution can be able to provide analytics by determining the number of people who visit the supermarkets and actually shop.

A recent report by the leading mobile operator, Safaricom shows that Kenya has 67% smartphone penetration accredited to a growing middle class that contributed to the uptake of these type of phones (Mupaso, 2014). Smartphones penetration is doubling every year and every single thing from shopping, bank transactions is done on phones. This study aims to build a mobile-based solution that can take advantage of the increasing use of mobile phones to help minimise check- out queues.

1.6 Scope and Limitations

This research project covered the Nairobi region where a lot of shoppers were located. The mobile application designed enabled consumers to shop and scan their own shopping items using the mobile application. The application was restricted to users with smartphones running on Android. The research was conducted within the Nairobi urban population.

Chapter 2: Literature Review

This chapter provides a review of the literature related to consumer shopping. The intent is to acquire both the global and local approach on shopping and the systems that have helped improve shopping in supermarkets.

2.1 Basis for Exploring Current Checkout Systems

Bianco (2014) stated that speedy check out systems were one of the most important pieces of the customer satisfaction puzzle and that the last thing a customer wanted when done with shopping is waiting in line to pay. The consumer-buying pattern is influenced by numerous factors comprising of the amount of time the consumer spends waiting in line at the checkout counter. Businesses and retailers that use checkout systems in their businesses spend significant amount of resources examining ways to improve their methods of customer checkout (Lu & Musalem, 2014). There is an overpowering need for businesses to value customers' time and implement more efficient checkout systems to improve the efficiency of queues and waiting lines. A survey by the Food Marketing Institute reported that 89% of shoppers interviewed pointed out that a fast checkout process is one of the top most priorities in their choice of a store that meets their expectations (Tomazelli, 2016).

2.1.1 Self-Checkout and Conventional Checkout

A moderately new development of the checkout process is the move towards self-service checkout, also known as self-checkout or self-scanning. The conventional checkout technique is facilitated by a supermarket employee who helps the customer register the products, calculates the due fee and accepts the payment (Hartman, 2008). Mostly, for each customer that checks out, one supermarket employee is required. A new checkout process is developed and introduced to the market to minimize labour costs. This innovative checkout system is called 'self-checkout' and lets the customer to implement most checkout tasks, without much help from an attendant (Bickers, 2009). This efficient concept requires different checkout systems that replace the attended checkout desks of the conventional checkout process. It allows one store attendant to service several checkout systems and therefore can help save labour costs. The upside of this new checkout process is more privacy for the customer and the perception of a speedier checkout (Andrews, 2009). The store can process more customers at the same time and therefore reduce the waiting lines, without having to increase the number of cashiers.

2.2 Mobile Device Consumers

A wide review of articles and reports identified shopping as an area of retailer interest. It is also a topic lacking an agreement on best approaches and practises. The Peck Fellowship used the first year to aggressively understand the retailer's e-commerce and m-commerce and commercial social media landscape, and the consumers operating within this space. 60% of American adults and nearly 40% of teens had smartphones, and smartphone penetration is accelerating at a rate of 10% annually for several years. Consumers using smartphones can no longer be characterized as innovators and early adopters as they have quickly penetrated into the late majority space (Smith, 2013).

Consumers reported that the excitement of mobile adoption was driven by the convenience and connectivity, as visualized in a world composed of their responses. The access to apps, internet and email was seen among the top advantage to owning a smartphone (Poushter, 2016). Data developed by Booz and Company showed that many shoppers were using their mobile while shopping (31%) as shoppers using online coupons (32%). A powerful potential in grocery app development for smartphones was the consumer's natural desire to use the smartphone to serve as a multimedia digital communication device, through texts, tweets, email, Instagram, and a multitude of social media sites. Calling someone on their cell almost seemed too intrusive. This ability to digitally connect and create exchange between the consumer and retailer, and consumer to consumer was seen as powerful (Smith, 2012).

Two studies from the Japanese market discovered sectors of mobile and fixed internet users. Okazaki, Katsukura and Nishiyama (2007) stated in their survey that though the different usage levels of mobile pulled advertisers, it revealed very little about customer's behaviour. Mahatanankoon, Wen and Lim (2005) identified treasured m-commerce operation modes and likely consumer-based applications. Applications of a particular interest for mobile shoppers seemed to be content delivery, transaction based on orders and payments services and location, time based services such as time sensitive supermarket offers, maps and routes to closest supermarket branches using GPS location. Other mobile functions potentially valuable to mobile device shoppers were memory support for probably saving shopping lists, pictures of the items at the supermarket, sharing of information and content. This additional functionality drove different behaviours as there were more uses for the device compared to desktop computers. The camera function could be used to scan the products, comparing products and other functions. The value lied in providing customer satisfaction.

2.2.1 Mobile Shopping Assistants

Mobile applications that enable consumers to interact with retail products have had a long standing tradition in this era (Okazaki & Hirose, 2009). Early prototypes were customized hardware devices like Personal Digital Assistants (PDAs) or pocket computers. They were the preferred platform to implement software prototypes which were later moved to be implemented as software applications on mobile phones. Some approaches attached shopping assistants to shopping carts or baskets.

Hardware Devices

AT and T Bell Laboratories presented an early experimental prototype of an indoor wireless system for personalised shopping assistance. The system according to Schmidt (2015), consisted of back end servers and a mobile hardware device which could be attached to a shopping cart and featured speech interaction using a microphone and headsets. It directed customers through the store, provided specifics on products of interest through its built-in screen, made price comparisons, pointed out items on sale and reserved personal shopping lists. The system also implemented a barcode reader.

According to Karpischeck (2012) the Metro Group Future Store Initiative presented the Personal Shopping Assistance (PSA), a system consisting of a tablet PC with a wireless network connection, touch screen and a barcode reader. The tablet PC could be attached to the top of a shopping cart and personalised by scanning loyalty cards. The PSA could then display product related information and speed the checkout procedure by transmitting the contents of the shopping basket to the cashier. The system also reinforced self-checkout and was evaluated with customer surveys (Kalyanam & Wolfram, 2009). PSA users reported high level of customer satisfaction and the sales was said to have increased through the use of PSA.

More current approaches also used specialized hardware devices to implement mobile shopping assistants in supermarket setups. According to Black et al. (2009) a context-aware shopping trolley was introduced to support the shopping experience in a supermarket.
The system was designed to help consumers locate items in the supermarket, and a prototype was implemented using a display attached to the shopping cart. A context-aware shopping cart equipped with a touchscreen attached to the top of the cart, Near Field Communication (NFC) and RFID readers, and a fingerprint scanner was later implemented (Kahl et al., 2011). The

system provided consumers with navigation in the supermarket, product recommendations and personalized shopping lists. The authors pointed out that in contrast to hand-held devices, the instrumented cart could be operated hands-free, which was a gain in a shopping scenario.

Pocket Computers

Shopper's Eye, an idealistic prototype of a location-based software agent running on a PDA and using GPS location and user-defined shopping goals to inform users about the availability and the price of products in nearby stores was introduced in 1998 by Fano (Karpischeck, 2012). The IBM SmartPad Project was also launched that provided an abundant access to electronic grocery shopping and provided a platform for managing shopping lists using PDAs.

Fleisch and Michahelles (2010) stated that the Pocket Bargain Finder, a hand-held device for augmented commerce was presented at the First International Symposium on Hand held and Ubiquitous Computing (HUC). The prototype was designed to scan barcodes of books at bookstores and find the best accessible price online. An initial assessment found the speed of the Internet connection to be the most limiting factor for a wide user adoption. The goal of the work was to study the predicted effect with currently deployed mobile applications for consumers in retail.

According to Chan (2012) in 2001 a project explorer at the media lab at Massachusetts Institute of Technology (MIT) worked on applications that associated virtual services to people, places, and things. The project implemented a personal shopping assistant (PSA) on a Pocket PC attached to a shopping basket. Consumers could scan products with an attached barcode scanner. The system provided further information on scanned products such as nutritional information, recipes, and product recommendations using an early version of an Object Naming Service (ONS) and web services.

The system later had additional features such as an RFID reader and products tagged with Electronic Product Code (EPCs) on RFID tags (Karpischeck, 2012). According to Chan (2012) the system was evaluated through informal user trials in a supermarket. The most important benefit to customers was seeing the total cost of scanned items.

Newcomb and Pashley (2009) stated that some users raised concerns about the time they spent scanning items, and they noted that operating the scanner and Pocket PC while holding the shopping basket was difficult enough to be a limiting factor to using the system. Forsblom et al. (2009) stated that a study was conducted on shopping habits usability tests done with

prototypes of a PDA-based shopping assistant. They study noted that grocery shopping was an especially hands-busy task, a fact that was to be considered when designing shopping assistants. The MyGrocer project according to Giaglis and Doukidis (2007) developed a pervasive retail system for Fast Moving Consumer Goods (FMCG) in 2001 and 2002.

A more thorough evaluation of consumer reactions to the MyGrocer prototypes was done in a field study with 60 consumers in two supermarkets. Consumers reported a highly improved shopping experience and found minimized checkout time to be the most attractive feature (Roussos et al., 2010). Roussos et al. (2010) further discussed implications for the design of consumer experience and mobile commerce appliances. The MyGrocer project was the first large-scale research project on mobile shopping assistants and some of its findings on user perceptions were reflected in recent design of mobile shopping applications.

Mobile Phone Applications

According to Ballagas (2007) the mobile phone was the first truly pervasive computer. Shekar (2010) presented iGrocer, an early prototype of a mobile shopping assistant implemented and operated on a mobile phone. The system was implemented in J2ME and read product barcodes with a barcode scanner accessory. It was designed to assist consumers in buying decisions at the point of sale based on user-defined nutrition criteria and price limitations.

Adelmann et al. (2010) developed a fast and reliable toolkit for barcode scanning known as Batoo. Its main features included the ability to scan barcodes from any angle. Later versions could even decode barcodes in blurry images which eliminated the need to wait for the auto-focus of the camera. Karpischeck (2012) compared the Batoo to other barcode scanners in a user study and found that Batoo was one of two from a total of 11 mobile barcode scanners with a perfect reliability of 100%. According to Karpischeck (2012) the other barcode scanner with perfect reliability in this study was ZXing.

According to McMillan (2010) research on mobile shopping assistants had far focused on prototypes that had not been widely deployed and evaluated on a large scale. While other mobile applications had been researched on a larger scale as well as smartphone usage in general and researchers reported good results from deploying applications in app stores

2.3 The Purchase Decision Making Process

Solomon et al. (2007) defined consumer purchase as a response to a need where the consumer undergone a series of steps to satisfy those needs. According to Kotler and Keller (2008) consumer purchase was a reflection of the consumer decision making process, whose main

stages were problem identification, information search, evaluation of alternatives, purchasing decision and post purchase. Solomon et al. (2007) further explained that not all decision making process were dependable with this model as several external factors were able to affect how consumers progressed from one stage to another. Shopping was considered as a habitual decision making process. The decisions related to most supermarkets demanded a low level of participation from most consumers, being strongly related to the experience of past shopping trips and buying routines (Solomon, Bamossy, & Askegaard, 2007). Supermarket product offers and other store environments were usually complex and rich in information than those characterizing other types of purchase and this complexity was associated with the stimuli designed to influence consumer decision making process at the point of purchase.

Customers were usually exposed to in-store displays and product categories as they purchased with the intensity of the exposure being influenced by several contextual factors like location, number of aisles, shopping trip type and purchase involvement (Inman, Ferraro, & Winer, 2004). Shoppers must be motivated by in-store stimuli they are exposed to. This was influenced by a number of factors like age and need for cognition. The recognition of the need for a product if the consumer did not plan to shop beforehand should be acknowledged. This was again influenced by a number of factors like impulsiveness, gender, household size not forgetting income.

Maja (2014) presented an approach when it came to the utilisation of mobile phones for shopping and it was divided into four categories: mobile advertisement (use of mobile phone by retailers), wireless localization technology such as the GPS, use of mobile phones while shopping and mobile payments.

Table 2.2 contains a list of fields of mobile commerce in traditional retailing including an initiator of mobile phone use. The initiative of mobile Bluetooth marketing belonged mainly to the supermarket store but this form of marketing it lost its value when the customer did not switch on the mobile phone Bluetooth. According to Maja (2014) the most popular way of mobile marketing had been sending promotional offers and sales through SMSs. There were many ways the use of mobile phones was utilised by customers such as searching for prices from other stores online, shopping list on mobile, scanning QR and barcodes and many more.

Table 2. 1 Impact of Mobile Telephony in Traditional Retailing *(Maja, 2014)***.**

Fields of m-commerce in retailing	**Store**	**Initial Customer**	**Both**

Bluetooth marketing			V
Promotional SMS to mobile shoppers	V		
Mobile shopping using RFID			V
Online price search		V	
Shopping List		V	
Calls		V	
Online reviews		V	
Scanning Barcodes		V	
Goods payment			V

The popularity of modern mobile phones has increased in a very active way. By the end of 2012, the percentage of American people with smartphones had increased from 14% to 40% (Smith & Zickuhr, 2012). Wheeler and Jones (2011) stated that retailers noticed a massive potential in mobile marketing that enabled the acquisition of new customers and maintaining their customers. Companies nowadays are beginning to explore the individual consumer reference during the purchase process.

Technological development made it possible for retailers to implement new business models of customer service strategy which included mobile phone solutions as shown in Figure 2.1. According to Maja (2014) supermarkets in the future will be forced to integrate the use of mobile phones to improve their relationship with customers. A research done by KPMG International (2012) stated that mobile phones had a variety of applications which could be used by retailers for marketing their products and in turn keeping customers informed about special offers, new product arrivals and sales.

2.3.1 Pre-Decisional Stages

How purchases were decided upon by consumers was not only greatly influenced by the purchase environment but also by several pre-decisional factors like the goals consumers pursued within a specific purchase which could be diverse as satisfaction of general needs, emotional gratification, and acquisition of essential items (Santos, 2009). This reflected different shopping motivations which shaped consumer decision making process and could be distinguished as being of a utilitarian or hedonic viewpoint (Babin & Griffin, 1994). Utilitarian were known to be task-oriented, problem solving consumers who made rational decisions only.

On the other hand, hedonic consumers often looked for enjoyment, emotional or sensor stimulation and satisfaction of desires while doing their shopping.

Santos (2009) stated that it could be a highly stressful task for some consumers rather than it being pleasant or enjoyable. The habitual purchase which focused on the purchase of essential items was considered to be of utilitarian motivation (Solomon, Bamossy, & Askegaard, 2007).

The establishment of accomplishment of such shopping goals suggested a series of pre-decisional steps such as where a particular shopping trip could be conducted, supermarkets to visit or what particular brand of products to choose from (Webb & Chang, 2014) .

According to Laine (2014) the time of shopping trips was defined by not only the availability of the consumer but also the periods the consumer believed to be more convenient or appropriate to visit the selected supermarket. The decision of which stores to visit and which products to purchase was greatly influenced by the consumer's expectations of which alternatives would satisfy his or her existing needs more (Rani, 2015). Other pre-decisional factors such as using or not using a shopping a list, shopping alone or being accompanied by someone were also likely to influence consumer's shopping and behaviour outcomes (Santos, 2009).

The use of written shopping lists could act as an important shopping tool for goal achievement. Shopping lists yielded the benefits of ensuring that the needed items were acquired (Thomas & Garland, 2004). For others shopping list may have meant fewer stresses as the shopping process and budget expenditure were kept under control. Unaccompanied shoppers were less likely to use a written a shopping list and were more likely to stray more from their spending goals while accompanied shoppers tended to navigate more throughout the store but saw their companions to having less influence on their shopping purchases (POPAI Institute, 2011).Shopping was known to have been indeed heavily influenced by consumer demands and shopping plans and this had a great and important influence on the time and budget spent at the supermarkets (Santos, 2009).

2.3.2 Compatibility as Pointer to Mobile Retail Acceptance

Smartphones had penetrated many areas of the human activity such as education, work and entertainment. This flow had continued to shape user values and experiences. There was one determinant of a theory known as the Roger's diffusion of innovation that examined what assisted in the diffusion of innovative technologies (Mallat & Rossie, 2009).

Rogers (1983) defined compatibility as the point to which an innovation was observed to be as consistent with past experiences, existing values and needs of potential adopters. Innovation was said to be successful when users were able to adopt it seamlessly.

The more compatible the innovation the faster the rate of adoption. Many users had integrated smartphones into their daily operational activities. According to Chen and Gillenson (2002) if a user perceived that the mobile device was compatible with his or her values and experiences, other services would be adopted as well. Compatibility positively affected consumers towards utilising a virtual store

2.4 Queueing Theory

Li and Han (2016) defined queueing as a pervasive phenomenon that mostly occurred in supermarkets, restaurants and banks. People spent a substantial amount of time waiting in lines and long waiting time brought about dreadful user experience. Lane and Miluzzo (2010) stated that queue management is important as it helps in reducing inefficient resource allocation and revenue loss. Mobile phones have presented an attractive platform for people-centric applications (Rachuri & Musolesi, 2010).

2.5 Scanning Technologies

There are a number of scanning technologies that are in use today, some dedicated device scanning or mobile based scanning. Listed below are mobile device scanning technologies used synonymously with mobile devices. A mobile device could be used in place of a dedicated scanning device having an inbuilt reader that transmits radio frequencies over a tag or a mobile device camera to scan over barcode.

2.5.1 Mobile based Scanning Technologies

These scanning technologies include scanning processes that rely on a user physically scanning items using a handheld smartphone. Some of these technologies include: QR-Code and Barcode.

A. QR code scanning

QR-Code is an abbreviation for Quick Response Code. Ullrich (2011) defined it is a type of matrix barcode or two dimensional barcode designed initially for the automotive industry in Japan. A barcode is defined as a machine readable optical label containing information about an item that it is attached to. Figure 2.1 shows the structure of the QR Code.

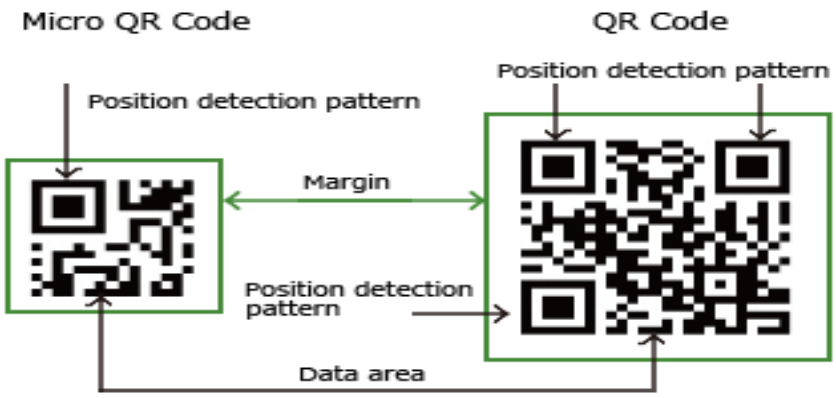

Figure 2. 1 QR Code *(Bhardwaj & Kumar, 2016)*

QR Codes could be used on a variety of mobile device operating systems. The mobile devices support URL Redirection that allowed the codes to send metadata to existing applications on the device. Many free mobile based applications came with the ability to scan the codes and hard-link to external URLs (Law & SO, 2010).

A QR Code is a kind of two dimensional symbol that was developed by Denso Wave. Figure 2.2 shows the comparison between a QR-Code and a traditional Bar Code. This technology was launched in 1994 with the aim of being a symbol to be easily interpreted by a scanner (Wave, 2014).

Figure 2. 2 Comparison between QR Code and Barcode *(Wave, 2014)*

QR-Codes use four standardised encoding modes namely; numeric, alphanumeric, byte or binary to store data efficiently.

According to Stechz (2012) QR Codes consisted of black square dots arranged in a grid the shape of a square on a white background.

These dots could be read by imaging devices such as cameras and dedicated scanners. The image captured is processed using Reed Solomon error correction until it could be interpreted appropriately. Data was extracted from the images patterns presented on both its vertical and horizontal components. The amount of data stored in a QR Code symbol depended on the datatype, version and error correction level.

A.1 Uses of QR Codes

According to Bhardwaj and Kumar (2016) QR Codes were more commonly used in consumer advertising. A smartphone was the preferred use as a code scanner which could convert the code into useful data such as a standard URL for a website. This removed the need for a user to type the URL into a web browser. QR Codes were also used in other applications such as commercial tracking of commodities for instance entertainment and transport ticketing, product or loyalty marketing and in-store product labelling.

B. Barcode

As pointed out by Kato and Tan (2007) barcodes were designed to carry significantly a lot of data. Mobile phones had evolved from a mobile voice communication device to what it is now, a mobile multimedia computing platform. Recent technology development and integration of these two made interesting and diverse applications of barcodes in mobile application systems and m-commerce services. Kuha and Chintho (2014) stated that in m-commerce systems, barcodes could be used to support pre-sale, buy-and-sell, post-sale activities for mobile commerce transactions. Barcodes could be used as advertisements, coupons, or promotion materials that can be captured and decoded by the user with mobile devices. Moreover, barcodes enable mobile devices to become a point of sale device that reads the barcode and facilitates payment transactions. After a payment transaction, barcodes could be used by customers as a receipt or proof of purchase to gain access to the purchased goods and services with their mobile phones (Zhang, Ren, & Xing, 2014).

B.1 Application of Barcode in M-Commerce

According to Kuha and Chintho (2014) people have gradually realized the importance of barcode and its great application value in M-Commerce because of the following:

1) Barcodes provide a new effective input channel for mobile customers carrying mobile devices with inbuilt cameras.
2) Barcode is becoming a popular approach to present semantic mobile data with standard formats.

3) Barcodes support a new interactive and efficient approach between mobile customers and wireless application systems.
4) Barcode technology can be and are being used in diverse applications in mobile commerce.

2.6 Existing Supermarket Self-checkout Technologies

There has been an introduction and design to a new form of supermarket where customers acquired detailed product information with supermarket facilities and got accelerated checkout process without human intervention.Zheng and Meagher (2009) stated that one of the contributions that has been brought about smart supermarkets is the concept of "paying anytime anywhere" which has given customers complete freedom when checking out and eliminating the time wasted in checkout queues.

2.6.1 Smart Market

Roussos and College (2007) presented a new form of smart supermarket technology known as Smart Market (SMart) which had three goals: the first one being to enable customers easy access to product information or other back-end supported functions; secondly, to provide quick and flexible checkout because the current checkout process was consistently reported as one of the most negative aspects of supermarket shopping and thirdly, to enhance management efficiency and reduce labour cost.

Zheng and Meagher (2009) provided a scenario to further explain how SMart worked where a user walks into the Service Terminal (ST) of a supermarket and inputs the product number. The SMart would then display the product location and the route on the ST screen. The user would then locate the product which has an RFID tag that would be read by the ST. The ST would then display the product information and payments follow.

2.6.2 BarCroid

Benedict and Pacana (2016) devised an application called BarCroid Scanner that aimed to aid time consuming and inconvenient shopping. It was developed for better enhancement of shopping experience and shop owners as well. BarCroid was capable of generating reports and inventory of a store which was great help for store owners. It had the following features: barcode Scanner, product's information, product's availability, location inside the store, money budgeter, history, inventory, generated reports, and mobility.

2.6.3 Amazon Go

Amazon recently introduced what many industry observers call a ‘game changer’ entitled Amazon Go. Amazon’s newest concept enables shoppers to enjoy the maximum convenience of shopping without the need to stop and check out (Kasavana, 2017). This process known as ‘walkout shopping’, saves time and money. Amazon Go has no cash registers and no lines because customers do not have to check out. Instead, they check into the store using an Amazon Go application on their smartphones. Sensors placed around the store sense what customers take off the shelves, and the customers are automatically charged on their established Amazon accounts when they leave. It is said to be like shoplifting, except the customers pay for products as they walk out of the store (Thoet, 2016).

2.7 Proposed Solution

This proposed system as shown on Figure 2.3 leveraged on the existing Barcroid application system with an added value to the research and the main components of the system which enabled the user to scan products and make payments using mobile money payments. These components had not been featured in other barcode scanning applications. Users of the application were customers and supermarket staff. Customers accessed the application through their smartphone and scanned products which were stored in the supermarket database while supermarket staff accessed the application to manage products by updating or creating products. The Administrator on the other hand accessed the web platform to manage products, users and supermarket as a whole.

Reports on the core data elements from customer shopping activities was done to provide better insight for better planning to improve customer shopping experience.

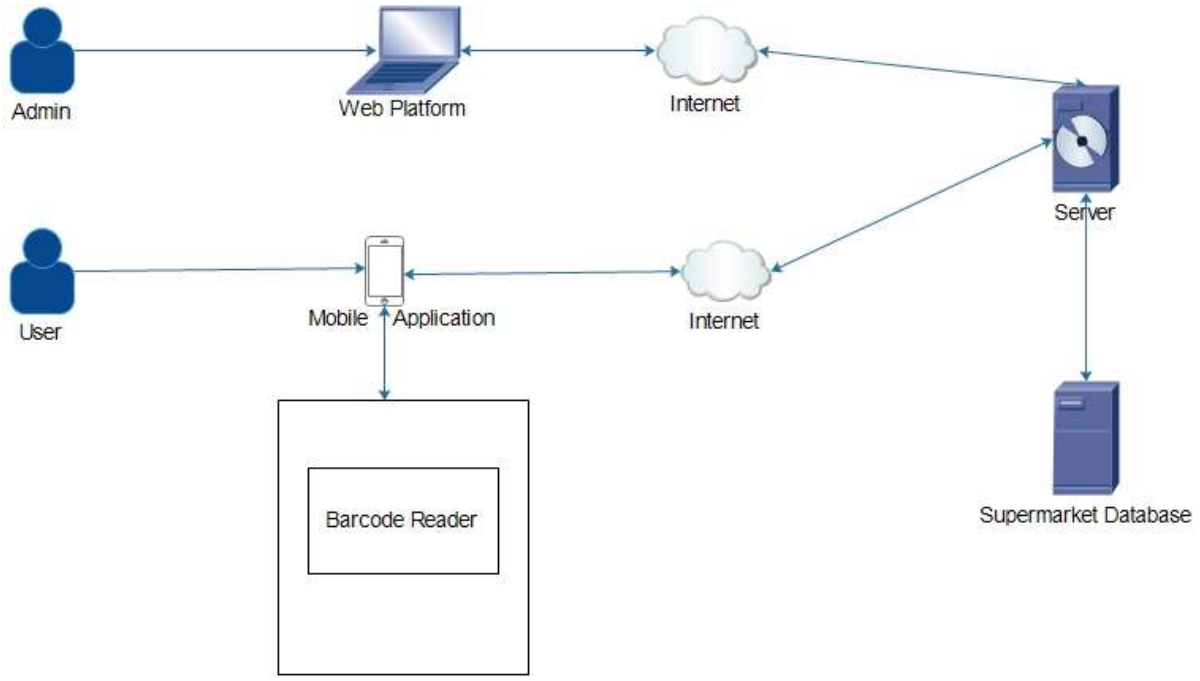

Figure 2.3 Proposed Solution

2.8 Gaps and Limitations on Existing Technologies

According to Xhiang, Wang, and Shen (2004) the limitation of using RFID tag is that the approach would be beneficial when focusing on an already secure supply chain. The research location of the study is in a place where locally developed applications are not embraced and the use of feature phones still exist. There is need for a solution that will help reduce check out queues at the supermarket that are caused mostly by manual mobile payments.

Chapter 3: Research Methodology

3.1 Introduction

This is a description of techniques chosen to achieve the objectives of the proposed system. It describes the methods used in conducting the research, how the solution was implemented, the tools and the techniques used. The methodology was aimed at answering the research questions mentioned in Chapter one.

3.2 Agile Development Methodology

The research methodology adopted was the agile development methodology as shown in Figure 3.1. Agile Development methodology allows flexibility in integrating user requirements due to its incremental and iterative nature. Design, testing and implementation is done throughout the project cycle. Agile development in its simplest form offers a lightweight framework for helping teams, overall risks associated with software development are reduced and it speeds up the delivery of initial business value, and through a process of constant planning and feedback, is able to ensure that the value is continuing to be maximized throughout the development process (Larman, 2004). As a result of this iterative planning and feedback loop, teams are able to continuously align the delivered software with desired business needs, easily adapting to changing requirements throughout the process. Agile development is incremental (multiple releases), cooperative (strong collaboration between developer and client), easy to understand and modify and adaptive to change (Abrahmsson, Salo, & Warsta, 2002).

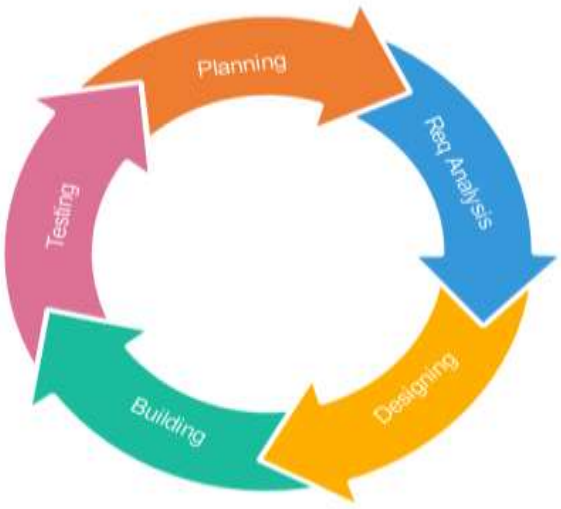

Figure 3.1 Agile Development Methodology (James & Walter, 2017)

Agile development was chosen because of its useful practises. These practises such as ability to move quickly and easily simplify mobile development so that the resulting application is adaptable after release (Gajos, 2015). There are a list of procedures that are essential to agile development and these are simple design, ability for releases in a short period of time, extensive team cooperation, anticipating the need for change and welcoming change and using it as an advantage (Boem & Turner, 2003).

3.2.1 Planning Phase

This was the initial phase of the software methodology and it involved identifying how the entire process was carried out. The resources required in developing the product were also identified in this phase. This study used a ghant chart for planning, this enabled the researcher to have a clear perspective of the actual time when the reaserch ought to have started and when the research would come to an end.

3.2.2 Requirements Analysis Phase

This second phase involved analysing the requirements of the system and what was expected of the system. Requirements analysis helped to reveal important information like what the client wanted, what tools was needed to develop and test the application and what was needed to make the development process a success. This stage involved gathering input from customers through an interview to determine the system requirements

3.2.3 Design Phase

The design of the system was done after the requirements analysis. According to Orsolya (2016) the design phase guides the researcher to understand what is needed to analyse data flow systematically, process data, store data and output information in context of the study
In selecting an appropriate methodology the researcher performed a one on one interview using pre-defined questions that sought to understand how the current systems worked. Consideration were made on limitations of the system at the time of study to identify key user requirements. Outcomes from the interview will greatly influenced results of the system analysis and design process. The concept of Object-oriented analysis ensured user requirements were modelled and analysed profoundly. Relationships of real world Objects were also identified.

Unified Modelling Language (UML) was used as the modelling language. This aided in modelling analysis and design diagrams. Other than that the UML notation offered clarification to user requirements. Use Case descriptions and diagrams was used to model system

functionality. The System Sequence Diagram modelled the System Flow showing data passing between main entities of the system. Various entities with corresponding attributes and methods of implementation is modelled using Class diagrams. The Entity Relationship Diagram was used to model the database. This showed the tables, attributes and relationships. The Database Schema modelled the table structure showing fields, data types and descriptions. Wireframes were later used to illustrate process flows of both the web and mobile applications. Balsamiq mockups was used to create the wireframes.

3.2.4 Implementation Phase

This was the actual implementation phase of the designs that was done on the previous phase. The database was created from the Entity Relationship Diagram (ERD) to bring out all the tables and their relationships. The design mock-ups was transformed into the actual system and the functionalities were added.

Prototype Development

This involved developing a mobile application that was connected to a central remote database. The application development environments that was employed are:

a) Mobile Application

   A mobile application was developed to be suited for the Android operating system. The programming language, Java, was used for the development of the mobile application. JavaScript Object Notation (JSON) was used as the web service which provided an interface between the database and the mobile application. The mobile application was then tested and compiled using an Android device and the Android Software Development Kit (SDK) emulator.

   Android was chosen as the client application because of the availability of the Android Development Tools (ADT), its flexible SDK and the massive support from online communities such as XDA Developers.

b) Database

   MySQL database management system was used to store the mobile application data. MySQL was chosen for a number reasons such as:

   i. Provides full compatibility with a lot of frameworks.
   ii. Open source.

3.2.5 Prototype Evaluation and Testing phase

The prototype underwent the following tests to find out whether it was in line with the specified goals of this dissertation:

Testing of the Prototype

The following tests were done to test the prototype's functionalities and user acceptance:

a) **Compatibility Tests**

These tests were done on various versions of the Android Operating system to determine the system's compatibility. Robotium Android testing tool was used to assess the compatibility of the developed application in different Android versions.

b) **Usability Tests**

This was done to determine the usability of the developed application. This helped to measure user satisfaction and check whether the application had any drawbacks. To achieve this, a number of respondents were sampled to test the application and give their response which helped in refining the prototype. The sampling was be done by giving the prototype to the end users and making observations as to how they navigated through the application.

c) **Load Testing**

This test was done to check the time the application takes to process the scanned items at the supermarket and show the item price. This was tested by scanning various supermarket items and making observations on how fast the prices, the total calculations and the online payment check-outs were made.

d) **Integration Testing**

This test was done to determine whether the modules would operate as desired when joined together. All of the modules of the prototype were combined and tested to see whether they all work perfectly.

e) **Validation**

To validate if the developed application solved the challenges faced using the current shopping techniques, a review feature was added in the application.

3.3 Summary

This chapter has described the methodology that was used to answer the research questions and determine whether a mobile application was the great solution to the challenges being faced by the current system. The main distinctive features of agile are agility and continuous progress. The next chapter looked at the software modelling techniques that further explained the processes involved in the application.

Chapter 4: System Design and Architecture

4.1 Introduction

Data collected was analysed to determine the feasibility of the research and gather requirements. This chapter goes through the requirements identified from the analysis of the data gathered from the previous chapter and the design and structure of the proposed scheme. The models used for the design and structure were: wireframes, use case diagrams, use case descriptions, sequence diagram, an Entity Relationship Diagram (ERD), a class diagram, and a context diagram.

4.2 Requirements Analysis

4.2.1 Functional Requirements

Functional specify the requirements that the application should fulfil to satisfy all the needs required by the system users. The requirements included: user account creation, user management, and product management, scanning products, payments and reports that showed the total payments done by the customer, the number of scans done and total number of products available in the supermarket.

Account creation includes customers registering and logging into the application. User management includes enabling the administrator to foresee the registration and management of user account profile. Product management involves all product related activities like: adding, updating, or deleting products by the supermarket staff and system administrator. Customers should be able to scan multiple items, get the total and make payments through mobile money payments like MPesa.

4.2.2 Non-Functional Requirements

These requirements specify the criteria used to evaluate the system operation. They were assembled in agreement with the functional requirements that define specific functions and behaviour. They include:

i. Usability: The system interface should be easy to use and interact with.
ii. Availability and reliability: The system should be reliable and always available to perform tasks requested by the user.

iii. Scalability: The system should be able to implement additional functionalities. Additional data should be easy to incorporate.
iv. Integrity: The system should ensure that the data collected and stored is not altered or corrupted.
v. Performance: The system should have a tolerable response time while performing its functions.
vi. Security: The system should allow only authorized users to use its functionalities.

4.4 System Design

4.4.1 Introduction

This section explained the design and architecture of the system developed. The database and its Schema was also explained further below as well as the UML diagrams was used to design the system and show the interactions between the user and the system.

4.4.2 System Architecture

Figure 4.1 explained the modules that made up the system and it also showed the interactions of the users with the system where the actors represent the user privileges. The system consisted of three users which were the system administrator, supermarket staff and the customers. The administrator had the utmost all the privileges of the system. They could edit, delete, and view products, manage users, view payments and scans that were done through the application.

The normal users could access the application through their mobile phone. The normal user were the customer and supermarket staff in possession of a mobile phone with the barcode reader application installed. The mobile application consisted of a Barcode reader that users interacted with by scanning supermarket products and the barcode details were checked against the data in the supermarket's database. The details which included the item's name, quantity and price will be displayed on the mobile app depending on the type of the user.

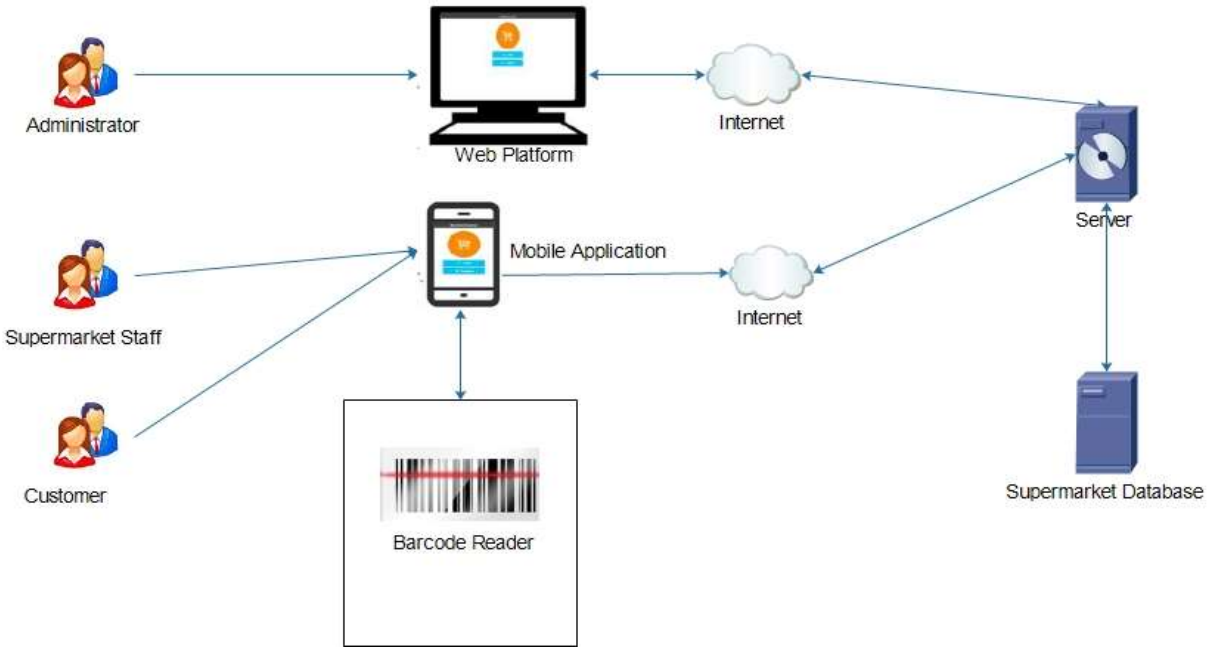

Figure 4.1 The System Architecture of the Proposed System

4.4.3 Context Diagram

Figure 4.2 shows the logical design and whole process of the proposed Barcode Scanner Application Framework. It shows how the relationship the system has with external entities. In this case the external entities are customer, system administrator and supermarket staff. Customers have to register through the application in order to access the application through a user account and make purchases through the system while the supermarket staff login into the application to manage products. The system administrator manage users account details, products, customer orders and payments.

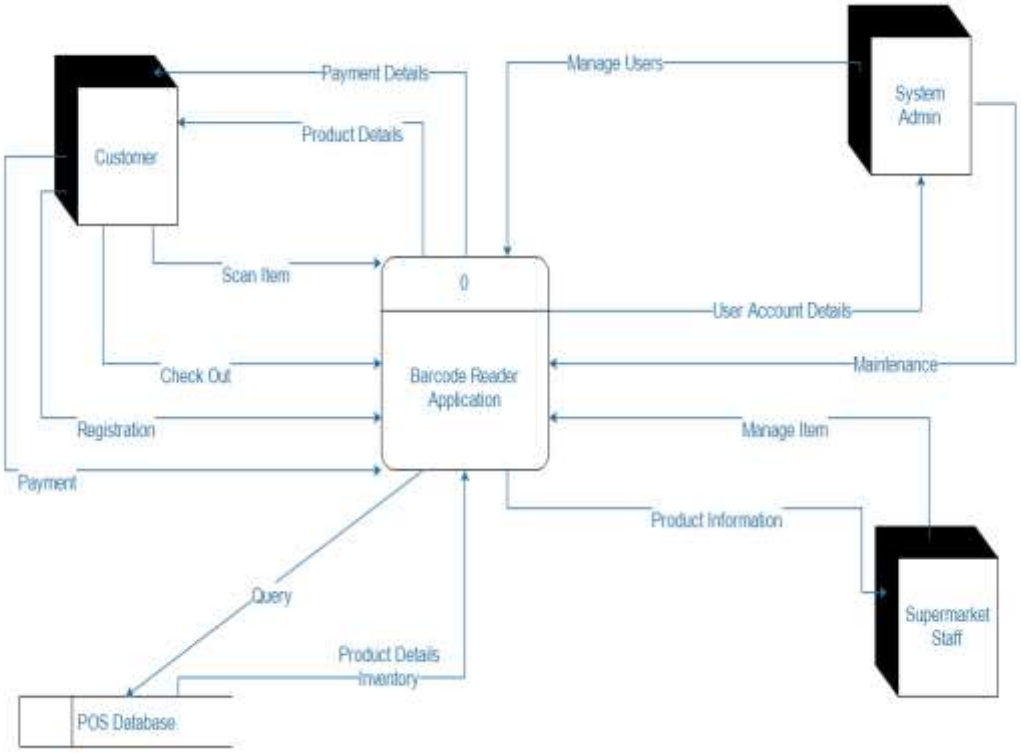

Figure 4. 2 The Context Diagram

4.4.4 Use Case Diagram and Description

The actors identified for the scheme were: the administrator, supermarket staff and customers. The customers will interact with the scheme through the mobile application while the administrators will interact with the scheme through the web backend. The use case shown by Figure 4.3 shows how the actors will interact with proposed scheme. The following are a list of actors who interact with the system:

Customer

This includes shoppers that will be using the Barcode reader application to purchase items at the supermarket.

Staff

This includes supermarket employees that will be using the Barcode reader application to enter and update items in the database.

System Administrator

This include the developer of the system. The system administrator is responsible for the maintenance and management of the system and users.

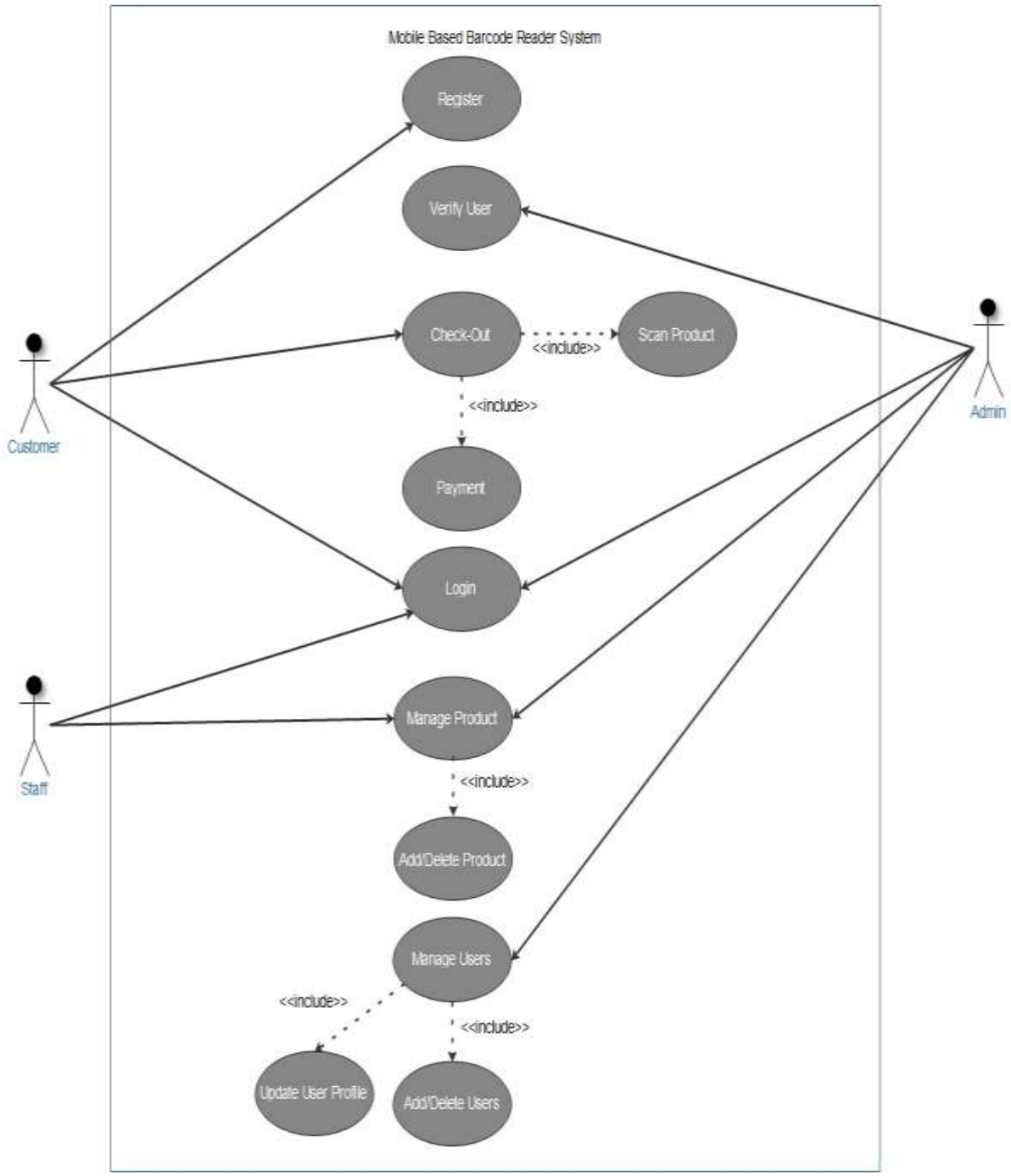

Figure 4.3 The Use Case Diagram

Use case Description

Below are the use case descriptions of the main features of the system as represented by Table 4.1, 4.2, 4.3, 4.4, 4.5 and 4.6. The major uses cases are explained in the tables.

Table 4. 1 Register Use Case Description

Use Case 1	Register
Use Case Description:	The user should register in order to use the application.
Primary Actors:	Customer
Precondition:	The user must have the application installed
Post condition:	The user can proceed to login
Typical case of Events **Actor Response** 1. Select Register button 3. User account details	 **System Response** 2. Displays the registration form 4. Save the registration information
Alternative flow Registration Information is not saved	

Table 4. 2 Check-out Use Case Description

Use Case 2	Check-out
Use Case Description:	The user scans items.
Primary Actors:	Customer
Precondition:	The user must have scanned items
Post condition:	The user must be able to perform payments.
Typical case of Events **Actor Response** 1. Select scan button 3. Select Payment Options	 **System Response** 2. Displays the barcode reader 4. Show payment details
Alternative flow Payment transaction fails	

Table 4. 3 Manage Users Use Case Description

Use Case 3	Manage Product
Use Case Description:	The supermarket staff deletes or updates products.
Primary Actors:	Staff
Precondition:	The user must be registered in the system
Post condition:	The Products are updated or deleted
Typical case of Events **Actor Response** 1. Update button 3. Delete button	 **System Response** 2. Displays the edit option 4. Confirms deletion
Alternative flow Product Update not successful	

Table 4. 4 Payment Use Case Description

Use Case 4	Payment
Use Case Description:	The system has different payment options
Primary Actors:	Customer
Precondition:	The user has scanned products
Post condition:	The user must be able to perform payments.
Typical case of Events **Actor Response** 1. Select payment options.	 **System Response** 2. Process payment
Alternative flow Payment not successful due to insufficient amount or technical error.	

Table 4. 5 Login Use Case Description

Use Case 5	Login
Use Case Description:	This use case describes the steps taken by the user to log in and out of the system
Primary Actors:	Customer , Administrator and Staff
Precondition:	The user must be registered to use the web application
Post condition:	The user gains access to the system.
Typical case of Events **Actor Response** 1. User enters username and password or logs out 3. User gains access to the system	**System Response** 2. System verifies login credentials and grants access to the mobile and web application or logs out the user
Alternative flow The user provides wrong username and password combination **a)** Access to the system is denied	

Table 4. 6 Manage Users Use Case Description

Use Case 6	Manage Users
Use Case Description:	The administrator deletes or updates user profiles.
Primary Actors:	System Administrator
Precondition:	The user must have administrator privileges
Post condition:	The user accounts are updated or deleted
Typical case of Events **Actor Response** 1. Update button 3. Delete Button	 **System Response** 2. Displays the edit option 4. Confirms deletion
Alternative flow User Account Update not successful	

4.4.5 Sequence Diagram

Figure 4.4 shows the sequence diagram which shows the flow of events and the interactions between the user and the objects and the messages that flow between them.

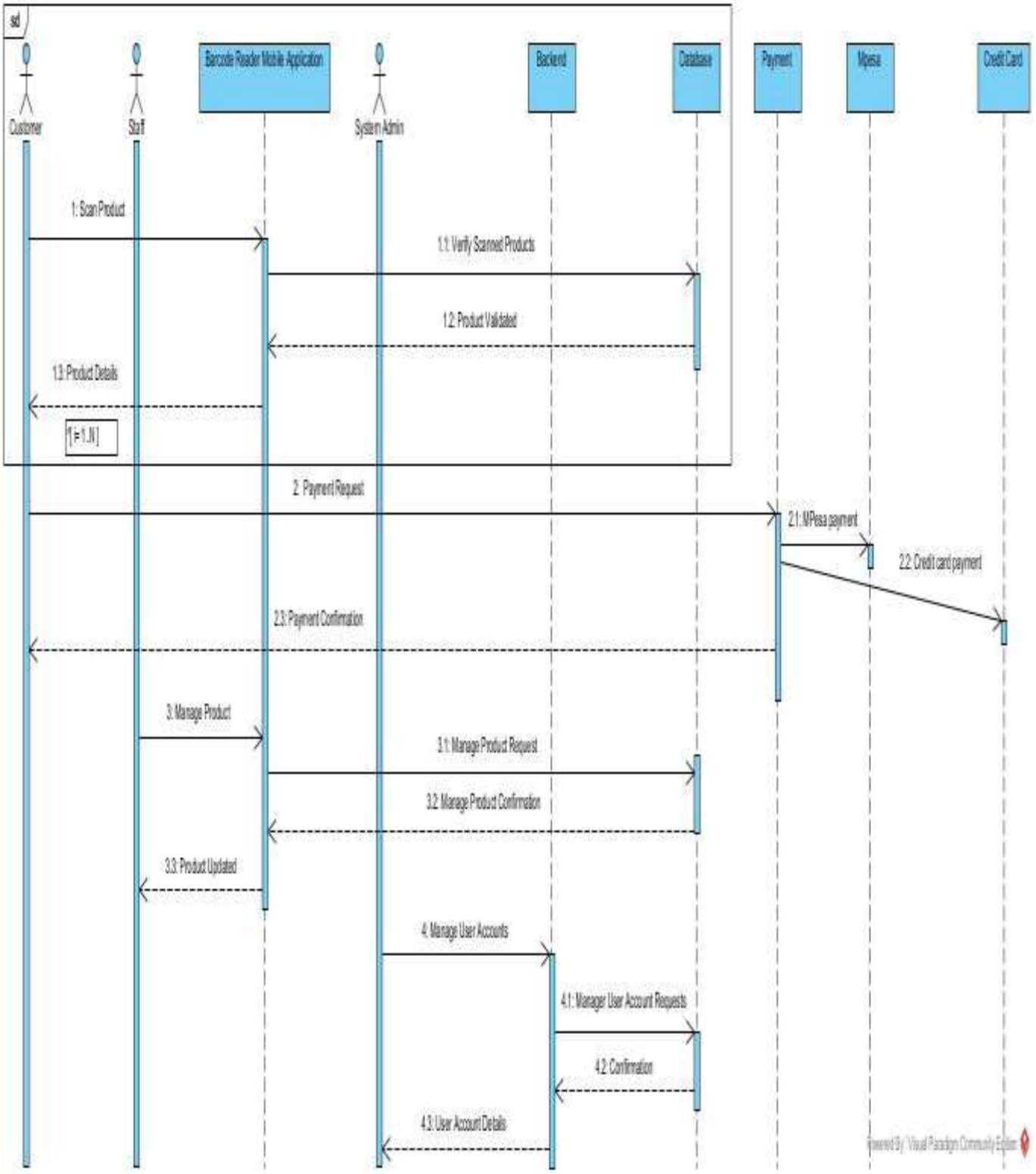

Figure 4. 4 The Sequence Diagram

4.4.6 Partial Domain Diagram

Figure 4.5 shows the partial domain diagram identifying relationships between entities of the application.

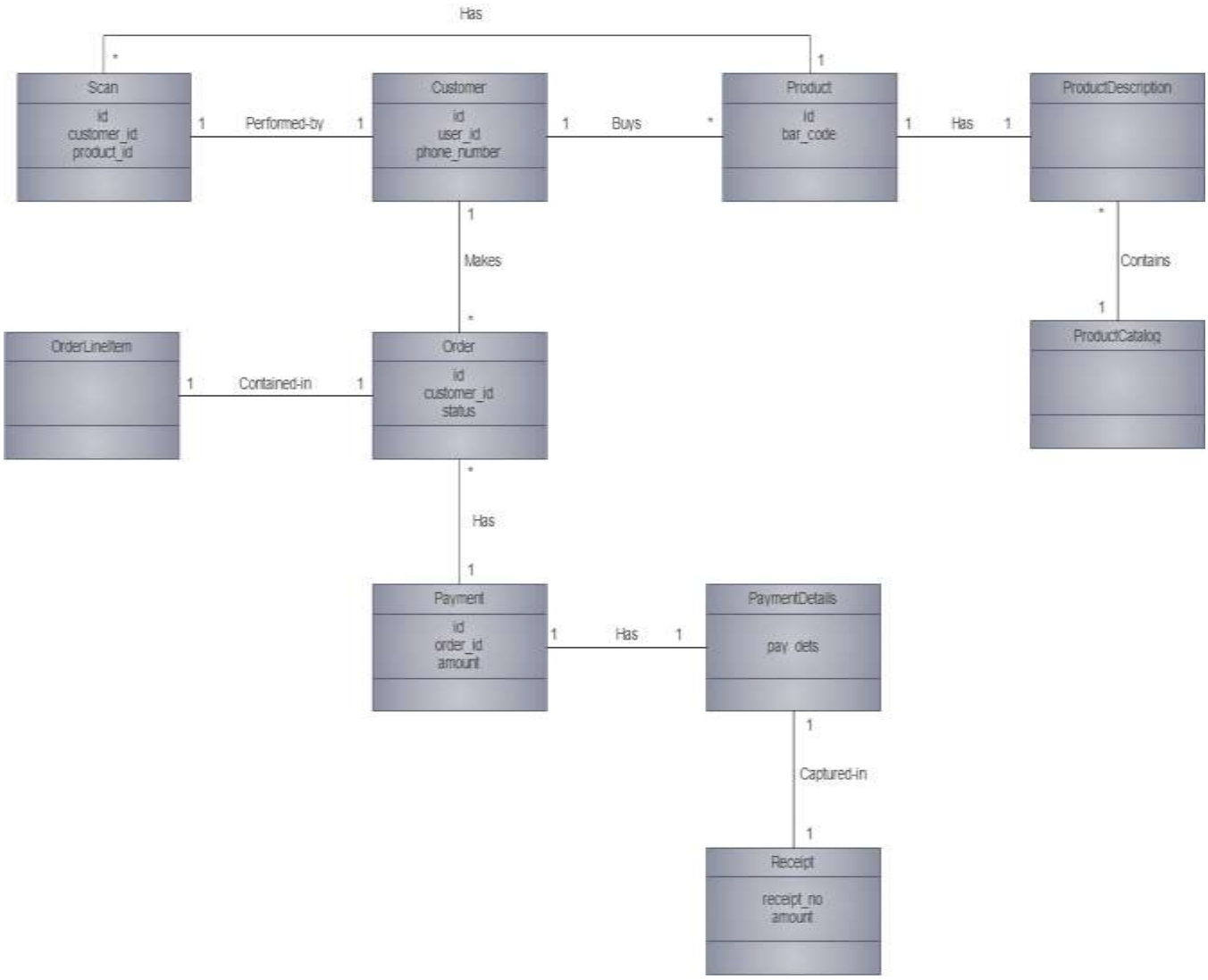

Figure 4. 5 Partial Domain Diagram

4.4.7 Entity Relationship Diagram

The entity relationship diagram below illustrates the structure of the database by demonstrating the tables and their relationships to one another.

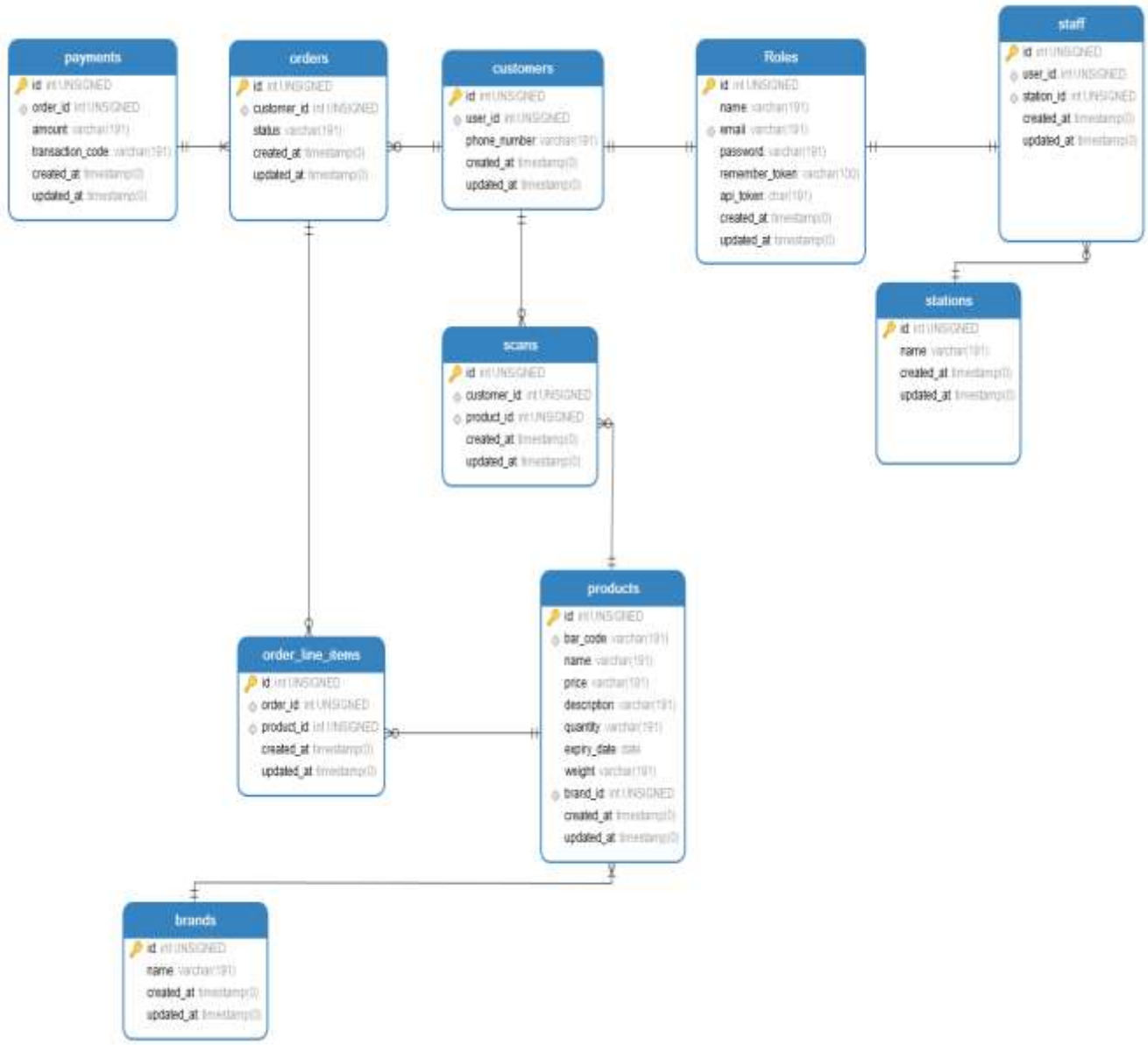

Figure 4. 6 Entity Relationship Diagram

The following is a detailed explanation of an Entity Relationship Diagram: An order has a many to one relationship with a customer because an order can belong to one customer but a given customer can have many orders. The relationship is optional because zero orders might belong to a given customer.

A payment has a one to many relationship with an order because a payment can list multiple orders but a given order can only be listed by one payment.

A customer has a one to many relationship with a scan because a customer can have many scans, but a given scan can be done by only one customer. The relationship is optional because zero customers might do a scan.

A scan has a many to one relationship with a product because a scan can be performed on one product but a given product can have many scans. The relationship is optional because zero scans might be performed on a product.

A product has a many to one relationship with a brand because a product can have one brand but a given brand can have many products. The relationship is mandatory because a product has to belong to a brand.

4.4.8 Database Tables

Table 4.5 shows the entities and the fields as well as their corresponding primary and foreign keys included in the database design.

i. Users Table

This table contains the general information of all the users of the system, these details are used during log in. Whenever a user enters their details the system checks against the details in the database and directs the user to a certain page.

Table 4. 7 Users Table

Attributes	Data Type	Index
id	Int(10)	id (Primary key)
name	Varchar(191)	
email	Varchar(191)	
password	Varchar(191)	

ii. Customer Table

This table contains the customer details, these details are used during log in. Whenever a customer enters their details the system checks against the details in the database if

the details match the user is logged in otherwise they are prompted to enter the correct details.

Table 4. 8 Customer Table

Attributes	Data Type	Index
id	Int(10)	id (Primary key)
user_id	Int(10)	user_id (Foreign key)
phone_number	Varchar(191)	

iii. Staff Table

This table contains the staff details, these details are used during log in. Whenever a staff enters their details the system checks against the details in the database if the details match the user is logged in otherwise they are prompted to enter the correct details.

Table 4. 9 Staff Table

Attributes	Data Type	Index
id	Int(10)	id (Primary key)
user_id	Int(10)	user_id (Foreign key)
station_id	Int(10)	station_id (Foreign key)

iv. Product Table

This table holds information about all the products available at the supermarket. Whenever a user scans these products, the barcode details are checked against the database to check whether the product exists.

Table 4. 10 Product Table

Attributes	Data Type	Index
id	int(10)	id (Primary key)
bar_code	int(10)	bar_code (Foreign key)
name	varchar(191)	brand_id (Foreign key)
price	varchar(191)	
description	varchar(191)	
quantity	varchar(191)	
expiry_date	date	
weight	varchar(191)	
brand_id	int(10)	

v. Order Table

This holds all the transactions done through the application by the customer. It keeps records of the customers' orders.

Table 4. 11 Order Table

Attributes	Data Type	Index
id	Int(10)	id (Primary key)
customer_id	Int(10)	customer_id(Foreign key)
status	Varchar(191)	

vi. Payment Table

This table holds the payment information of the orders done and the amount paid for a particular transaction.

Table 4. 12 Payment Table

Attributes	Data Type	Index
id	int(10)	id (Primary key)
order_id	int(10)	order_id(Foreign key)
amount	varchar(191)	
transaction_code	varchar(191)	

vii. Brand Table

This stable will store the brands of all the products in the supermarket. Every product has a brand therefore the supermarket groups the products according to brands.

Table 4. 13 Brand Table

Attributes	Data Type	Index
id	int(10)	id (Primary key)

viii. Station Table

The station table holds information on the various supermarket branches in order to group staff according to the stations available for the supermarket.

Table 4. 14 Station Table

Attributes	Data Type	Index
id name	int(10) varchar(191)	id (Primary key)

4.5 Wireframes

This section deals with the flow when the user interacts with the application. The wireframe diagrams can be found at Appendix C. The initial page that runs is a splash screen that will then be followed by a login page where the user will be required to login using an email address and password. On successful login, the home page will then display a barcode reader where the user can be able to scan items and add them to cart and then process the payment. The supermarket staff will also have access to an application where they will be able to upload products into the database by scanning the products. The staff application starts with a splash screen then directs the user to a login page, upon successful login they will be able to add or modify products into the database

4.5.1 Mobile Application Wireframes

Figure C.1 shows the first screen when the users starts the application. They are then taken to the home page where the user can select the options available. The homepage contains options whether the user would like to immediately start scanning and purchasing items or view the available sales and promotions available at the supermarket. After selecting the scan, the user will be taken to a screen where they can start scanning the items using a Barcode reader which uses the device's camera to perform the scanning as shown in Figure C.3. After which they can be able to make payments using mobile money as also shown in Figure C.3.

4.5.2 Web Application Wireframes

The landing page for the website backend shown on Figure C.5 will display the login page where administrators will login to access the dashboard. After successful login, the back end Dashboard will appear as shown by Figure 4.7. The administrator will be able to set-up assessments as of customer visits and actual purchases and be able to view reports and statistics. The administrators will be able to manage products and users as seen in Figure 4.10 and 4.8.

I. Dashboard Wireframe

This component contains system reports generated through transactions done through the mobile application. It shows the number of scans done that day this will be able to show the number of transactions done that day. This component also shows the number of active customers registered on the platform as well as the total amount of payments done.

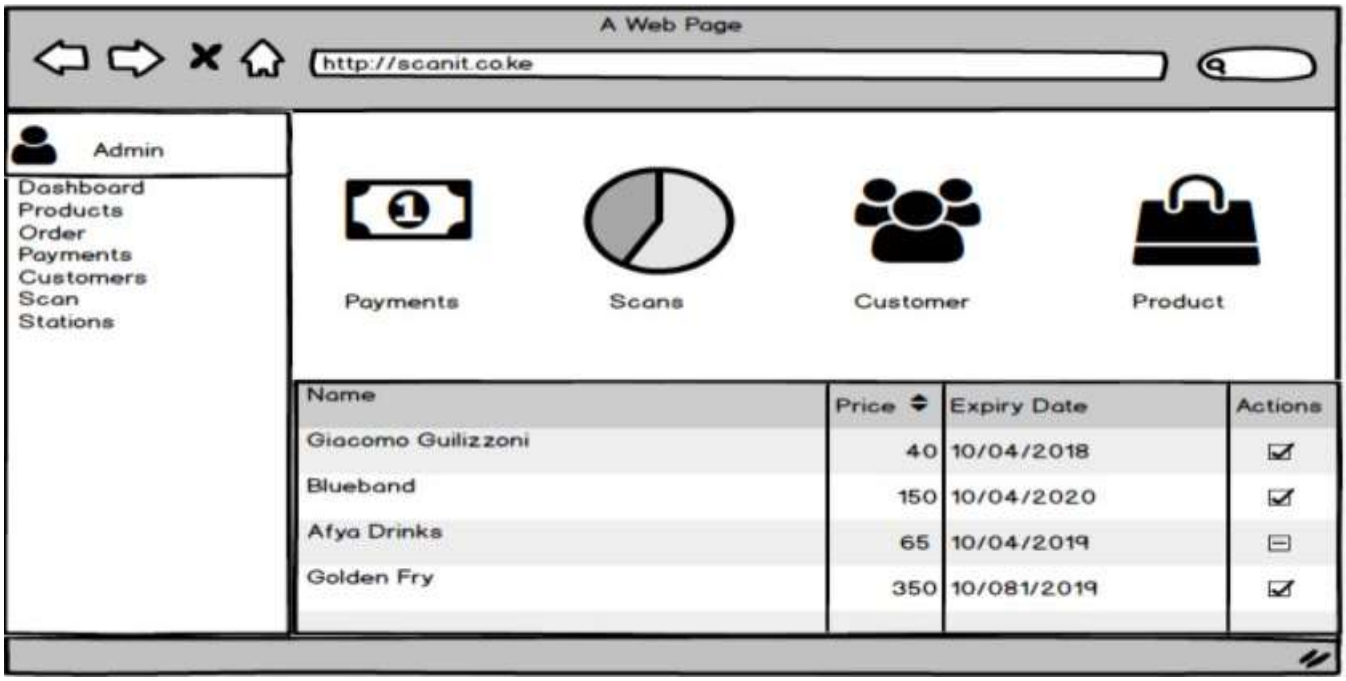

Figure 4. 7 Dashboard Wireframe

II. Manage Customers Wireframe

This component offers customer management roles. It allows an administrator to view registered customers activities, to edit user profiles, view and edit location names of geographic coordinates picked by registered users who have used the application and to finally manage user levels.

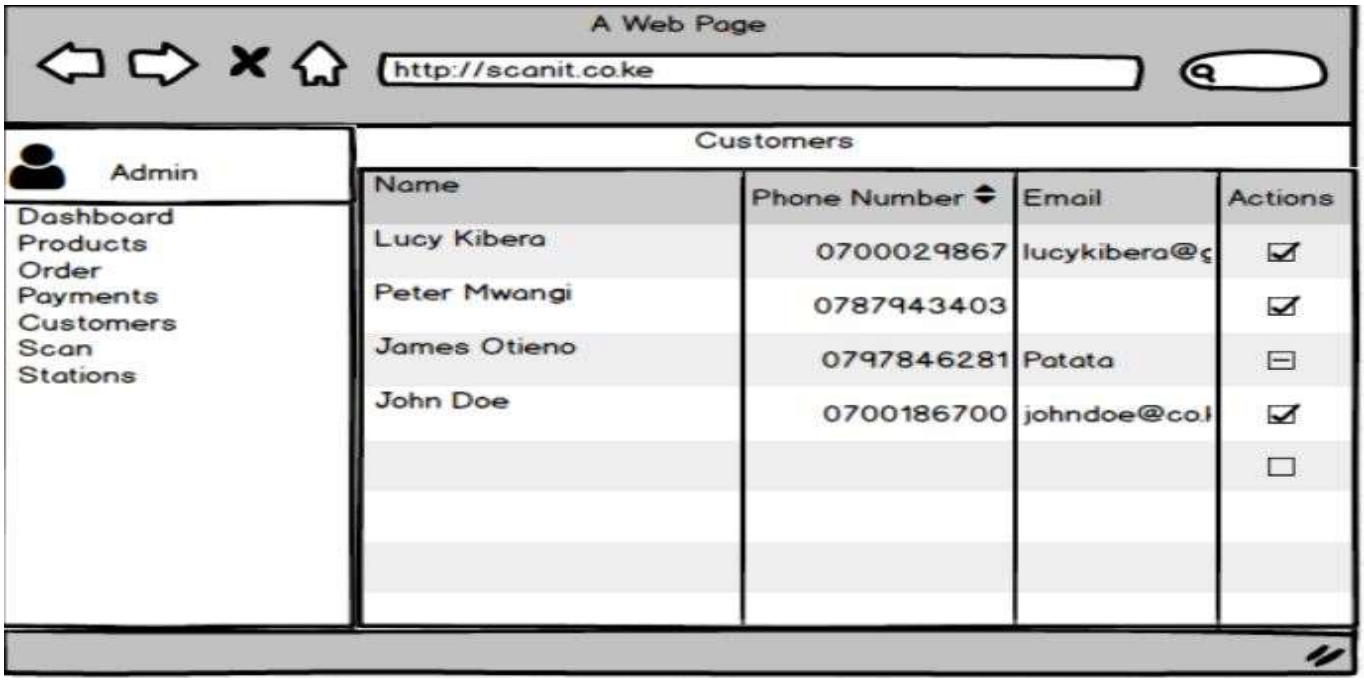

Figure 4. 8 Customer Management Wireframe

III. View Orders Wireframe

This component contains system reports generated through transactions done through the mobile application. It shows the number of scans done that day this will be able to show the number of transactions done that day.

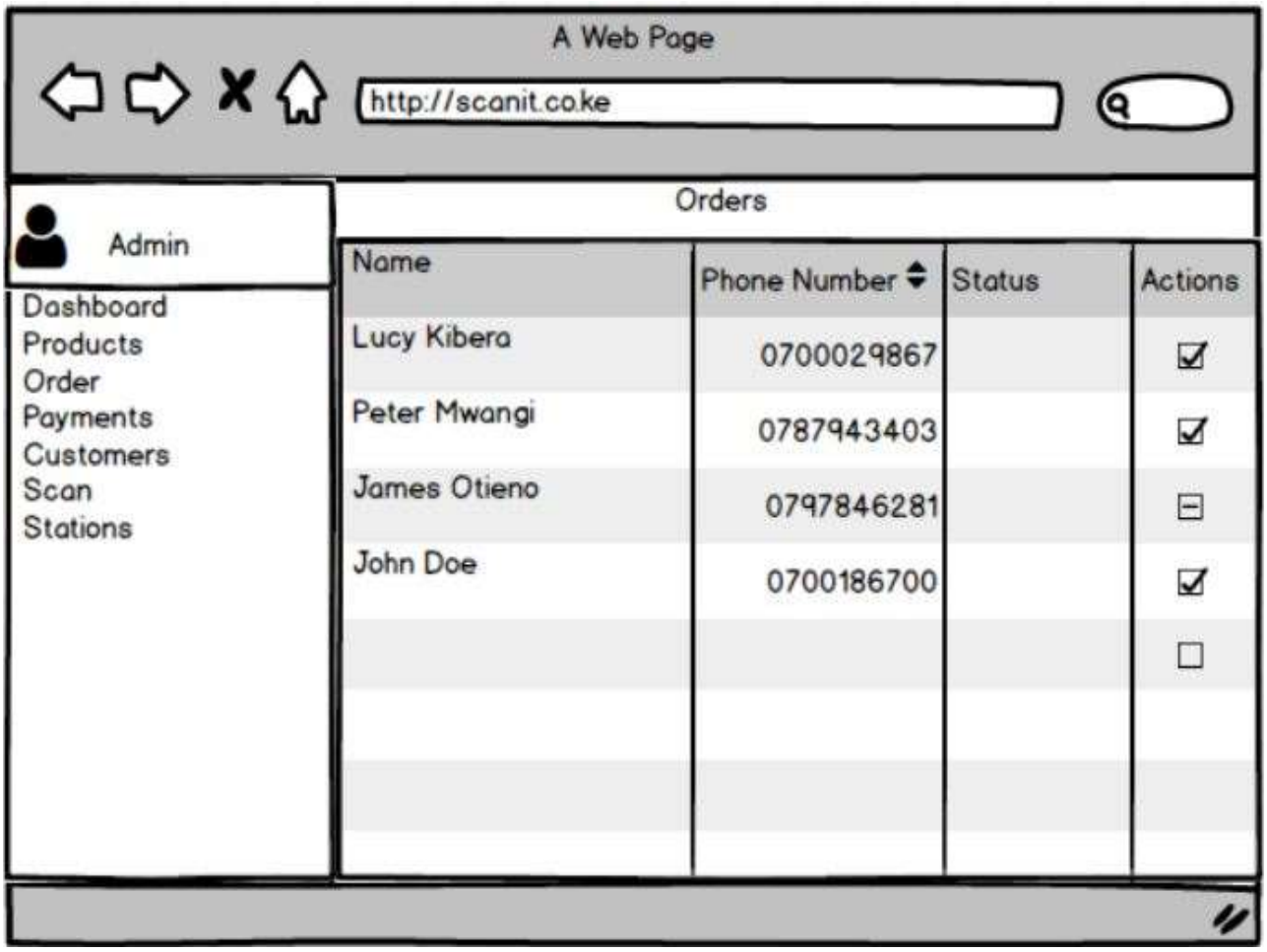

Figure 4. 9 View Orders Wireframes

IV. View Products Wireframe

This component offers product management roles. It allows an administrator to view supermarket products available on the shelf and editing the products details such as brand, description, price and quantity.

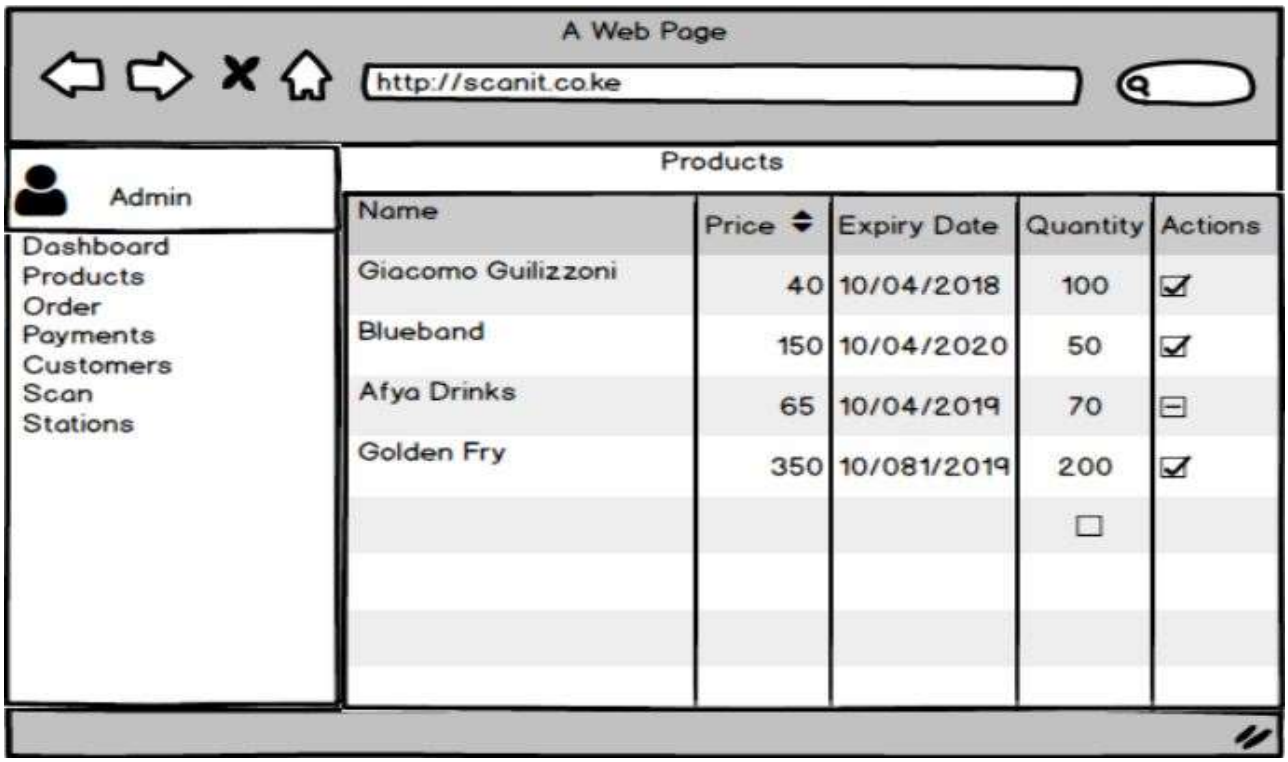

Figure 4. 10 Manage Product Wireframe

4.6 Summary

System analysis and design models aided in understanding system requirements. UML diagrams was used to help in understanding the system better. These included the use case diagram which was used to show system requirements, sequence diagram used to illustrate the system processes and how the user interacts with it, partial domain diagram used to identify relationship between entities and context diagram which shows how external entities interact with the system.

Chapter 5: System Implementation and Testing

5.1 Introduction

This chapter consists of the implementation of the proposed system. The system requirements were discussed in the previous chapter. The implementation environment for the mobile, web application and the database will be described in this section in an attempt to give a clear understanding of how the prototype works.

5.2 Implementation Environment

5.2.1 Mobile Application

The *Scan It* mobile application allowed customers to scan, view and purchase items at the supermarket, login and manage their profile. There is a merchant application that the staff will use to scan products and add new products to the supermarket database.

After downloading and installing the application the customer and staff were taken through a splash screen introducing the application for only the first time using the application. After the splash the login page loaded, Figure D.1 from where they were able to view the home page. The homepage contained options whether the customer would like to immediately start scanning and purchasing items or view the available sales and promotions available at the supermarket while for the staff, there was a page where the staff could scan items and enter products or edit the products in the database. The customers were able to make payments either using their M-Pesa or Master card.

5.2.2 Web Application

The landing page for the website backend shown on Figure D.3 displayed the login page where administrators login to access the dashboard. After successful login, the back end dashboard appears as shown by Figure 5.1. The administrator was able to set-up assessments as of customer activities and actual purchases and were able to view reports and statistics. The administrators were able to manage products, customer orders and customers as seen in Figure 5.3, D.6, and 5.2.

5.3 Implementation Details

5.3.1 Mobile Application

The prototype was designed to run on devices with an Android Operating system with a minimum version of 4.4 (KitKat) and a maximum version of 6.0 (Marshmallow). The device running the application required active Internet connection and a working Camera to enable

the scanning to take place. Full functionality of the application required interaction with a Barcode reader and an application that managed data manipulation and interaction with a backend server. Barcodes attached to supermarket items are captured by the mobile phone camera. A Barcode reader application is used to analyse and generate a Barcode number stored in the items Barcode. The Barcode number then used as the unique identifier of the supermarket item.

User experience was enhanced by providing functionalities in a simple but sleek manner. Also flow of the process was presented in a logical and easy way providing relevant data constraints in textboxes.

System Components

Some of the core components of the system are:

Login Page

To gain access to the application, users had to login or signup using their email addresses. The system validated the accounts to check whether the user account details existed and proceeded to take the user to the home page. This was to provide security and provide unauthorized access.

Home Page

The home page was different according to the type of user. For the staff, the homepage contained the main system component such as scanning where the staff could scan products using a barcode reader and upload the products into the supermarket database while the customer's homepage had a list of options the customer could choose from including the barcode scanning option. The barcode reader would then display the product's information and the customer could then proceed to check out by selecting the form of mobile payments available.

Figure 5. 1 Home Page

5.3.2 Web Application

The web application's main function was to retrieve and receive information sent by the developed mobile phone application to the database. This application resides in the HTTP web server and is directly linked to the supermarket database. The web application was designed for use by administration to manage users, generate and view reports. The reports generated included: a report to view the number of registered users using the application; Scan location of registered users using the application; Number of scans performed by each registered user; Total number of scans performed by all registered users and the total number of items purchased using the mobile application.

System Components

Dashboard

This component contains system reports generated through transactions done through the mobile application. It shows the number of scans done that day this will be able to show the number of transactions done that day. This component also shows the number of active customers registered on the platform as well as the total amount of payments done.

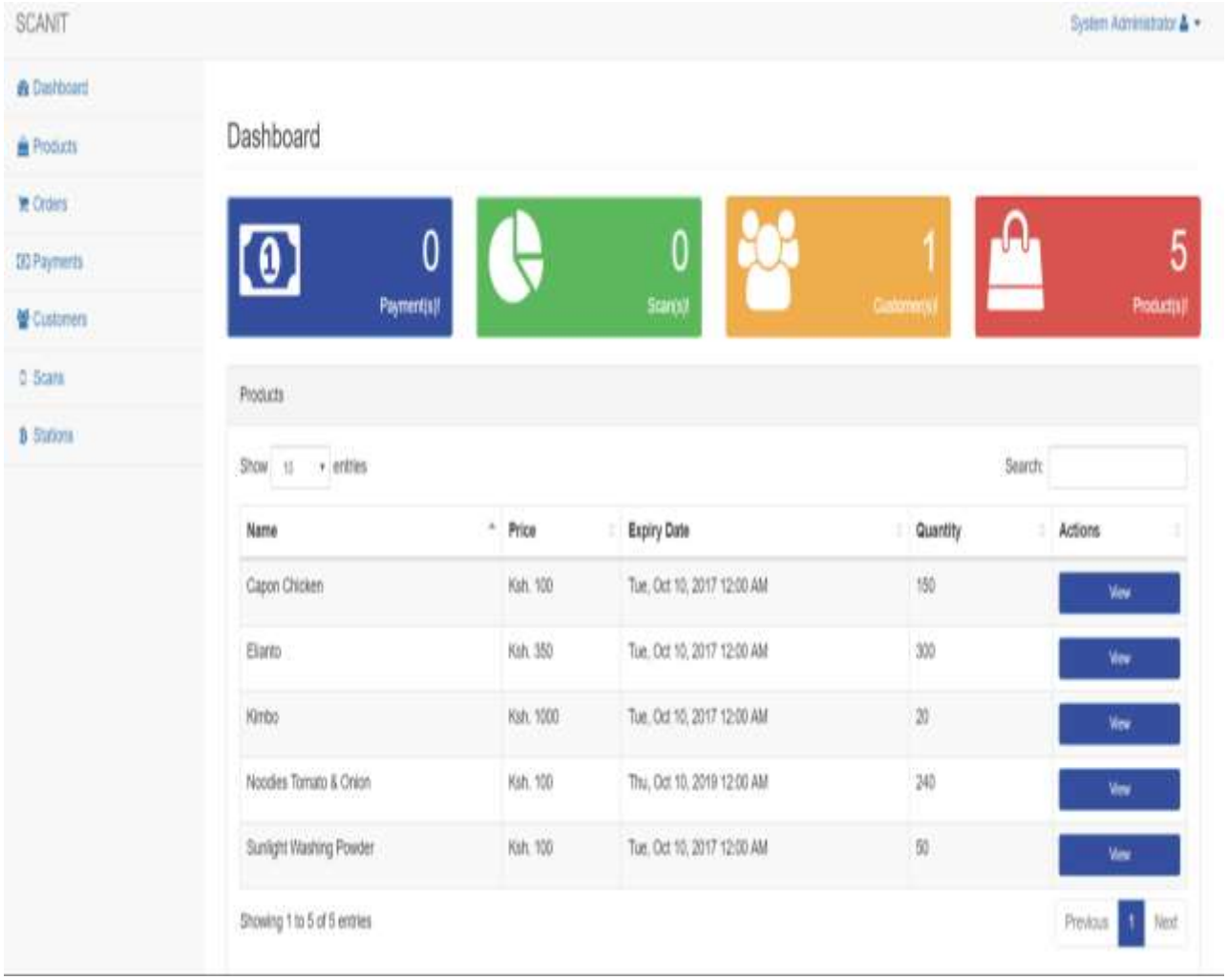

Figure 5. 2 Dashboard

Customer Management

This component offers customer management roles. It allows an administrator to view registered customers activities, to edit user profiles, view and edit location names of geographic coordinates picked by registered users who have used the application and to finally manage user levels.

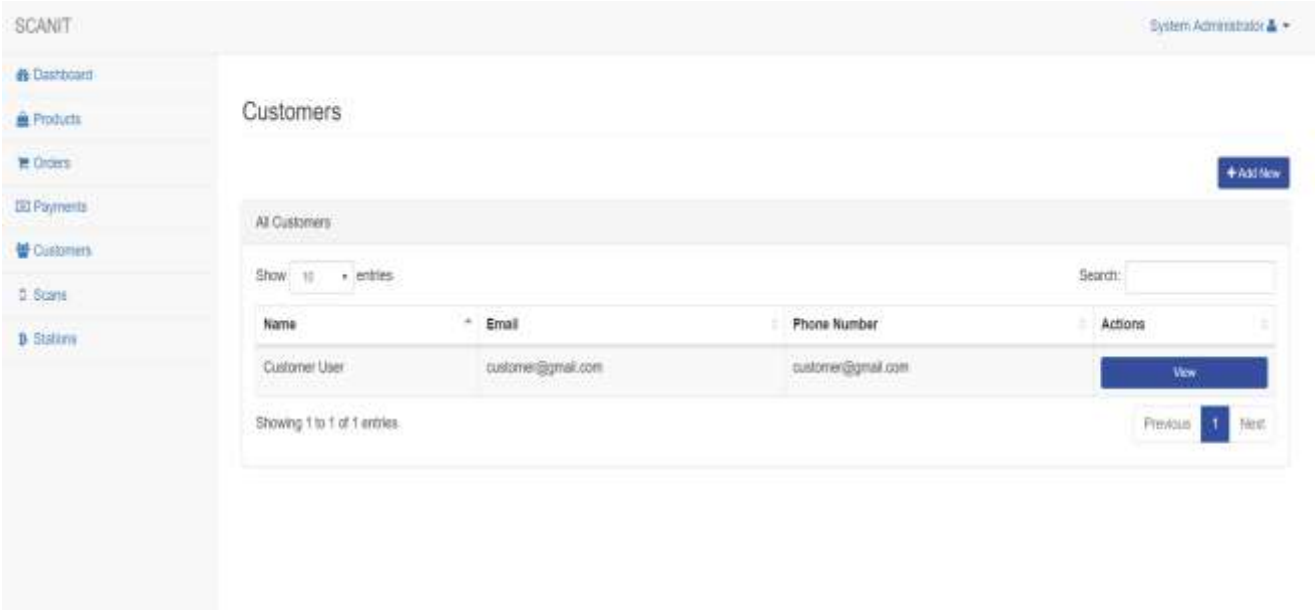

Figure 5. 3 Customers

Product Management

This component offers product management roles. It allows an administrator to view supermarket products available on the shelf and editing the products details such as brand, description, price and quantity.

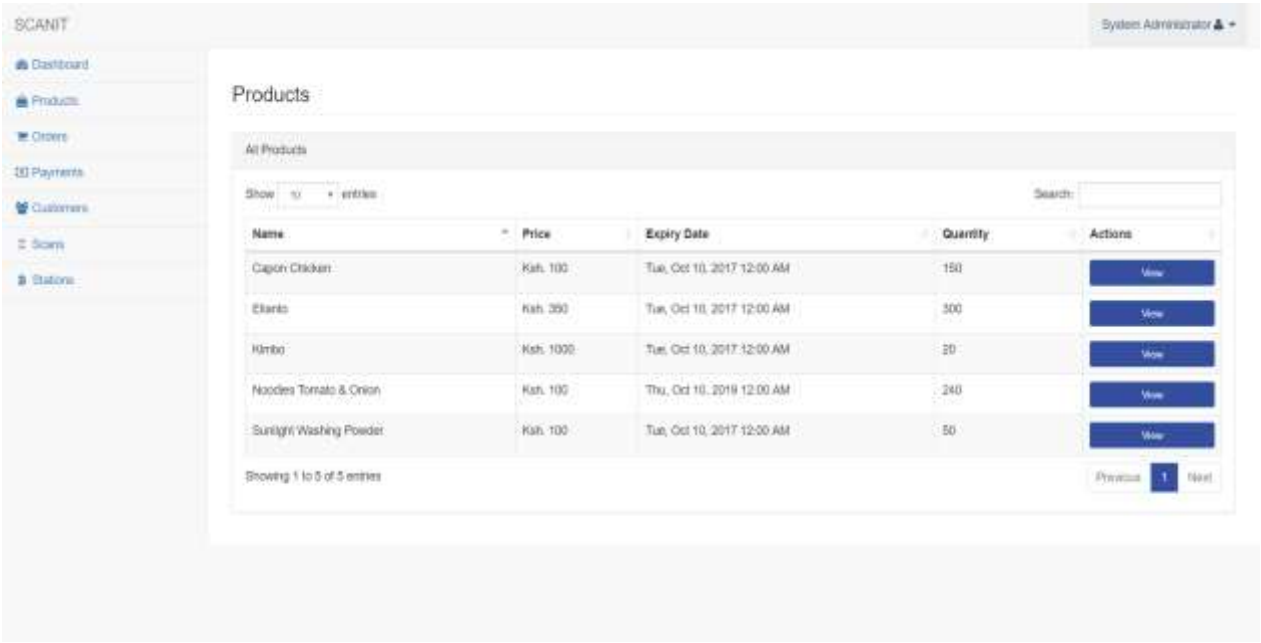

Figure 5. 4 Products

5.4 System Testing

5.4.1 Introduction

This section describes tests performed on the mobile and web application. Tests were done against Functional and Non-functional requirements of the application.

5.4.2 Usability Testing

This was used to determine whether the application was user friendly. It was used to gauge whether a new user can understand the application before interacting with it on a deeper level. The major things checked were the system flow from one page to another and whether the icons were easy to understand.

5.4.3 Functional Testing

Functional tests were done based on use cases to determine success or failure of the system implementation and design. For each use case testing measures were set with results being considered successful or unsuccessful. Tables 5.1, 5.2, 5.3, 5.4 and 5.5 show the major use cases and their test results.

Table 5. 1 Register Test Case

Identifier	1
Test Case	Register
Description	Users perform login with their Gmail account
Utilized use case	Login and Logout
Results	Successful login and access granted
Pass/Fail	Pass

Table 5. 2 Check-Out Test Case

Identifier	2
Test Case	Check-Out
Description	Users scan the items and purchase
Utilized use case	Check-Out
Results	Successful check-out
Pass/Fail	Pass

Table 5. 3 Manage Item Case

Identifier	3
Test Case	Manage Item
Description	Administrator is able to edit and add items that are on the supermarket shelves
Utilized use case	Manage Item
Results	Successful edit and addition
Pass/Fail	Pass

Table 5. 4 Payment Test Case

Identifier	4
Test Case	Payment
Description	User performs the actual purchase
Utilized use case	Payment
Results	Successful payment and receipt issued
Pass/Fail	Pass

Table 5. 5 Manage Users Test Case

Identifier	5
Test Case	Manage Users
Description	Administrator is able to update user profiles
Utilized use case	Manage Users
Results	Accounts are updated, deactivated or activated
Pass/Fail	Pass

5.4.4 Compatibility Testing

Compatibility was done to ensure that the mobile and web applications were compatible with the available platforms. The mobile application was tested against the predefined available Android platforms while the web based application was tested against available web browsers.

Android Platform Compatibility Testing

Table 5. 6 Android Compatibility Test

Android Platform	Compatibility
Android Version 6.0	Yes
Android Version 5.1.1	Yes
Android Version 4.4.4	Yes

Web Browser Testing

Table 5. 7 Browser Compatibility Test

Browser	Compatibility
Google Chrome	Yes
Internet Explorer	Yes
Mozilla Firefox	Yes

5.5 User Testing

The end users of the application were directly involved in user testing. User testing was done to achieve the following: user friendliness, aesthetics, functionality and acceptance.

5.5.1 User Friendliness

The simplicity of learning and usage of the application was tested by potential users. The results were as follows; 82% of the potential users specified that the application was easy to learn and use. Figure 5.5 shows a summary of the results.

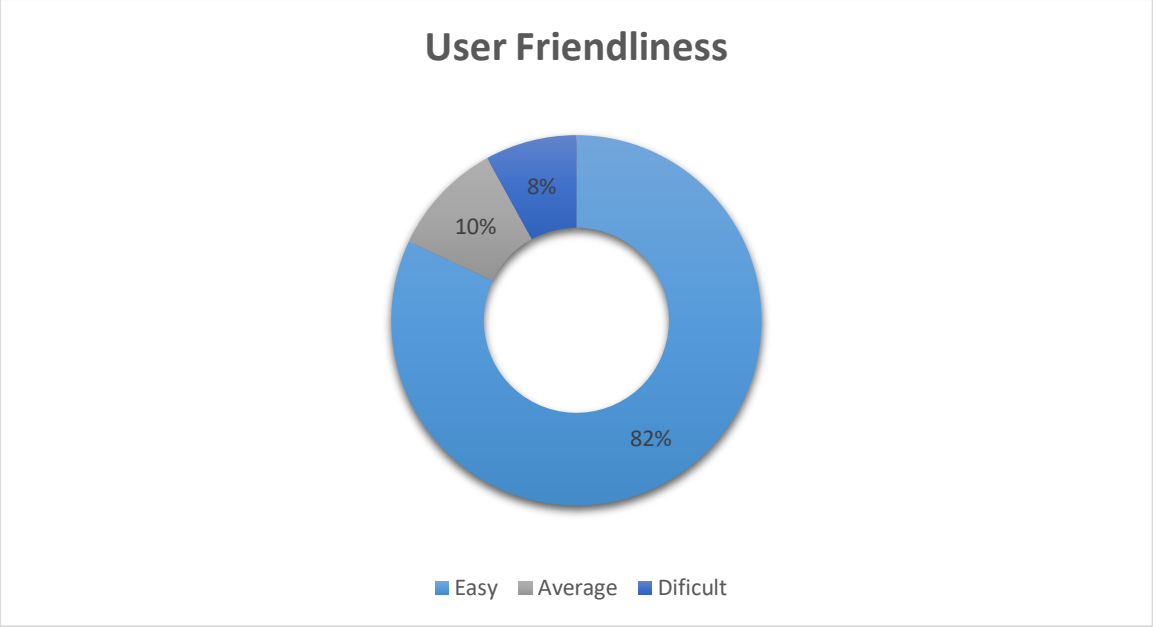

Figure 5. 5 User Friendliness

5.5.2 Acceptability

User acceptance was established to measure if the application was a great success. 80% of the potential users appreciatively accepted the application for use at the supermarket. About 10% were unconvinced about the application which meant that there were some features about it that they would have preferred to be different. This test was a great success as many users acknowledged the application. Figure 5.6 provides a summary of these results.

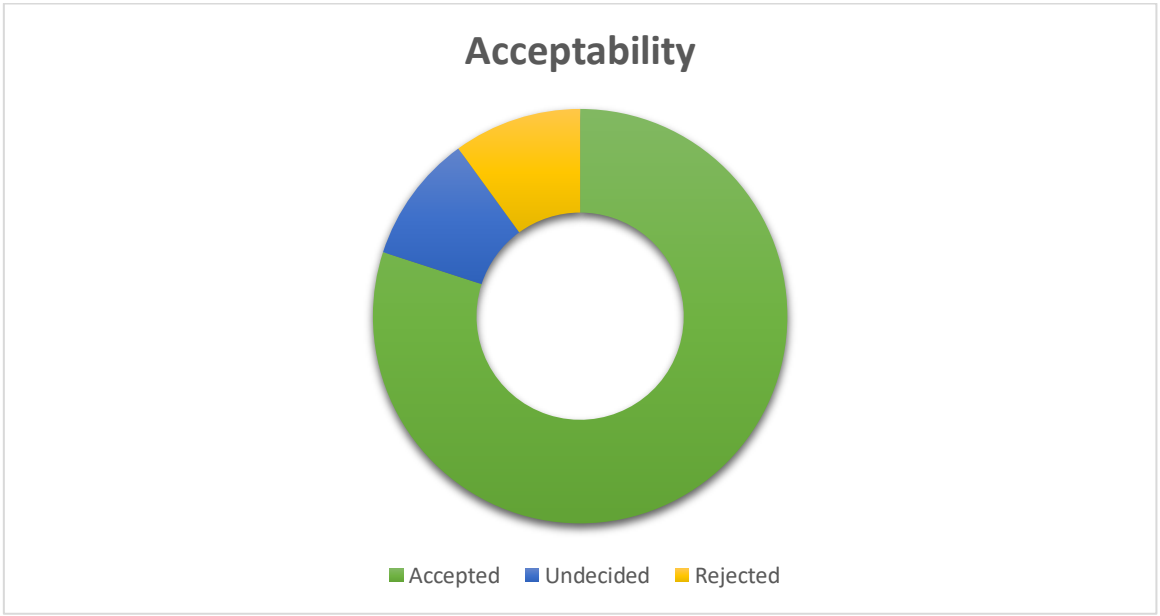

Figure 5. 6 Acceptability

5.5.3 Functionality

Prospective users of the application tested the system functionality against the user specifications. About 75% of them stated that they were very content with the application's functionality signifying that the developer achieved most of the user functionality and requirements specification, 25% specified that they were satisfied with the application's functionality meaning that some of the user specifications were not totally meet. This result was used to polish the system until an acceptable application was developed. A summary of the results is shown in Figure 5.7.

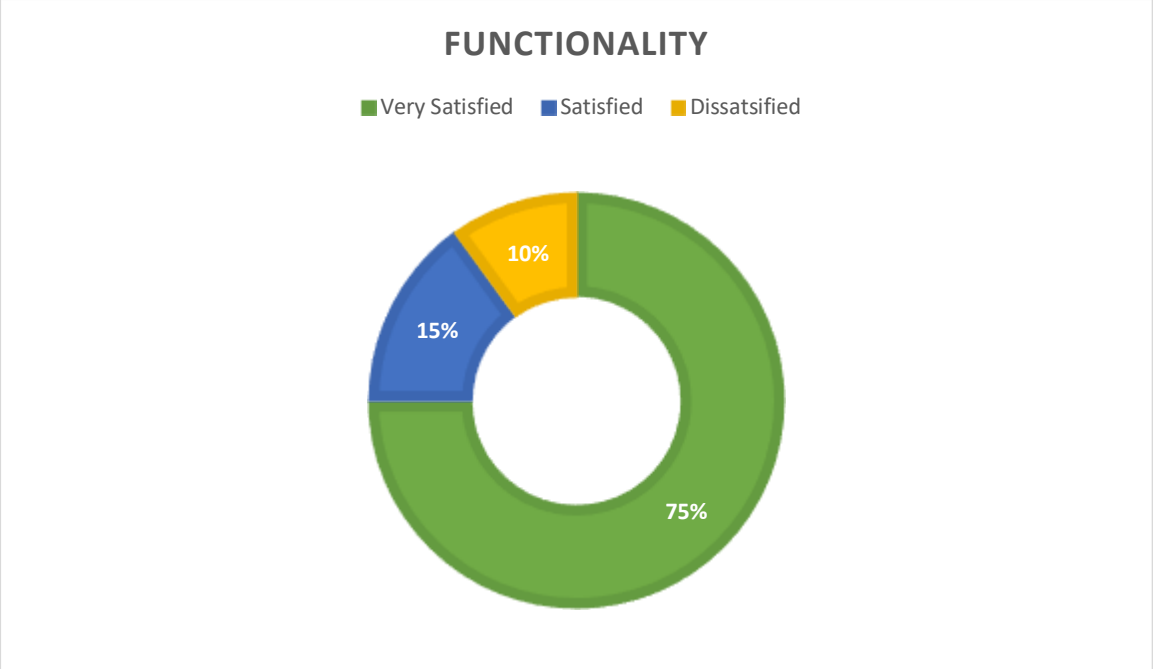

Figure 5. 7 Functionality

5.6 System Evaluation and Testing

This was done in order to determine whether the Barcode reader system solves the problem of improving customer shopping experience. Figure 5.8 shows what users thought of its performance and if the system solved the problem. The figure below shows that the majority of users were very pleased that the implementation addressed the raised subjects and that the application actually improved shopping experience.

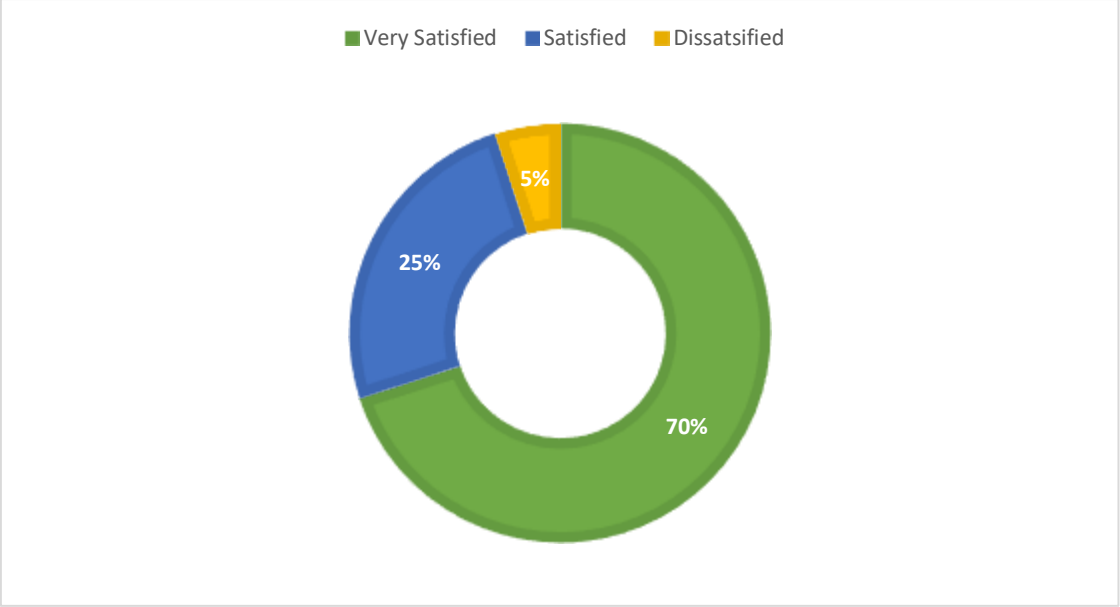

Figure 5. 8 System Evaluation

5.7 System Requirements

Prospective users of the application filled out the system requirements questionnaire and about 85% of them owned Android smartphones and about 10% of them stated that they owned iOS phones. 50% of them stated that they frequently used M-Pesa for day to day payments while 40% specified that they used Cash for payments and the other 10% used their credit cards. A summary of the results is shown in Figure 5.9

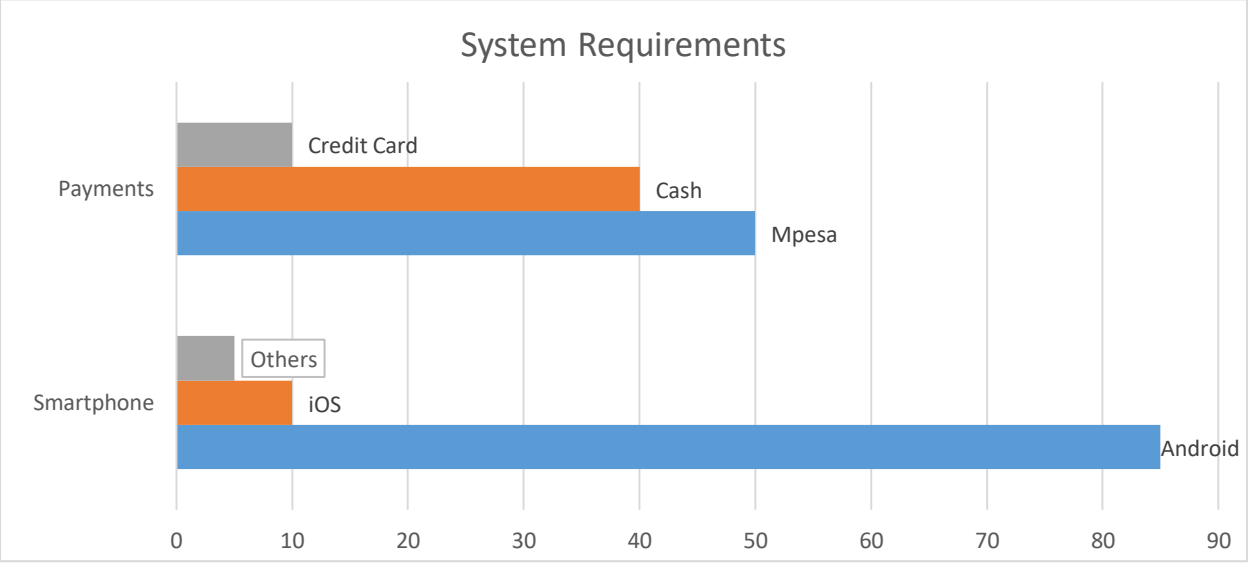

Figure 5. 9 System Requirements

5.8 Summary

The system requirement conveyed in the requirements stage provided beneficial understanding of what functionalities the users preferred to have in the application. This resulted to development of the application that met the objectives and the user requirements .The objectives were met with the implementation of the application. This was made possible by the implementation of the agile methodology, as it enabled continuous flow of information that helped in coming up with a good design for the application.

Chapter 6: Discussions

6.1 Introduction

This research was done with the aim of examining how customer shopping experience can be improved at the supermarkets, tools and methods being used in order to enable self-check-outs and improve customer shopping experience. The research finding assisted to recognise whether there was a need for barcode reader system, the sought level of acceptance and the desirable features in such a system in order to develop a system that resolved these challenges. This chapter will discuss all the findings in this dissertation and analyse the findings in relation to the research objectives.

6.2 Findings and Achievements

Kenya has no systematic method of self-check-out systems. The literature review pointed out some of the techniques that have been used internationally and locally to help solve this challenge. The techniques include the use of technologies such as RFID, SMS and Barcodes. RFID application is a reliable technology in identifying and tracking items in retail stores having enormous supply chain management systems. Considering the region of research, it would be too expensive a venture to follow. The supermarket items are already equipped with RFID chips making it easier for the research to be conducted.

A review of the literature indicated that the techniques used for purchasing items at the supermarket, the things that influence shopping behaviour and the models that aid in understanding how users accept technologies. Automation of this process especially by use of a mobile based system comes with the benefit of providing the service to large number of people at a go any time they request for the service. With many individuals owning one or more mobile devices it makes it easier for them to use their mobile devices to use this service without having to rely on supermarket staff to do the scanning and check-outs.

The use of Barcodes have been there for a while now. They are now combined with other emerging technologies to advertise and collect other information such as market behaviour towards certain products in the market. With the availability of data enabled mobile devices cheaply to the public, the use of Barcodes will be the preferred technology for automatic identification and data capture. The technology proves to be simple, universal and affordable to use and implement.

The research was carried in a local supermarket in Nairobi County. The target population for this study were consumers who shopped at a local supermarket, EastMart supermarket located in the Nairobi CBD. A total of 25 respondents were interviewed daily for a span of 7 days. The total number of respondents interviewed were 175 individuals. The local supermarket was selected because of strong presence within the area of research.
The findings indicated that majority of shoppers were aged 25-35 years. A high number of respondents with data enabled mobile devices were found to own devices that run on the Android Operating system. Lastly, majority of the shoppers were people with educational level above form four level.

The findings collected from the research led to the development of a mobile based solution used to purchase supermarket products by scanning the Barcodes attached to them. The technology comprised of a mobile and web based application. The mobile application was strategically developed for use by the general public who had access to a data enabled phone with a camera and running an android operating system.
The web application was developed for management by administrators and could be accessed using a standalone computer, laptop or mobile device. Cumulative research findings specified that a majority of the users found the application beneficial for its intended purpose. From the usability testing 82% of the respondents indicated that the application was user friendly in that it was easy to learn and use. 75% of the respondents indicated that the applications functionality was praiseworthy. Finally 88% of the respondents found the application useful and acceptable.

6.3 Assessment of the Research Objectives

This dissertation identifies the challenges faced by customers due to a slow check-out system. A mobile and web application was designed and developed with a selected technique from the literature review and results from system analysis. The research objectives acted as a guideline to develop a mobile and web application. The first objective was to do a market research on slow check out systems and on customer shopping behaviour and preferences. This objective was achieved through study of literature and questionnaires in Appendix A.

Analysis of the respondent feedback yield the following challenges: long check-out queues and time wasting. The second objective was to determine the existing technologies that assist in shopping in retail supermarkets. This objective was achieved through study of literature and

questionnaires in Appendix A. Some of the existing technologies found were Barcodes and QR-Codes.

The third objective was to design and develop a mobile application that can enable customers scan and items and purchase. This objective was achieved through the design, development, implementation and testing of the mobile and web application. The mobile application was developed for the Android platform while the web application was developed using Laravel framework. Functional testing where the system functionality was tested, compatibility testing where the mobile application was tested against different Android versions and the web application was tested against different web browsers and finally user testing where the aesthetics, user friendliness, application functionality and user acceptance were tested.

The fourth objective was validate the efficiency and effectiveness of the developed mobile application. This was to validate if the developed system addresses the challenges faced in supermarkets. This objective was addressed by a comprehensive literature review in the study of existing technologies that help improve and automate shopping experience. It was seconded by questionnaires feedback where respondents found the features in the application helpful in offering an efficient way to improve shopping experience.

6.4Advantages of the Proposed Mobile Application

The advantages of the proposed solution are : the application is very easy to use and straight forward, the application can easily be adopted by users of all levels of education and technological backgrounds, the application simplifies the process of check-out by providing mobile payments like MPesa, this application is affordable, it makes it possible for anyone to use it at no cost provided they have internet and finally the application also incorporates a web application that makes it easier for the administrator and the professionals to store and manipulate data seen in the mobile application.

6.5 Limitations of the Proposed Mobile Application

The limitations of the proposed solution are: the mobile application is only usable by smartphone owners with Android operating system and another limitation is that some information on mobile application and the entire web application need Internet for one to access them.

Chapter 7: Conclusions, Recommendations and Future Work

7.1 Conclusions

The main goal of the dissertation was to develop a mobile application that helped improve customers shopping experience by having the shoppers scan products using a Barcode scanner reader application. The opportunity that exists in Kenya concerning Barcode reader applications are not well tapped especially with the increase in adoption of smartphone devices with the Android Operating System. Thus the mobile application comes into play by providing a solution that enables supermarket customers to scan the supermarket items and make an actual purchase.

The application was aimed at coming up with a solution that would ensure that customers do not encounter slow check-out queues. System testing was performed, look and feel, ease of use, system functionality and acceptance was done.

7.2 Recommendations

The developed system is very important for supermarkets that would like to improve customer shopping experience. However, the researcher noted that more can still be done to improve on this and gave the following recommendations.

i. Have the application implement anti-theft mechanisms to prevent theft in self-check-out systems and implement and allow for credit card payments.
ii. Expand the scope of the application by also offering users with the option of ordering the items wherever they are and have them delivered to their homes.

7.3 Future Work

The solutions provided in this research can still be enhanced or added upon as there is room for enhancement. This is achievable because, research is ongoing and technology is unceasingly cultivating the way things self-check-out systems are done and more technological advancements are embraced that could further this research. The system will implement anti-theft mechanisms to ensure that the system is secure and stable. The mobile application will also be developed for other mobile platforms to allow users who do not have Android to access the mobile application's functionality and the application should also ensure full security so that there should be no cases of theft at the supermarkets or customers carrying extra items that have not been paid for.

References

Abrahmsson, P., Salo, O., & Warsta, J. (2002). Agile Development Software Methods: REview and Analytics. *VTT Electronics*.

Adelmann, R. (2010). Evaluation of 1D barcode scanning on mobile phones. *Internet of Things 2010 Conference (IoT2010).* Retrieved April 25, 2017

Andrews, C. (2009). Do-It-Yourself': Self-Checkouts,Supermarkets, And The Selfservice Trend In American Business. Retrieved May 29, 2018, from https://drum.lib.umd.edu/bitstream/handle/1903/9593/Andrews_umd_0117E_10632.pdf?sequence=1&isAllowed=y

Anic, I. D., Radas, S., & Miller, J. C. (2011). Antecedents of consumers' time perceptions in a hypermarket retailer. *Service Industries Journal*, 809-828. Retrieved January 13, 2017, from http://www.tandfonline.com/doi/abs/10.1080/02642060903067530

Arvidson, E. (2011). The Internet's Influence on Retail. *Chron*. Retrieved from http://smallbusiness.chron.com/internets-influence-retail-26824.html

Babin, & Griffin. (1994). Journal of Consumer Research. *Work and/or fun: Measuring hedonic and utilitarian shopping value, 20,* 644-656. Retrieved December 20, 2016

Baker, J., & Cameron, M. (1996). The effects of the service environment on consumer perception of waiting time : An integrative review and research propositions. *Journal of the Academy of marketing science*, 338-349. Retrieved January 13, 2017, from https://www.researchgate.net/publication/225439812_The_Effects_of_the_Service_Environment_on_Affect_and_Consumer_Perception_of_Waiting_Time_An_Integrative_Review_and_Research_Propositions

Bakos, J. Y. (1997). Reducing buyer search costs: Implications for electronic marketplaces. *43*, 1679-1692.

Balasubramanian, S., & Peterson, R. A. (2002). Exploring the implications of mcommerce for markets and marketing. *Academy of Marketing Science Journal, 30,* 348-361.

Barclays. (2015). Retrieved December 11, 2016

Benedict, J., & Pacana, D. (2016). A Barcode Scanner Application Framework Using Android Phones for an Enhanced Shopping Experience. *International Journal of Applied Engineering Research* . Retrieved April 25, 2017, from https://www.ripublication.com/ijaer16/ijaerv11n23_22.pdf

Bhardwaj, N., & Kumar, R. (2016). Decoding Algorithm for color QR code:A Mobile Scanner Application. *Fifth International Conference on Recent Trends in Information Technology*. Retrieved April 25, 2017, from ieeexplore.ieee.org/iel7/7563753/7569511/07569561.pdf

Bickers, J. (2009). Self-Checkout. Retrieved May 29, 2018, from https://www.panoston.com/wp-content/uploads/2017/05/PanOston_G_Self_Checkout_To_Launch04-05-14-11-11-56.pdf

Black, A. (2009). Pocket BargainFinder: A Handheld Device for Augmented Commerce. Retrieved April 25, 2017, from https://pdfs.semanticscholar.org/0e00/7015cac6831a767960602ecec7d12c919d67.pdf

Boem, B., & Turner, R. (2003). Balancing Agility and Discipline. *A guide for the perplexed*.

Brynjolfsson, & Smith. (2000). Frictionless Commerce? A Comparison of Internet and Conventional Retailers. *Management Science, 46*, 563-585.

Chan, W. (2012). Project Voyager: Building an Internet Presence for People, Places, and Things. Retrieved April 25, 2017

Chaure, B., & Jain, P. (2016). Development of E-Shopping Cart with Theft Control Mechanism: No Queue. *International Conference on Emerging Technological Trends*. Retrieved April 9, 2018

Chen, L., & Gillenson, M. L. (2002). Enticing online consumers : An extended technology acceptance perspective. *Information and Management, 39*, 705-719. Retrieved December 20, 2016

Chun, H., Lee, H., & Kim, D. (n.d.). The intergrated model of smart phone adoption. *Hedonic and utilitarian value perceptions of smart phones*. Retrieved December 21, 2016

Costa, R. (2016). Who, Where, What, When, Why and How to use Scrum - A simple guide. *Linkedn*. Retrieved February 26, 2017, from https://www.linkedin.com/pulse/who-where-what-when-why-how-use-scrum-simple-guide-rui-costa

Court, D., Elzinga, D., Mulder, S., & Vetvik, O. J. (2009). The consumer decision journey. *McKinsey Quarterly*.

Cox, P. (2015). Worldwide implementation and support blog. *Why Aren't Supermarkets Doing Anything About Queue Wait Times?* Retrieved December 11, 2016

Craighead, C. W., Karwan, K. R., & Miller, J. L. (2004). The effects of severity and customer loyalty on service recovery strategies. *Production and operations management*. Retrieved January 13, 2017, from http://onlinelibrary.wiley.com/doi/10.1111/j.1937-5956.2004.tb00220.x/abstract

Criterio. (2014). State of mobile commerce. Retrieved December 21, 2016, from http://www.criteo.com/media/1427/criteo_mob

Daugherty, T., Li, H., & Biocca, F. (2008). Consumer learning and the effects of virtual experience relative to indirect and direct product experience. *Psychology & Marketing, 25*, 568-586.

Davis, F. D. (1989). Perceived usefuleness,perceived ease of use and user acceptance of information technology. *MIS Quarterly, 13*, 319-340. Retrieved December 21, 2016

Deeter-Schmelz, D., & Moore, J. N. (2000). Prestige clothing shopping by consumers: A confirmatory assessment and refinement of the PRECON scale with managerial implications. *Journal of Marketing Theory and Practise*, 43-58. Retrieved January 13, 2017, from http://www.tandfonline.com/loi/mmtp20

Edelman, D. C. (2010). Branding in The Digital Age: You're Spending Your Money In All the Wrong Places. *Harvard Business Review, 88*, 62-69. Retrieved December 22, 2016

Fleisch, E., & Michahelles, F. (2010, December 11). Enabling Research on Consumer Product. Retrieved April 25, 2017, from https://pdfs.semanticscholar.org/2232/d31852b4a9a5243422a435e5e46e66ba597e.pdf

Forsblom, A. (2009). Predictive text input in a mobile shopping assistant methods and interface design. *ACM*.

Fraser, A. (2005). Customer fury is all the rage. *The Australlian*. Retrieved January 13, 2017

Gajos, P. (2015). What is Agile Development for mobile apps? Retrieved from http://sourcebits.com/app-development-design-blog/what-is-agile-development-for-mobile-apps/

Gao, Q., & Salvendy, G. (2009). Perception of interactivity: Affects of four key variables in mobile advertising. *International Journal of Human-Computer Interaction, 25*, 479-505.

Giaglis, G., & Doukidis, G. (2007). Improving the Retail Grocery Supply Chain through Mobile Shopping of Electronically Referenced Products. *Proceedings of the 15th International Conference on Electronic Commerce.* Retrieved April 25, 2017

Gu, J., Lee, S., & Suh , Y. (2012). Determinants of behavioral intention to mobile banking. *Expert Systems with Applications, 36*, 11605-11616. Retrieved December 22, 2016

Gurendo, D. (2015, June 30). Software Development Life Cycle (SDLC). Scrum Step by Step. *XB Software* . Retrieved February 26, 2017, from https://xbsoftware.com/blog/software-development-life-cycle-sdlc-scrum-step-step/

Hartley, N., & Ward, T. (2006). The effect of waiting and 'pushy' sales staff on customers'. Retrieved Jnauary 13, 2017, from http://www.acrwebsite.org/volumes/13077/volumes/ap07/AP-07

Hartman, T. (2008). A Hybrid Checkout System. Retrieved May 29, 2018, from http://essay.utwente.nl/59064/1/Bsc._Thesis_IO,_Hartman_Tycho,_A_Hybrid_Checkout_System.pdf

Heineke, J., & Davis , M. M. (2007). The emergence of a service operations management as an academic discipline. *Journal of operations management*, 364-374. Retrieved January 13, 2017, from http://www.sciencedirect.com/science/article/pii/S0272696306001318

Inman, J. J., Ferraro, R., & Winer, R. S. (2004). Where the rubber meets the road: A model of in-store consumer decision-making. Retrieved from http://www.cba.uh.edu/mark/papers/inman.pdf

InternetWorld. (2014). Retrieved December 21, 2016

Jake , B. (2018, January 28). Amazon's Checkout-Free Store Makes Shopping Feel Like Shoplifting. Retrieved May 2, 2018, from https://www.theatlantic.com/business/archive/2018/01/amazon-go-store-checkouts-seattle/551357/

James, M., & Walter, L. (2017). Scrum Methodology. *Learn Scrum*. Retrieved February 26, 2017, from http://scrummethodology.com/

Kahl, G. (2011). IRL SmartCart - a user-adaptive context-aware interface for shopping assistance. *ACM Press*. Retrieved April 25, 2017, from http://dl.acm.org/citation.cfm?id=1943465

Kalyanam, K., & Wolfram, G. (2009). *Future Store Technologies and Their Impact on Grocery Retailing.* Springer Berlin Heidelberg. Retrieved April 25, 2017

Karpischeck, S. (2012). Mobile Barcode Scanning Applications for Consumers. Retrieved April 25, 2017, from https://www.ripublication.com/ijaer16/ijaerv11n23_22.pdf

Kasavana, M. (2017, January 11). How Amazon Go is reinventing retail and its possible impact on self checkout kiosks. Retrieved May 2, 2018, from https://www.kioskmarketplace.com/blogs/how-amazon-go-is-reinventing-retail-and-its-possible-impact-on-micro-market-kiosks/

Kato, & Tan. (2007). 2D barcodes for Mobile Phones. *Proceedings of 2nd. International Conference on Mobile Technology, Applications and. Systems.* Retrieved April 25, 2017

Kendall, K. E., & Kendall, J. E. (2013). Need for system analysis and design. 7-9.

Kennedy, M. (2016, December 6). Amazon To Open Convenience Store With No Lines. Retrieved May 2, 2018, from https://www.npr.org/sections/thetwo-way/2016/12/06/504570582/amazon-to-open-convenience-store-with-no-lines

Kim, C., Mirusmonov, M., & Lee, I. (2010). An empirical examination of factors influencing the intention of mobile payment. *Computers in Human Behavior*. Retrieved December 21, 2016

Kostecki, M. (1996). Waiting lines as a marketing issue. *European management Journal*, 295-303. Retrieved January 13, 2017, from http://www.sciencedirect.com/science/article/pii/0263237396000096?np=y

Kotler, P., & Keller, K. L. (2008). *Marketing Managment.* India.

KPMG International. (2012). Issues Monitor: Sharing knowledge on topical issues in the Retail industry., *12.* Retrieved from http://www.kpmg.com/Ca/en/IssuesAndInsights/ArticlesPublications/Documents/issues-monitor-retail-september-2012.pdf

Kumar, P., & Krishnamurthy, P. (2008). The impact of service-time uncertainty and anticipated congestion on customers' waiting time decisions. *Journal of Service Research*, 282-292. Retrieved January 13, 2017, from http://journals.sagepub.com/doi/abs/10.1177/1094670507313543?legid=spjsr%3B10%2F3%2F282&patientinform-links

Kumar, S., & Zahn, C. (2003). Mobile communications: Evolution and impact on business operations. *Technovation, 23*, 515-520.

Laine, K. (2014). *The Factors Influencing the Choice of Grocery Store among Finnish Consumers.* Retrieved February 21, 2017, from https://www.theseus.fi/bitstream/handle/10024/75026/Metropolia%20Media%20Production%20Thesis%20Kirsi%20Laine%2012052014.pdf?sequence=1

Lane, & Miluzzo. (2010, September). A Survey of Mobile Phone Sensing. *48*, 140-150. Retrieved April 25, 2017

Larman, C. (2004). Agile and Iterative Development: A Manager's Guide. Retrieved April 20, 2018, from

Law, C., & SO, S. (2010). QR Codes in Education. *Journal of Education Technology Development and Exchange*. Retrieved October 8, 2015, from http://sicet.org/journals/jetde/jetde10/7-So.pdf

Lee, G. (2017, October 17). Why 90 percent of sales still happen in brick and mortar stores. *Retail Technology Review.* Retrieved May 29, 2018, from https://www.retailtechnologyreview.com/articles/2017/10/17/why-90-percent-of-sales-still-happen-in-brick-and-mortar-stores/

Li, Q., & Han, Q. (2016, January). Collaborative Recognition of Queuing. *IEE Transactios on Mobile Computing, 15*. Retrieved April 25, 2017

Lu, Y., & Musalem, A. (2014). *Measuring the Effect of Queues on Customer Purchases.* Retrieved May 29, 2018, from http://repositorio.uchile.cl/bitstream/handle/2250/126320/Measuring%20the%20Effect.pdf?sequence=1

Mahatanankoon, P., Wen, H. J., & Lim, B. (2005). Consumer Based M-commerce : Exploring consumer perception in mobile applications. *27*.

Mahmoud, Q. H., & Yu, L. (2006). Havana agents for comparison shopping and location-aware advertising in wireless mobile environments. *Electronic Commerce Research and Applications, 5*, 220-228.

Maja, K. J. (2014). The Use of Mobile Phones by Customers in Retail Stores. *a case of Poland*. Retrieved December 15, 2016

Mallat, & Rossie. (2009). The impact of the use of context on mobile services acceptance: the case of mobile ticketing. *Information and management*. Retrieved December 20, 2016

Mathew , J., & Sarker, S. (2004). M-Commerce Services : Promises and challenges. *Communications of AIS*. Retrieved December 22, 2016

Matilla, A. S., & Hanks, L. (2012). Time styles and waiting in crowded service environments. *Journal of Travel and Tourism*, 327-334.

McDonnel, J. (2007). Music, scent and time preferences for waiting lines. *International Journal of Bank Marketing*, 223-237. Retrieved January 13, 2017, from eprints.qut.edu.au/12879/1/12879.pdf

Mupaso, T. (2014). Kenya has 67% smartphone penetration, way above the continent's figures. Retrieved December 11, 2016

Newcomb, E., & Pashley, T. (2009). Mobile computing in the Retail Arena. *ACM*.

Newman, A., & Cullen, P. (2002). Retailing: Environment and operations. Retrieved January 13, 2017, from https://www.cengage.co.in/category/academic-professional/business-economics/marketing/retailing/retailing-environment-operations-rt

Okazaki, S., & Hirose, M. (2009). *International Journal of Advertising, 28*, 77-104.

Okazaki, S., Katsukura, A., & Nishiyama, M. (2007). How Mobile Advertising works: The role of trust in improving attitudes and recall. *Journal of Advertsisng Research, 47*, 165-178.

Orsolya, A. (2016, October 19). Retrieved January 20, 2018, from https://uxstudioteam.com/ux-blog/agile-design-process/

Piaceski , D. (2012). RFID Update: The Basics, The Wal-Mart Mandate, EPC, Privacy Concerns, and More. Retrieved September 28, 2015, from http://www.inventoryops.com/RFIDupdate.htm

POPAI Institute. (2011). Shopper Influence study. Retrieved December 20, 2016, from http://www.popai.com/store/downloads/POPAIResearch-Shopper-Influence-Study-2011.pdf

Poushter, J. (2016, February 22). Smartphone Ownership and Internet Usage Continues to Climb in Emerging Economies. Retrieved May 29, 2018, from http://www.pewglobal.org/2016/02/22/smartphone-ownership-and-internet-usage-continues-to-climb-in-emerging-economies/

Rachuri, & Musolesi. (2010). Emotionsense: A mobile phones based adaptive platform for experimental social psychology. *Ubiquitous Computing*. Retrieved April 25, 2017

Rajamma, R. K., Paswan, A. K., & Hossain, M. M. (2009). Why do shoppers abandon shopping cart? Perceived waiting time, risk, and transaction inconvenience. *Journal of Product and Brand management*, 188-197. Retrieved January 13, 2017, from www.emeraldinsight.com/doi/abs/10.1108/10610420910957816

Rani, P. (2015). *Factors Influencing Consumer Buying Behavior.* Retrieved February 21, 2017

RFID Journal. (2005). The Basics of RFID Technology. *RFID Journal*. Retrieved May 27, 2015, from http://www.rfidjournal.com/articles/view?1337

RFID vs Barcodes. (2012). Retrieved September 15, 2015, from http://www.aalhysterforklifts.com.au/index.php/about/blogpost/rfid_vs_barcodes_advantages_and_dis

Rogers, E. M. (1983). The diffusion of innovation. *Free Press*. Retrieved December 20, 2016

Rohm, A. J., & Swaminathan, V. (2004). A typology of online shoppers based on shopping motivation. *Journal of Business Research, 57*, 748-757. Retrieved December 20, 2016

Ropraz, F. (2008, May). Using RFID for Supply Chain Mnanagement. *Information Systems Research Group* . Retrieved from http://diuf.unifr.ch/main/is/sites/diuf.unifr.ch.main.is/files/file/courses/eBiz_fs08/fabien_ropraz_eBusiness_RFID_Paper.pdf

Roussos, & College. (2007). Enabling Rfid in Retail. *49*, pp. 25-30. IEE. Retrieved April 25, 2017

Roussos, G. (2010). A case study of Pervasive Retail. *Proceedings of the 2nd international workshop on Mobile commerce.* New York. Retrieved April 25, 2017

Santos, F. N. (2009). Shopping Habits. Retrieved December 20, 2016

Schmidt, B. (2015, September 11). Fitness tracker or digital personal coach: how to personalize training. *Ubicomp*. Retrieved April 25, 2017, from http://dl.acm.org/citation.cfm?id=2800961

Shankar, V., Venkatesh, A., Hofacker, C., & Naik, P. (2010). Mobile marketing in the retailing environment: Current insights and future research avenues. *Journal of Interactive Marketing, 24*, 111-120. Retrieved December 22, 2016

Shekar, S. (2010). iGrocer: a ubiquitous and pervasive smart grocery shopping system. *Proceedings of the ACM symposium on Applied computing.* Retrieved April 25, 2017

Smith. (2012). The Best and Wors of Mobile Connectivity.

Smith. (2013). Smartphone Ownership Update. Retrieved December 12, 2016

Smith, A., & Zickuhr, K. (2012). Digital Differences. *Pew Research Centre*. Retrieved April 25, 2017, from http://www.pewinternet.org/2012/04/13/digital-differences/

Solomon, Bamossy, & Askegaard. (2007). *Consumer Behavior: A European perspective, 3rd Edition.* Retrieved December 20, 2016

Stechz. (2012). Retrieved June 15, 2015, from http://www.stechz.com.hk/tech_2dbarcode.html

Taylor, S. (1994). Waiting for service: the relationship between delays and evaluation of service. *Journal of Marketing*, 56-69. Retrieved January 13, 2017, from

https://www.researchgate.net/publication/248365213_Waiting_for_Service_The_Relationship_Between_Delays_and_Evaluations_of_Service

Thoet, A. (2016, December 7). What Amazon's cashier-free store could mean for millions of workers. Retrieved May 2, 2018, from https://www.pbs.org/newshour/science/amazons-cashier-free-store-mean-millions-workers

Thomas, A., & Garland, R. (2004). Grocery Shopping: list and non list usage. *Market intelligence and planning, 22*, 623-635. Retrieved December 20, 2016

Tomazelli, J. (2016, May 30). The effects of store environment elements on customer-to-customer interactions involving older shoppers.

Ullrich, J. (2011). Malicious images: what is a QR code? Retrieved August 20, 2015, from https://isc.sans.edu//diary/Malicious+Images+What+s+a+QR+Code/11305

Van , R., Semejn, J., & Ribbink , D. (2012). Waiting for service at the checkout : Negative emotional responses, store image and overall satisfcation. *Journal of Service management*, 144-169. Retrieved January 13, 2017, from https://www.researchgate.net/publication/233386861_Waiting_for_service_at_the_checkout_Negative_emotional_responses_store_image_and_overall_satisfaction

Violino, B. (2004). Farm Harvests RFID's Benefits. *RFID Journal*. Retrieved August 26, 2015, from http://www.rfidjournal.com/articles/view?810

Wave, D. (2014). About QR code. Retrieved June 02, 2015, from http://www.qrcode.com/en/

Webb, T., & Chang, B. (2014). *What information do consumers consider, and how do they look for it, when shopping for groceries online?* European Research Council. Retrieved February 21, 2017, from http://doi.org/10.1016/j.appet.2015.01.025

Wheeler, S., & Jones, R. (2011). How smartphones are Changing the Face of Mobile. Retrieved April 25, 2017, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3080339/

Xhiang, Z., Wang, H., & Shen, J. (2004). An approach to security and privacy of RFID system for supply chain.

Zhang, B., Ren, K., & Xing, G. (2014). Secure barcode-based visible light communication for smartphones. Retrieved April 25, 2017, from http://ieeexplore.ieee.org/document/6848214/

Zheng, F., & Meagher, M. (2009). The Introduction and Design of a New Form of Supermarket: Smart Market. *International Symposium on Information Engineering and Electronic Commerce.* Retrieved April 25, 2017

Appendices

Appendix A: System Requirements Questionnaire

Dear Respondent,

I am a Masters student in the Faculty of Information Technology, Strathmore University conducting a research entitled, a mechanism for improving customer shopping experience at the supermarket using a mobile application.

You have been selected to form part of this study. I kindly request you to complete the questionnaire below. The information requested is needed for academic purposes only and will be treated in strict confidence.

Kind Regards,

Kizi Dimira Othuon

* Required Fields

1. What is your gender? * Mark only one oval.
   - ◯ Male
   - ◯ Female

2. What is your age group? * Mark only one oval.
   - ◯ 13-17
   - ◯ 18-24
   - ◯ 25-34
   - ◯ 35-54
   - ◯ 55+

3. Do you own a smartphone? * Mark only one oval.
   - ◯ Yes
   - ◯ No

4. If yes, Which Operating System is the phone running? * Mark only one oval.

- Android
- IOS
- Blackberry
- Symbian
- Other

5. How often do you shop in a supermarket? * Mark only one oval.

- Rarely
- Often
- Never

6. If often, what time of payments do you use? * Mark only one oval.

- Mobile Money
- Credit card
- Cash

7. What would you like the supermarkets to improve in?* Mark only one oval.

- Check-out queues
- Once a week
- Twice a week

Appendix B: User Testing Questionnaire

1. Did you manage to do the following task? (Yes/No)
   a) Scan Items
   b) View Item details
   c) Make Purchase using the available payment options.
   d) Login and out of the web application
   e) Add and manage a user's information
   f) Add and manage items that are stocked in the supermarket.

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

   - Very attractive
   - Attractive
   - Not attractive

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

   - Easy
   - Average
   - Difficult

4. Rate the system functionality based of whether it met the user requirements (functionality)?

   - Very satisfied
   - Satisfied
   - Dissatisfied

5. Did the Scan It system improve your shopping process?

   - Very satisfied
   - Satisfied
   - Dissatisfied

6. Would you accept to use the system for shopping?
    - Gladly accept
    - Accept
    - Reject

Appendix C: Wireframes

Staff Application Screen

Figure C. 1 Login and Home Page Wireframe

Customer Application Screen

Figure C. 2 Login and Homepage Wireframe

Figure C. 3 Scan and Order Wireframes

Figure C. 4 Navigation Drawer Wireframes and Payment Options Page

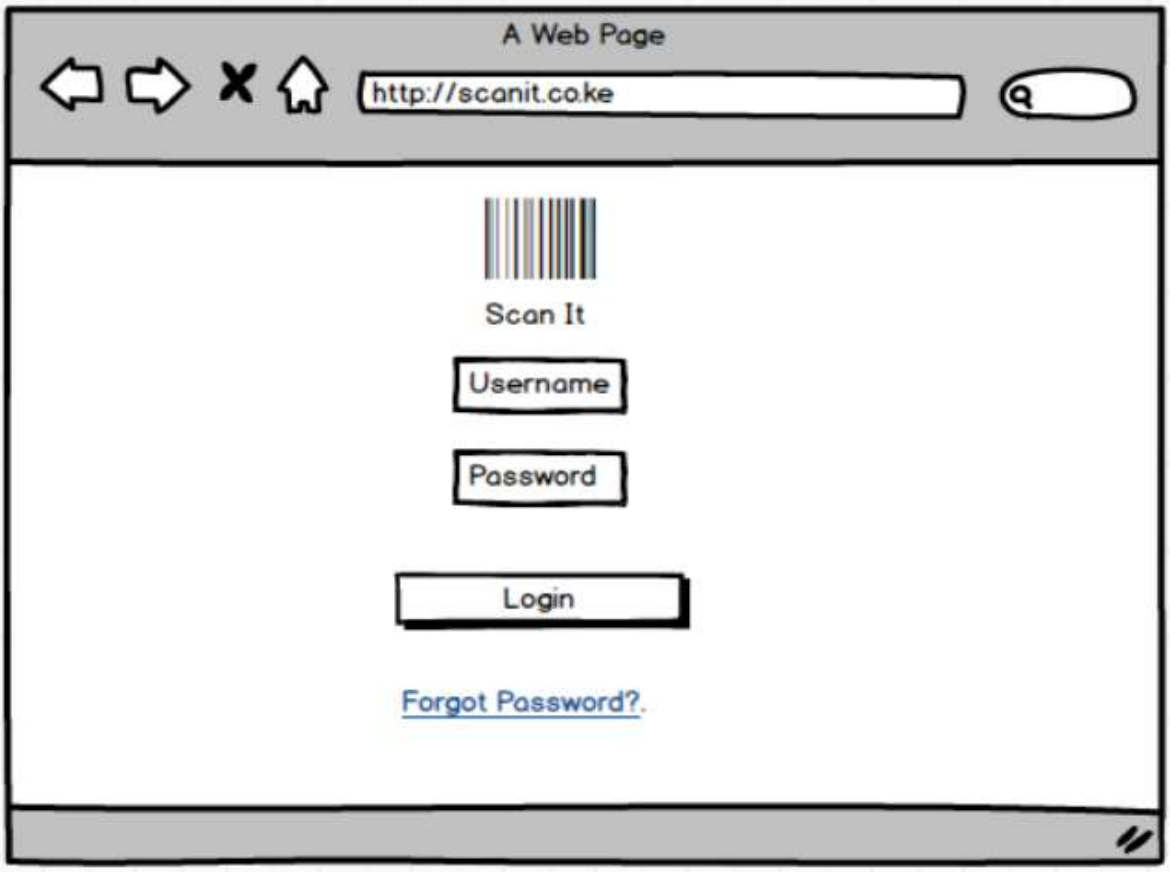

Figure C. 5 Login Web Page

Appendix D: Screenshots

Staff Application

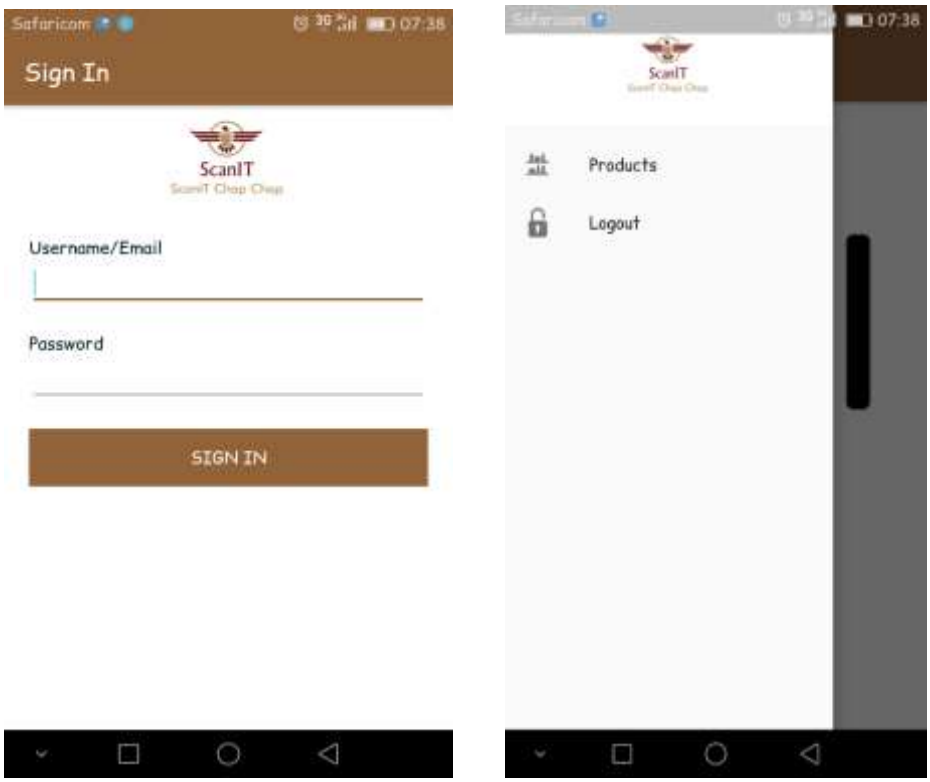

Figure D. 1 Login and Navigation Drawer Page

Figure D. 2 Products Page

Customer Application

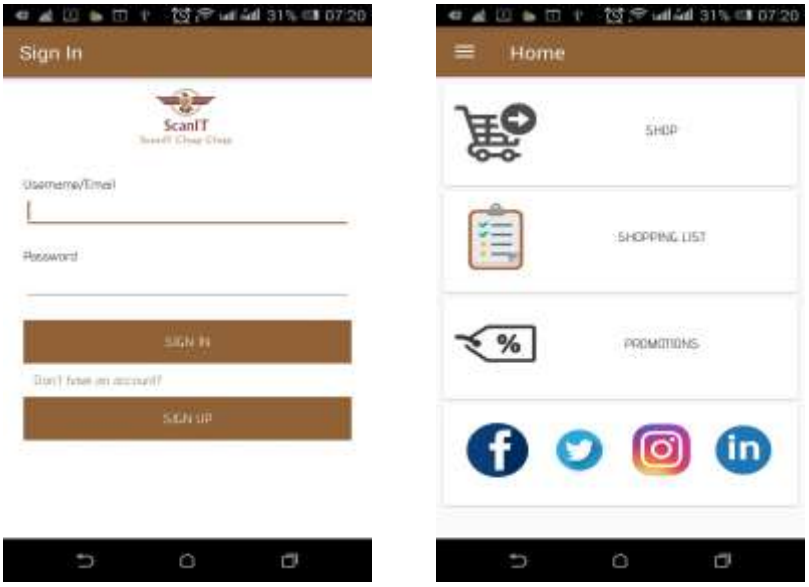

Figure D. 3 Login and Home Page

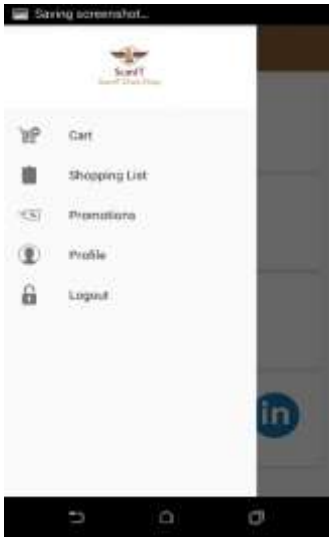

Figure D. 4 Navigation Drawer

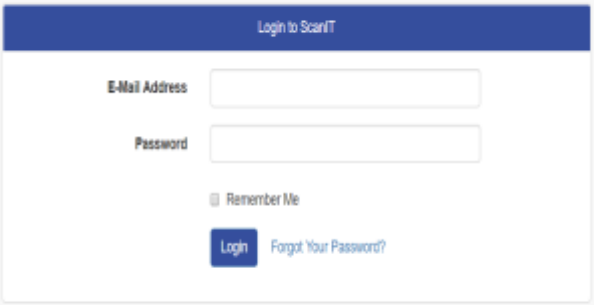

Figure D. 5 Administrator Login

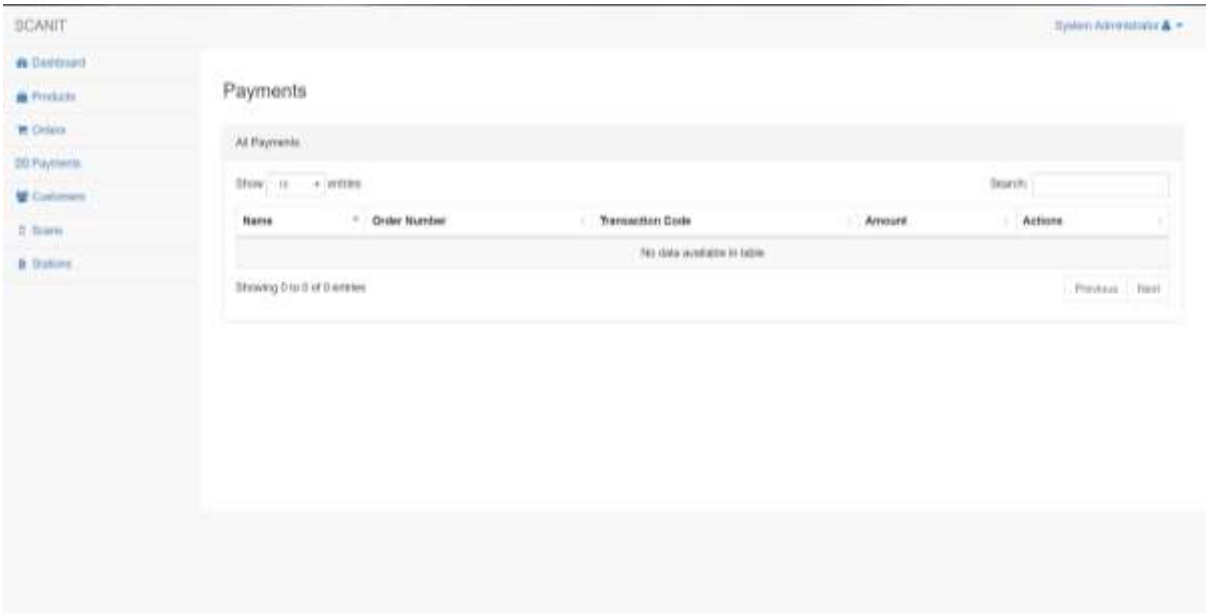

Figure D. 6 Payment

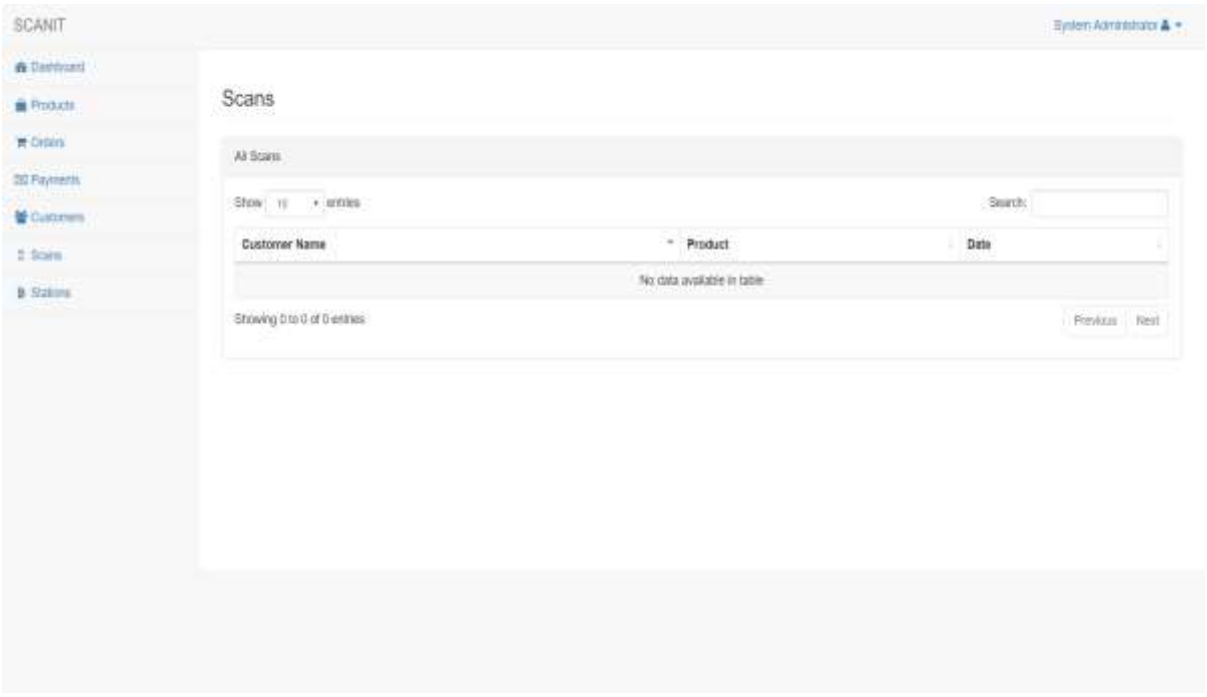

Figure D. 7 Scan

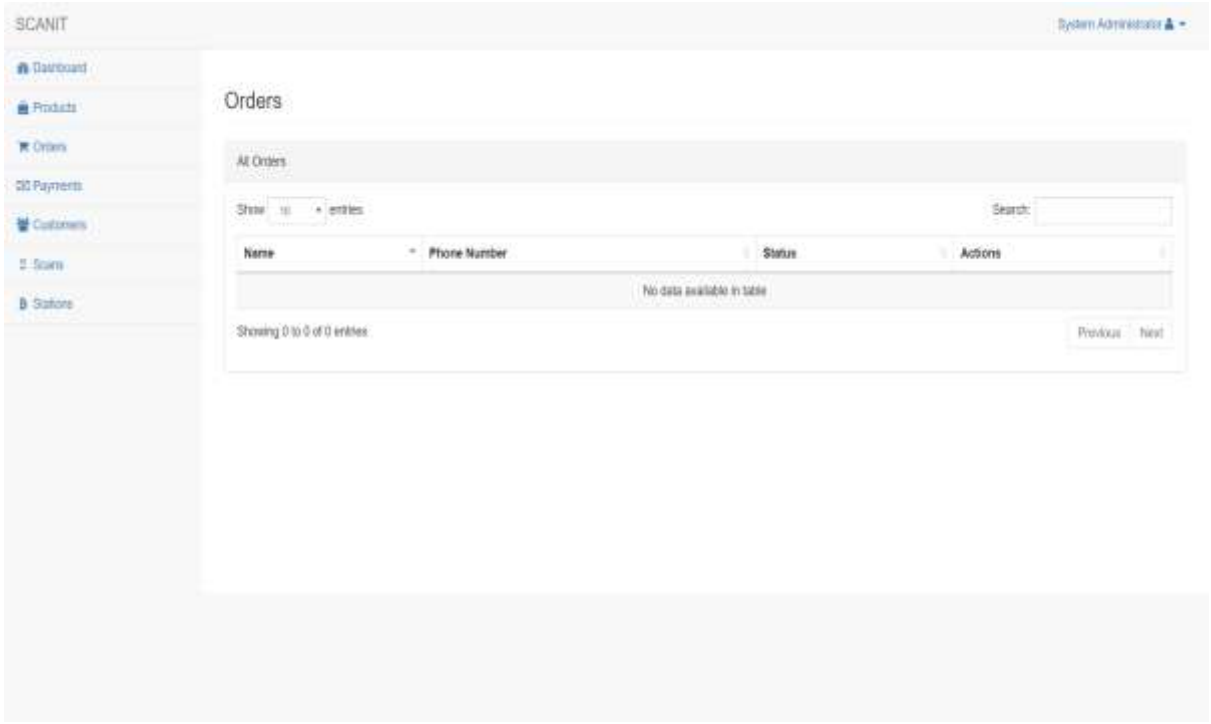

Figure D. 8 Orders

Figure D. 9 Stations

Appendix E: Turnitin Results