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Payment System Model in Retail Stores through POS Terminal using Mobile Banking

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This is to certify that the thesis prepared by Girma Teferra, titled: *Payment System in Retail Stores through POS Terminal using Mobile Banking* and submitted in partial fulfilment of the requirements for the Degree of Master of Science in Computer Science complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Abstract

The development of electronic payment system enables faster pay-outs and reduced time use. Mobile technology is revolutionizing the financial industry. Mobile banking is one of the approaches to the provision payment for goods and services. In most country all over the world POS payment machine is widely used with the retailing firms especially supermarkets. Customers spend a lot of time in the queue without doing anything when purchasing a product from the supermarket especially during holidays or peak times.

Many researchers have been introduced solutions which can improve electronic payments on retail store such as contactless card, contactless connection on mobile payment technology like RFID stickers, NFC, remote mobile payment systems (SMS or USSD), 2D barcodes with mobile (smart) phone, mobile Point of Sale (mPOS) and security but no research has been done using mobile banking to improve the efficiency of retail payment system; limited for retail sales service.

The aim of this research was to design a system model for a card payment with a POS terminal using mobile banking used in a retail store for saving service time. The literature review forms a comprehensive overview of payment system in retail store, mobile banking and POS payment machine technologies. Data were collected by observations of checkout processes at Shoa Shopping Centers in the Addis Ababa area and the system model developed with Java programming language and MySQL.

The solution has done main modification on the supermarket and mobile banking applications. The model has eight components and out of them five components namely Mob-Pop, Mobile Banking, Supermarket POS, POS Payment Machine and Payment Switch have a significant role to yield an efficient payment system that can caused an optimized service time saving on checkout process in a retail store. An Expert review and a prototype have used during the evaluation. Results showed that the speed of checkout process increased more than 50% fast, if proper functioning is ensured by the banks and supermarkets, although customers also want to learn how to use the new payment technology.

Keywords—Mobile banking, POS payment machine, OTP, Mob-POP, Payment switch, Supermarket POS, Payment Model.

Dedication

*This dissertation is dedicated in memory of to "my **mom Mulu Mengistu Kassa** who always answer the question of my soul"*

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Acronyms and Abbreviations

ACH	Automated Clearing House: settlement facility, process the exchange of electronic transactions between participating financial institutions.
ATM	Automatic Teller Machine
DVC	Dynamic virtual bank cards
E-cash	Electronic cash
EDI	Electronic Data Interchange
EFT	electronic funds transfer
EMV	Euro pay, MasterCard and Visa
E-payment	electronics payment
ePOS app	A point of sale application installed on the supermarket desktop for processing sales.
E-wallets	electronic wallet; act as a pocket for holding money
HCI	human-computer interaction
M-Birr	mobile birr
MMO	Mobile Money Operator
MNO	mobile network operator
Mob POP	mobile point of purchase application
M-payment	mobile payment
M-Pesa	A Safaricom (Vodafone subsidiary) is a MNO base in Kenya, enabling customers to make payments via their mobile phone and to transfer money between two users using encrypted SMS and recharge their SIM card.
mPOS	mobile POS
MPSP	Mobile Payment Service Provider; to create an account with as a trusted third-party

M-wallet	mobile wallet
PCD readers	NFC card readers
NFC	near-field communication
OTP	one time password
OTT	Over-the-top; internet companies and merchants can act as trusted third-parties
P2P	Person-to-Person
PICC	proximity integrated circuit card
PIN	personal identification number of an account holder
POS	point of sale terminal / point of sale payment machine
PMRPMB	Payment System Model in Retail Stores through POS Terminal using Mobile Banking; a payment system model (PSM)
PMP	proximity mobile payment
PTD	Personal Trusted Devices, such as wireless phones
RFID	Radio Frequency Identification
RMP	remote mobile payments
SAS	supermarket application server
SDB	supermarket database
SE	secure element; which holds the credit/debit card information or prepaid value to execute the payment
SUS	System Usability Scale
TTP	trusted third party
TxN	transaction
USSD	Unstructured Supplementary Service Data

CHAPTER ONE

1. Introduction

1.1 Background

An efficient and reliable electronic payment system enables faster pay-outs, better tracking, transparent transactions, reduced time use, cost savings and increased trust between sellers and buyers. The development and acceptance of technology in the e-payment system involves financial transaction, user and e-payment technology tend to shape their own perceptions and expectations [1].

In most countries all over the world, for purchasing items, electronic POS terminal is widely used than cash and specifically with the retailing firms. Leading among the retailers adopting the system are the supermarkets and groceries. There are different challenges in the retail store, for instance they need to implement a new system from one party, i.e., one-stop shopping, lack of support branch expansion through their infrastructure, absence of seamless experience which is lack of customer data record (lack of centralized customer data with knowledge management), so many technologies exist to drive marketing and sales but they don't seem to work together, issue of technological upgrading of business processes (deploying out-dated technology) which needs to be replaced and/or updated to create a unified customer experience, spent more time at the checkout process during purchasing items, etc.

When making a payment most importantly occurring in supermarkets where customers lining up as they waited for their turn and forced to tolerate long lines queues, when they arrived, the customer takes their products to a cashier who swipes their ATM card in the card reader. The customers spend a lot of time in the queue of the cashier without doing anything and this is due to the slow nature of the payment system as well as the checkout process and this was so especially during holidays or peak times. Some customers would abandon the queue and leave the store without purchasing. Moreover, the long queues discouraged customers from returning to the stores in future [2]. One of the common key considerations by shoppers, which contribute to the choice of their retailer, is the fastest service by which they are served.

Currently, more than 37 million POS terminals (payment terminals) which a device used to inserting debit/credit cards are installed in retail stores worldwide in 2017 [3]. During 2014 only 6% of adults reported using an electronic payment instrument (mobile services, online, POS terminal, ATM machine, wire transfers etc.), but the National financial inclusion strategy envisions that it will increase to 40% by 2020 [4]. In 2017/18, a total number of about 20,000 POS terminals are installed in most of the commercial banks in Ethiopia, out of them 11,796 POS terminals belong to Commercial Bank of Ethiopia; however, this number is increasing as adoption is high [5]. Using a POS terminal and an ATM Card to buy groceries is made convenient by all commercial banks in Ethiopia whereby customers can accesses their bank accounts for paying for groceries through a network connected to their bank. You can even find a POS terminal in most retail stores; nonetheless still sometimes, you have to spend some time in the queue of a retail store to make card payment using a POS terminal.

But there is a possibility of saving checkout service time by doing a transaction while we are waiting in the queue in the retailer store before we arrive to the counter or a cashier for inserting a payment card in to a POS terminal to make a card payment, by using the feature of both the Mobile Banking and POS terminal. The checkout process comprises the time of both making payment and waiting in the queue. The conventional checkout procedure here in Ethiopia is facilitated by a store employee (a cashier) who helps the customer register the products, calculates the due fee and accepts the payment. The general checkout process is a customer collect items they would like to purchase and lining up waiting in the queue for their turn to a cashier, customer place items purchased on front belt, cashier scanning of products, cashier ask for customer the payment card, give customer the payment card to the cashier, cashier scan the customer's payment card, cashier return customer's payment card, customer receive the payment card, calculate total, cashier allow payment (Cash or PIN), customer pay with cash or using PIN, cashier hand over receipt, customer receive receipt and packing purchased items

With the right technologies and controls in place, venders as well as consumers will be developing some level of trust as securing with their payment system as they are receiving payments from their bank account. It could be based on the customer's level of trust and security algorithms like AI, the checkout security application will tell the employees which

customer to control at checkout, for instance there is a visual control or re-scanning a certain amount of items in the customer's cart. The checkout security application will be optimized and configurable for minimal interaction and maximum security.

Mobile banking is one of the approaches to the provision of financial services through wireless network, which has been made possible by the widespread adoption of mobile phones. It involves the use of a mobile phone to perform various financial transactions via a client's bank account. The functional capabilities of mobile telephony have been rapid, and have extended usage well beyond classical (telephone calls and short messaging) applications. The author in [6] suggests that because of the immediate availability of mobile phones in the hands of many, they are being considered commercially viable instruments for carrying out various types of activities, especially financial transactions. The statistic depicts that the number of mobile-cellular subscriptions in Ethiopia from 2000 to 2017, that is in 2017 the number of mobile subscriptions in Ethiopia was at 62.62 million in 2015 [7]. From this figure, smartphone contributes much for its set of services and applications it offers by its stronger hardware capabilities and extensive mobile operating systems. Given the rapid pace of change in the area of mobile phone use, they have increasingly become tools that consumers used it for access to bank services (mobile banking), payment for goods and services (mobile payments), and financial management and shopping decisions.

Mobile released application covers a wide range of services worldwide are online mobile shopping, mobile banking, mobile e-wallet, mobile POS, mobile browsing, mobile payment, auctions, content purchase and delivery, mobile money transfer, purchase of ticket and reward schemes, travel and weather information and writing contracts on the move, mobile vouchers, coupons and loyalty cards, Location-based services, Information services, mobile brokerage, mobile marketing and advertising, Airlines flight booking, Hotels for room reservation etc.

Given the functional capabilities and the multiple formats in which a card payment POS terminal and mobile banking are used by financial service providers, this research will focus on the relative merits of both the card payment POS terminal and the mobile banking technology together in making a card payment in retail store environment.

1.2 Motivation

Over the years we have experienced a progress in of payment systems. Modern trends indicate that electronic payment systems have become a significant element in all trade and commerce activities globally. Consumers have changed the way they pay, turning the card payment into the most frequently used instrument of payment. As the use of card for payment among consumers increased, the substitution of cash by cards also becomes significant. Due to the rapid increase in mobile phone ownership and the mobile phone hardware capabilities, personal mobile devices have become a vital part of people's everyday life. These devices have the potential to transform the ways of conducting common commercial activities.

Currently here in Ethiopia, Banks invest a lot and using more effort to improve their system including Electronic Banking by implementing different kinds of technologies. Despite the benefits that electronic payment systems have brought to, there is still the issue of efficiency and security to address the consumer need. The main motivation of the thesis is to combine mobile banking and card payment POS terminal technologies for best effort because of gaining efficiency due to improving time wastage compared to the existing payment system. Clear evidence of this is presented in the paper published by [2] as they explain in their paper that the long queues discouraged customers from returning to the stores in future in order to clarify the potential benefits of electronic payment technology in the context of saving time. Thus, we intended to improve the payment system obstacles that are causing the low support of electronic payment system.

1.3 Statement of the Problem

The process of paying is an essential part of customers' electronic payment system buying activities. Consumer satisfaction from the purchase depends heavily on the time of queuing and the time of undertaking a transaction at the counter [8]. According to Kumar et al. [9], most payment situations are often pressured and time critical. They observed that speed and convenience are the key features of payment situations and the service providers have developed practices which enable them to smoothly and quickly complete the transactions.

Time is one of the main themes in this thesis. Time is an important term in general and especially in the same context with consumer and business. When purchasing items in retail store, there are events that delay the checkout process that is a customer collect items and lining up waiting in the queue, cashier scanning of products as well as the customer's payment card and calculate total and finally customer pay with cash or using PIN, this creates long queue and takes more time. Thus, there is a necessity to ease the checkout process by minimizing the time a cashier takes to serve a customer by reducing the cashier's task and do the tasks by the customer itself. This gives opportunity to the cashier to get time to serve more number of customers. This providing faster services and better purchasing experience for customers with an efficient system which saves time that can help easily process the transaction and makes simple day to day operations in the retail stores.

Time has many different implications among different fields of study and it can be seen as a subjective phenomenon. The shift and the different perspective that the impact of technology reflects to a time is enormous. Accordingly time has many definitions in theory, but it is much more complicated to define in the computer science, where the meaning varies a lot in different subfields as well as due to the speed of technology.

The research made by Polasik et al. [10], for the time efficiency study of payment process at the Point-Of-Sale (POS) through a wide range of payment methods from cash and standard cards to contactless cards, RFID stickers and mobile payments (NFC and remote) was analyzed. They found payment methods, such as contactless cards and contactless mobile payment such as RFID stickers or NFC are time efficient and are competitive to cash in

terms of time efficiency. Such a difference in duration of a payment transaction may also have an effect on the queue when most clients decide to pay.

The literature reviewed by Castle et al.[11], surrounding mobile financial applications which covered the top computer science publications, the paper were focused on related to mobile payment application and mobile money systems via NFC to address how payments are often time-critical. They observed that even though the mobile technologies have a significant contribution to assist the payment process in a financial sector, lack of quantitative data about these limited the features offered by various services. Moreover, Bansal and Singla [12] combine the ATM & Mobile banking to reduce the time of withdrawal money from ATM. But in retail store environment such as supermarket as time is the main factor for its service success, our research could be applied to optimize the payment process with developing an efficient payment solutions by combining mobile banking and POS terminal to save service time. So, the focus of the research is enhancing the time spent by customers while checking out including paying, may result in decreasing queues which is advantageous for both merchants and consumers.

1.4 Objectives

General Objective

The general objective of the research is to design a system model for a card payment with a POS terminal using mobile banking used in a retail store for saving service time.

Specific Objectives

The specific objectives are the following:

- Critically review and understand payment system service in retail store
- Examine the current status of mobile banking and POS terminal particularly in Ethiopia
- Design a model that facilitates payment by combining mobile banking and POS terminal that performs card-present transactions that is facilitated by connecting to each other via the bank system.
- Develop a prototype to show the validity of the proposed model
- Evaluate the proposed payment solution

1.5 Methods

Employs practices of the multidisciplinary scientific field of Human-Computer Interaction in order to research issues of user acceptance and user-related factors in the new electronic payment systems. The following method shall be used in the research:

- **Critical literature review**

  A systematic review is conducted looking for the right type of papers including important and relevant studies in order to understand the payment system in retail store, e-banking deliver channels, POS terminal technology and other related researches. Moreover, elicitation as well as analyses of the gaps that are not covered by the related research works will be performed.

- **Data collection**

  Data will be collected using a systematic observation and questionnaire. In this study, human to system interaction and data which are generated from the model will be identified and used appropriately.

- **System modeling and designing**

  - The system design task includes developing the system model and identifying proper algorithms to model components.
  - Prototyping

- **Evaluation**

  Testing will be made on the proposed payment model and its efficiency will be evaluated in terms of its goals and contributions. Specifically, the efficiency of the proposed payment model will be evaluated by two methods:

  - Expert review: Based on Focus Group Discussion
  - Prototype: Using Java and MySQL for developing web based application

1.6 Scope and Limitations

The payment process includes:

- Identifying products (which is tangible) to be purchased and the payment activity takes place where the flow of information associated with purchasing,
- the collaboration is between the mobile banking and POS payment machine,
- Task: there should be a merchant and a physical person, who is conducting purchasing activities using electronic payment system.

The following are therefore excluded from the scope:

- Intangible (Purchasing information, Purchasing services)
- Money payments and exchange
- Controlling mechanism like checking for identifying the items purchased when the consumer is going to out of the retail store
- Even though security is an issue I did not give much attention in this research

Lack of the real environment for testing cases might be impact on the completeness of the research.

Difficult to get statistical data on the usage and/or the distribution of POS terminal on retail stores as well as the habit of customers who are using debit card or cash for shopping at the super market. Similarly, there is difficult to get the number of mobile banking users and card holders.

1.7 Application of Results

This research's contribution will yield a new mobile phone based artifact; specifically a payment system using combined mobile banking and POS terminal with the goal of designing efficient payment system and making it easier payment process both for consumers and vendors during purchasing at the retail store.

This research will devise a new payment method, which can be applicable for several retail store like supermarkets. Aside from simplifying this payment process, the research will contribute by giving new insight and knowledge about what an information technology can do to increase the efficiency of payment system for venders to apply for a retail store, and if it is possible to completely automate this payment process including items excluded from

the scope. Considering this research objective is primarily designed an efficient payment system as a contribution to retail store, which currently does this payment process wasting time, if this research and product proves to be successful, it will be a great contribution for financial sectors. Although there could be exists similar systems in the market which focus on some of the same objectives as this research, the dependencies and infrastructure is so different for different payment system.

1.8 Organization of the Rest of the Thesis

The rest of this thesis is organized into five major Chapters. This section gives an overview on the contents of each Chapter.

Chapter Two will gives theoretical framework on electronic payment system in general and retail payment system in particular. Furthermore, retail payment characteristics, types of e-payment technologies, developments and historical background of e-payment, POS in retail store are discussed briefly. Besides, the contribution of mobile banking service for bank and retail environments is discussed concisely.

In Chapter Three, major advancements of e-payment and its contributions on improving the efficiency of payment system will be described. Furthermore, various electronic payment systems currently in use by various retail store are briefly discussed.

Chapter Four presents the proposed payment system. In this Chapter the big picture of the proposed architecture as well as issues considered during its design will be put concisely. Besides that, relationships between components and their high level description is given in the first part of this Chapter. Moreover, the major components used in the big picture are exploited and discussed independently and briefly.

Chapter Five presents topics that are concerned on describing the implementation details of the proposed model. Tools used to develop the prototype as well as their significance specific to this prototype development are described. Steps followed during prototype development are illustrated by coupling it with the pictorial illustration of outputs gained from each component and even methods inside it. Additionally, this Chapter presents results gained after conducting expert reviews. Results are illustrated using tabular view.

The last section in this thesis, Chapter Six, will summarize the major concepts raised in this research work. In addition, recommendation, contributions of the research and future works that could be done to improve the efficiency as well as performance of the proposed model are briefly described.

CHAPTER TWO

2. Literature Review

2.1 Overview

ICT and Digital technologies had made great evolutionary development in finance, economics, operational costs and enhanced organizational performance [13, 14]. The era of ICT and digital innovations has come along with a dynamic change in the world business environment, whereby business transactions are constantly shifting from cash-based transactions to electronic-based ones [15]. Also, the global rise of the internet and its rapid use over the years had contributed much in facilitating electronic commerce in global business environment [16].

Subsequently, with the introduction of e-payment system, the world payment system turned out to align with the current trend of cashless transactions among individuals, businesses and governments [17]. As a result of this, the world payments system is gradually changing from coins and paper based money to electronic forms that provide more convenient, fast and secured process of making payments among individual and organizations [1]. Likewise, the global annual non-cash transactions had been on the increase over the years [18].

Electronic payment system had also brought about efficiency, fraud reduction and innovativeness in the world payment system [19]. Thus, the use of e-payment technology is ever increasing in today's business environment.

As the Information is carried and processed at great speeds within and across a variety of communication networks allowing the transfer of enormous amounts of information in real-time through a network of networks [20]. This increasing global penetration of ICTs enabled by the Internet has also reached the retail industry, particularly the buying of groceries in supermarkets.

2.2 Online Transactions

Online payment methods implies the entire set of means through which customers can pay for their purchases over the Internet; when you purchase goods and services online, you pay for them using an electronic medium. This mode of payment, without using cash or cheque, is referred as an online or electronic payment system. There are a lot of payment methods to

match all contexts (pay in advance, pay afterwards, and payment and delivery at the same time). A payment method can stand in a one-to-one relationship with an instrument, as with credit cards, but it can also incorporate several payment instruments in one method, as with e-wallets; can be topped up by debit/ credit card or Online Banking e-payments.

An online transaction is a computerised monetary transaction and is a password-protected method of transferring funds remotely from one technology to another [21]. Moreover, it is a PIN-debit transaction that authorizes a transfer of funds over an EFT that is a transaction that takes place over a computerized network, either at the same bank or to a different. Consider a scenario in which a customer wants to purchase items from the supermarket; an online payment method presented at the checkout or on the merchant's payment web page. In supermarkets, an online transaction is initiated at a POS machine and automatically processes monetary transfer from the customer's bank account to the POS machine once it is authenticated by the customer through their PIN. That is, the customer takes their products to a cashier who swipes their ATM card in the card reader. The POS terminal checks the card's validity, connects to the bank that issued the card and once the payment has been credited to the account, it prints out a receipt to the customer [22]. A POS machine is the point at which a customer makes a payment to the merchant in exchange for goods or services [23]. It enables their customers to pay for their shopping utilizing an ATM card rather than liquid cash. The money must be taken electronically from the customer's account and paid to the store's account.

2.3 Electronic Payment System

A. Concept of Electronic Payment

Payment systems have undergone a reasonable progress passing from a physical transfer of cash for goods or services to transactions exchanging money as digital data. Electronic Payment refers to any type of electronic transaction, operated under financial regulation, involving funds transfer from a buyer to a seller of goods or services, completed through the Internet, or, more generally, over an electronic network.

2.3.1 Definition of E-Payment

As of the year 1960, in the five decades that have passed since their appearance, important technological developments have taken place, which expanded the possibilities of electronic

payment systems and have attracted much attention from researchers and information system designers due to their vital role in modern electronic commerce. These changes, naturally, have an impact on the definition of electronic payments, which is evolving depending on the needs of each period.

For instance, Briggs and Brooks [24], sees e-payment as a form of inter-connections between organizations and individuals aided by banks and inter-switch houses that enables monetary exchange electronically.

In another perspective, Peter and Babatunde [25] viewed e-payment system as any form of fund transfer via the internet. Similarly, according to Adeoti and Osotimehin [26], electronic payment system refers to an electronic means of making payments for goods and services procured online or in supermarkets and shopping malls. Another definition suggests that e-payment systems are payments made in electronic commerce environment in the form of money exchange through electronic means [27].

Antwi et al. [28] defined e-payment as a payer's transfer of a monetary claim on a party acceptable to the beneficially. Also, Teoh et al. [29] viewed e-payment as any transfer of an electronic value of payment from a payer to payee through an e-payment channel that allows customers to remotely access and manage their bank accounts and transactions over an electronic network. Thus, based on the above definitions, e-payment system can simply be defined as a collection of components and processes that enables two or more parties to transact and exchange monetary value via electronic means.

2.3.2 Brief Historical Development of e-Payment System

The history of e-payment can be traced back to 1918 the time when currency was first moved in United States (U.S) by the Federal Reserve Bank with aid of telegraph. However, that technology has not been widely used in US until the time when their ACH was incorporated in 1972. Since from that time, the electronic currency became widespread. Credit card industry can also be traced to 1914 when department stores, oil companies, western Union and hotels start issuing cards to their customers to enable them to pay for goods and services. Due to the increasing number of credit cards usage, the industry has grown rapidly which lead to the introduction of a debit card too. Debit and credit cards are

now used in transactions payments for all types of purchases and or services rendered all over the world [15].

A. Trends of Electronic Payment System

Electronic payment systems have been in operations since 1960s and have been expanding rapidly as well as growing in complexity. After conventional payment system, EFT based payment system came into existence. It was the first electronic based payment system. An EFT is a financial application of EDI, which sends credit card numbers via secured private networks between banks and business entities. To use EFT to clear payments and settle accounts, an online payment service will need to add capabilities to process orders, accounts and receipts. Thereafter the development of digital currency becomes e-payment means. As such, digital currency payment systems have the same advantages as paper currency payment, namely anonymity and convenience.

2.3.3 Types of E-payment Services

In the literature, we find several suggestions for electronic payment systems`. As presented in Zayed [30], the first classification of electronic payment systems, proposed by Medvinsky & Neuman in 1993, was based on two criteria; the form of the money and the transfer's way of the funds. The authors distinguished between electronic money based systems and credit-debit card based systems.

However, with the rise of Internet and the emergence of several kinds of payment solutions, other classifications have come. As the author in [30] noted the study of Havinga and alii in 1996 which distinguishes between systems based on means of payment; bank cards, virtual money and credit-debit systems. And, in 1997, Wayner introduces a more practical classification by keeping the category of virtual money based systems, presented previously in 1993 and in 1996 above, and distinguishing the category of account based systems. After that, a different type of classification will follow, the author in [30] noted the researches of Kuttner & McAndrews, Abrazhevich in 2001 and Stroborn and alii in 2004.

Based on the work identified by different researches, the analysis of all these works carried out us to conclude that electronic payment system thus far generally fall into one of two major groups: those based on accounts and those based on electronic money. Nevertheless, the focus this research is based on these two groups of systems and emphasis is given to

account based payment systems. Indeed, we were able to identify several categories constituting each group based on their operational principle. Thus, our approach reveals two levels in classification of electronic payment systems. So, for simplicity, we keep the first level of classification that distinct between of "account-based systems" and "electronic money based systems". In the second level, we brought together payment systems in three main categories: card based payment systems, mobile based payments systems and others payment systems. For the mobile based payment systems we distinguish between mobile banking and mobile payment. Further classification of electronic payment systems are listed below.

a. Card based payment

i. **Credit card:** the most common way of paying on the Internet. As a customer communicates their card number and expiry date directly to a merchant; basically an electronic card with magnetic data strip or a chip, issued to customers by banks and other credit agencies. It allows users to pay for purchase or services by borrowing from the credit card company. When users use a credit card; the issuer puts money toward the transaction. This is a loan; users are expected to pay back in full unless users won't to be charged interest. Credit card not required to be connected to users account. It's both for remote and proximity payments.

ii. **Debit card:** known as ATM card. They are magnetic strip and chip enabled cards, issued to customers by their respective banks with saving accounts. It can be used with a PIN in almost everywhere in retail stores, gasoline, restaurants and pay phones. Customers who want to spend online within their financial limits prefer to pay with their Debit cards. They are for proximity payment.

iii. **Smart Card:** It is about the size of a credit card, made of a plastic with an embedded microprocessor chip that has the customer's personal and financial information stored in it and can be loaded with funds to make online transactions and instant payment of bills. When necessary, the money has to be reloaded from his/her bank account. The device requires a special key from the issuing bank to start a money transfer in either direction.

iv. **Dynamic virtual bank cards** (DVC): allow banks to generate a single-use card, cryptogram number and expiry date every time the card user buys online.

v. **Pre-paid phone and scratch cards:** payments included in the phone bill.

vi. **Electronic wallets** are based on smart card technology, which is used to store data about the customer's funds. Cash is loaded into the e-wallet by a transfer from the cardholder's account. In this way, banks are not involved in the transaction at the moment of purchase. E-wallets mainly target the micro-payment market. At present, they can be used at points of sale, vending machines, parking meters, ticket machines, etc.

b. Other Payment Systems

i. **Virtual wallet:** are quite similar to those based on electronic wallets. The only difference is that cash is stocked on the software instead of on a smart card. After having created an account at the system issuer, the buyer only has to enter their ID and password at the moment of transaction. The virtual wallet is used for macro and micro-payments via the Internet.

ii. **Virtual money**: were pure electronic currencies. The consumer buys coins from the provider of this sort of money and stores them on his hard drive. The form of this sort of money is not very different from the money included in virtual wallets. But the principles are different because it is not necessary to deposit money before receiving electronic money and there is no official exchange rate for it, as with an official currency like the US dollar.

iii. **Internet banking:** It is a simple way of paying for online purchases directly from the customer’s bank. It uses a similar method to the debit card of paying money that is already there in the customer’s bank. Net banking does not require the user to have a card for payment purposes but the user needs to register with his/her bank for the net banking facility. While completing the purchase the customer just needs to put in their net banking id and pin. That is, a service that allows the customers to conduct the financial transactions electronically, with the use of internet.

iv. **Electronic Cheque:** Electronic cheque is messages that contain all the information that is found on an ordinary Cheque but it uses digital signature for signing and endorsing and has digital certificate to authenticate bank account. They are typically used in orders processed online and are governed by the same laws that apply to paper checks; such as the customer sends his payment order to a merchant, who

presents it to an e-check issuing institution, in order to authenticate it and make the payment. Then, the data related to the e-check is transmitted to a clearing system. The procedure of fund transfer is the same as in the case of a paper check. Similar to the card based system, electronic checks are used for macro-payments but their unit transaction costs are lower.

v. **E-mail based payments**: used for micro-payments; small businesses. E-mail payments are not processed via e-mail. E-mails are used for notification, but funds are transferred in the same way banks settle inter-bank transactions. A customer loads an amount of money from his bank account into a service provider account, then specifies the sum of money to be sent and enters the email address of a recipient. Both customer and recipient are notified that the money has been sent. The recipient receives the money and withdraws it from their bank account. Online auctions constitute the largest source of e-mail payment revenues.

vi. **Micro-payments:** can be handled by incorporating the consumption of a service into phone or Internet billing. Payments included in the phone bill are paid via a telecom kiosk, while Internet bill-based solutions can be operated in ISP kiosks and personal account systems.

vii. **Electronic cash:** Electronic cash (E-cash) is a currency in the form of data. The user opens an account in the bank that carries out the electronic cash business and stores money for purchase either from retails or online merchant who accept the electronic cash. Users can download the electronic coin bag containing small cash directly from the account, and then it can work. Similar to regular cash, e-cash enables transactions between customers without the need for banks or other third parties. When used, e-cash is transferred directly and immediately to the participating merchants and vending machines.

c. **Mobile based payments:** are the payments carried out by PTDs (Personal Trusted Devices), such as wireless phones or PDA (Personal Digital Assistant) and facilitating the services are using different technologies of which a technology may enable one or all services. These technologies include SMS, near-field communication (NFC), RFID, WAP protocols, Wi-Fi, Internet, Unstructured Supplementary Service Data (USSD) [31]. It is basically considered as mobile banking, m-wallet and m-payment.

i. **Mobile banking:** It allows users to manage their bank accounts remotely from their mobile devices. That is, it is an internet based facility provided by banks that enables the customers to execute bank transactions, via cellular devices. The scope of offered services may include facilities to conduct bank transactions, to administer accounts and to access customized information.

ii. **M-Wallet:** In this method, first money from bank is transferred to this wallet, then this wallet can be used as source to transfer money directly into providers account examples are Android Pay, Apple Pay, Airtel, M-Birr, Hello Cash, etc. The M-wallet allows users to pre-load payment account information on their mobile devices, such as smartphones, and to choose payment options. Google Wallet uses Gmail for making online payments/ transactions.

iii. **M-payments:** It is not account based. It can be used for: making online payments such as wireless Internet shopping, face-to-face shopping, vending machines, event and public transport ticketing, P2P (Person-to-Person) payments, etc.

Mobile payments can be characterized as; online payment, in-store payment and money transfer. Online payment is when the user uses the internet on their mobile, m-commerce, or on any other device, e-commerce, to purchase goods or services whereas in-store payment is when a user uses their mobile to pay for a good or service via mobile terminal while in the store. Finally, the third category is money transfer, where a user can purchase a good or service by the transfer of e-money. Mobile payment is generally classified by two main aspects; 1) online or offline payments, 2) remote or proximity [32].

In **off-line payments** the transaction between buyer and seller is direct, so data exchange totally takes place between their respective devices. Thus, it is unnecessary to involve third-party entities. However, this method requires that the buyer's device contain a stored value such as an electronic wallet which needs to be charged in advance before effecting any transaction.

On-line payments need the involvement of third-party entities, such as MNO and companies that first authorize the money transaction and then check the status of the payment procedure. Customers can directly access their bank account via the web and use their mobile phone as a credit card.

Remote mobile payments are online payments that require customers to surf the internet on their mobile in search of the product or service, and use an installed app to pay, while the funds for the purchase may be stored in a prepaid account or withdrawn directly from the bank account; include payments that the distance between seller and buyer devices is makes no difference for the transaction [33]. For such payments the MNO provides a data connection via web browser or SMS. RMPs can be implemented using open-loop; an existing infrastructure for payments or using a closed-loop payment system; works only within the same vendor in which buyer and seller create an account with a trusted third-party or with a Mobile Payment Service Provider (MPSP).

Proximity mobile payment is when a mobile phone is used for in-store payment of a good or a service at a physical payment terminal. PMPs can be made both online and offline [34]. Also called contactless payments involve the use of short range messaging protocols such as Bluetooth, infrared, RFID, and contactless chip to pay for goods and services over short distances; include payments that need buyer and seller located physically close and require the use of a specific app either a wallet or the buyer's financial institution app [32]. A mobile wallet is an application hosted by the device, required in the offline mode of the mobile proximity payment, which has access to the secure element (SE) which holds the credit/debit card information or prepaid value to execute the payment [34]. However, in the online mode of mobile proximity payment, the buyers' financial institution app connects online to retrieve card details; therefore the mobile phone serves as a credit or debit card.

Mobile payment Business Models

The stakeholders involved in the mobile payments chain include customers, merchants, financial institutions, mobile network operators (MNOs), third party service providers, hardware and software providers and supervisors that include governments and international regulatory agencies. There are three main mobile payment business models; based on MNOs, banks and third party providers [35].

The carrier-based or MNO-based: the MNO provides the technology, manages the operations and rewards all involved players and it is one where the customer has either a billing system with their MNO, where the amount paid appears on the customer's bill, or has a prepaid balance that is dedicated for purchasing products. This business model does not

allow macro-payments, only micro-payments. M-Pesa, a Safaricom (Vodafone subsidiary) is a MNO base, enabling customers to make payments via their mobile phone; to transfer money between two users using encrypted SMS and recharge their SIM card with cash [36].

The bank-based model is one where mobile network operators are not included in the payment process. Banks are responsible for the management of the payments through their mobile application; users are associated with their bank that provides them with the payment method via mobile terminal. MNOs involved only if when banks use SIM-based technologies. Since a payment in this model is done through the bank account, both micro (lowest values) and macro (larger value) payments are supported by the model [37].

Finally, the third-party business model: here, neither the banks nor the MNOs are in charge to manage the SE, but the TTP operates as an independent intermediary between them; uses their own infrastructure setup to manage the payments; internet connection and the user's bank account for payment. This is an intermediary among banks, operators, retailers and customers; supports both micro and macro-payments and it allows a customer to manage more than one bank account at the same [35].

Vizzarri and Vatalaro [32] state that Over-the-top (OTT) internet companies and merchants can act as trusted third-parties, therefore the third-party payments model is further divided into two, OTT-based and Merchant-based. OTTs, such as Apple and Google, can act as trusted third parties due to their experience in e-commerce organization, while merchants, such as Starbucks, SHOA Supermarket here in Ethiopia, etc. have direct initiatives relationship with their customers usually through loyalty programs.

2.4 Payments at the Retail Store

The focus in this entire thesis is on retail payments, such as merchandising, since these are the payments in which time is critical and real time transaction is occurred during payment process. This is because the retail sales are the scenario in which generic payment is not fast enough. The rest of this section will therefore focus on payments system for retail store.

2.4.1 Payments at the Retail Point-Of-Sale

This section focuses on payments at the retail point-of-sale, meaning a payment at the vendor's physical sales location, from a customer to the retailer in return for a product delivered by the retailer. Typical examples include stores, for example in supermarkets.

Other payment scenarios are excluded, since the study focuses only card payment POS on retail point-of-sale payments. Examples of these other scenarios include remote payments in e-commerce settings and bills paid by customers from their home, which currently often happens via internet banking.

i. **Retail payments**

Most vendors try to offer multiple payment methods at their point-of-sale to their customers, so they can choose they want to use, since there is a wide variety of customer preferences. Most methods for payment at the retail point-of-sale are generic payment systems offered to the entire population, vendors and customers, by financial institutions, such as (National/Central) banks. The most common examples of these generic payment systems are cash, debit cards, credit cards, pre-paid electronic payments and cheques. Cash remains the most common retail payment method, especially for small purchases, although the electronic payment alternative is becoming increasingly popular [38].

ii. **The payment tool**

There are three types of interested party directly involved in a payment at the retail point-of-sale: customers, retailers and payment service providers, for this research Bank. Customers pay for their purchase at a retailer point-of-sale using the payment system offered by the payment service provider. In terms of payment systems: the customer has a payment tool, which is used to conduct the payment. Examples of such 'tools' are cash, debit/credit cards. For the customer to be able to use the payment tool at a point-of-sale, the vendor needs to be connected to the payment service provider as an acceptant of the payment system. How this is done highly depends on the payment system. To accept cash, the retailer simply needs change, so the customer is able to pay the proper amount. But to accept debit cards, the retailer needs a business bank account as well as a debit card terminal, which is connected to their bank.

iii. **Payment time**

The payment time defines when the actual funds are transferred from the consumer to retailer compared to when the purchase occurs. There are three possible scenarios for payment time:

(1). *Real-time* payment, where the funds are transferred at the same time as the purchase,

(2). *Prepaid* payment, when the customer buys the right to consume a product or service in advance or

(3). *Postpaid* payment where the consumer pays after the consumption of the good or service [39].

The payment time is such an important design choice in payment systems since it has a great impact on the order of the steps in a typical payment business process. Although all these systems are very popular, the Real-time payment is important for this thesis, since such a system represents the current situation at the bank transaction processed by both mobile banking and card banking.

a. **Real-time payment**

When the actual payment coincides with the purchase of the good or service, it can be characterized as real-time settlement. The primary characteristic is that money changes hands from payer to payee at the moment the sale is done. This can either be cash, which physically changes hands, or a bank-transaction, which directly transfers the amount due from the customer's to the retailer's bank account. The latter can be done by debit card or some forms of internet payment [40]. The payment systems in this category are exclusively existing payment methods offered by banks and financial institutions.

2.4.2 Developments in Retail Payment Systems

When it comes to the retail going from cash to cards and from cards to online and mobile payments, consumers require improvements with regard to the convenience and speed of payment methods.

Three of the most promising technologies will be shortly discussed here: 2D barcoding, contactless payment and NFC payment.

i. **2D Barcoding**

It is a fast and inexpensive way to encode and read information in for example logistic chains and retail stores. Its main applications are identification of a certain product or product group. For example, at many retail points-of-sale the barcode of a product is scanned to identify the product. The checkout terminal uses the code to retrieve the proper information about the product, such as the prize. Barcodes can also be used to identify customer accounts. Many customer loyalty programs use plastic cards with a barcode which

allows the customer to identify himself at the point-of-sale; a new generation of 2D barcodes is the QR-Code. The main advantage of 2D barcodes is that they are able to store much more information than the conventional barcodes and are thus more widely usable [41]. These barcodes, along with the rise in mobile (smart) phone use, have already been successful in retail payment scenarios.

ii. Contactless payments

A payment with a contactless chip can be done by simply holding the device containing the chip in close proximity to the card-reader. The reader either reads the chip's ID and deducts the amount from the corresponding account in a central database or deducts the amount from the balance on the chip itself. Contactless chips that work by the Radio Frequency Identification (RFID) standard in ISO/IEC [42] can be read and (re)written by a RFID-reader, which communicates with the chip on the card via an antenna.

An important note is that these chips work passively: They get their power from the electromagnetic field, so they need to be close by the antenna to function.

iii. **Mobile NFC payment**

An extension to the contactless chip technology described in the previous section is Near Field Communication (NFC) [43]. NFC chips use the same radio frequency communication standard as the contactless chip, but they are able to function in two ways: both as a reader and as a sender of data. This makes (payment) applications possible with more functionality than just the contactless chip [44]. The concept adapts existing noncontact card payment methods that use a high frequency (HF) range of 13.56MHz to enable authorization and payment to be made when a mobile phone is close to a payment system. NFC is a low-power, low cost communication solution that focuses on personalized communication and allows various types of sensitive data to be exchanged in perfect security.

Contrary to contactless chips, the NFC chip does require power, so it is not usable as stand-alone device like a contactless chip, but needs to be integrated into a device with a power source, most commonly a mobile smart phone [45]. This currently is a problem in the use of NFC based applications. Although expectations for the future in the medium to long-term are quite good, there are currently only a few smart phones on the market with an NFC chip [46].

In the context of mobile payment processing, an NFC enabled mobile device can interact with an NFC enabled POS device to perform payment functions through NFC connectivity by using ISO/IEC 14443 standards for NFC card readers (PCD readers) and NFC devices; for NFC client proximity integrated circuit card (PICC) communication. To complete a mobile commerce transaction, it is essential that the mobile devices and POS equipment are both NFC enabled.

There are also issues to improve electronic payment systems, for instance to reduce the time of withdrawal money from ATM with increasing level of security by adding a new feature in the Mobile banking [12]. Moreover, mPOS systems allow merchants to process transactions conveniently and quickly using mobile phones or tablets rather than "traditional" point-of-sale (used as a cash register) systems. It is with a merchant account and suggested card reader. The system takes two forms. One type, hardware based, consists of a small reader that plugs into a mobile device such as a smart phone or tablet. Consumers swipe their credit/debit cards through the device to make a payment. Merchants typically use the mobile device not just to accept payments but also for various other personal or business purposes. Payments are processed through software apps stored on the device. The other type is software based and usually requires manual entry of card information onto the phone or tablet. In some cases, the merchant can photograph the credit/debit card instead of entering data found on the card [44].

2.5 Characteristics of Payment System at Retail Store

The most important characteristics specific to payments at retail store are efficiency and robustness.

i. **Efficiency**

Why not pay directly with cash at the retail point-of-sale? The main answer is that cash is cumbersome and transactions are relatively slow [47, 10]. Due to the large transaction volume and often high peak moments, for example at peak time, it is critical to have a high efficiency at the point-of-sale for the sales volume. A low efficiency is also costly due to the added personnel requirement for vendors and consumers are fading-up waiting for long queue. This was the main considerations to improve for the system. The system was meant to avoid long queue thereby shortening the time it took to execute payment transactions. For

clients, this meant shorter queues at the retail store. It meant more productivity of their sales personnel, faster turnaround, and more sales at peak times. In addition, it reduced the need for controlling cash registers.

ii. Robustness

The sale of items is a usual part of operation of every supermarket, whether it is a holly day or a normal day. It is not only extremely important that the system is reliable and robust, but the conditions are very difficult. That is what happens when a system does not function properly: People get upset, and there is almost no control over money at the point-of-sale. One of the reasons that the system did not function properly was the network to the bank which can affect both mobile banking and card banking as POS machine is part of it.

2.6 Mobile Banking

Banking systems adopts technology to support bank services efficiently. Mobile banking is a platform of performing financial activities from portable devices such as mobile phones, or tablets that is connected to telecommunication network. Mobile Banking as defined by Singh et al. [48] is a channel whereby the customer interacts with a bank via a mobile device, such as a mobile phone. According to them mobile banking is a subset of electronic banking (e-banking) – the logical development of electronic banking made possible by the ever-increasing spread of Internet-enabled phones and PDA's. It is the type of execution of financial services in the course of which, within an electronic procedure, the customer uses mobile communication technology in conjunction with mobile devices. The mobile communication can be carried out via different technologies, e.g. GSM/GPRS (Global System for Mobile communication /General Packet Radio Service), EDGE (Enhanced Data Rates for GSM Evolution) or UMTS (Universal Mobile Telecommunications System).

Mobile banking brings benefits to consumer where consumer can access their bank account at their convenient time and locations. Moreover, it includes: security, user-friendly interface, save time, dynamic facility, dynamic account monitoring, real time access and ubiquitous access. Through mobile banking, reduces the cost and time to travel and queued for banking services.

It provides service includes e-account statements, account histories, transaction records, loan statements, card statements, various options of bill payments and many more. It is cash-

based in that the user needs to deposit money into their account. For mobile banking transaction to take place there is need for collaboration between the Mobile Network Operator (MNO), Mobile Money Operator (MMO), the supermarket and the customer [49]. In this respect, the mobile money transfer is initiated by the customer and the money transfer is acknowledged by the supermarket till operator. Figure 2.1 below shows the process of customer request Account View Information from his bank using mobile banking application.

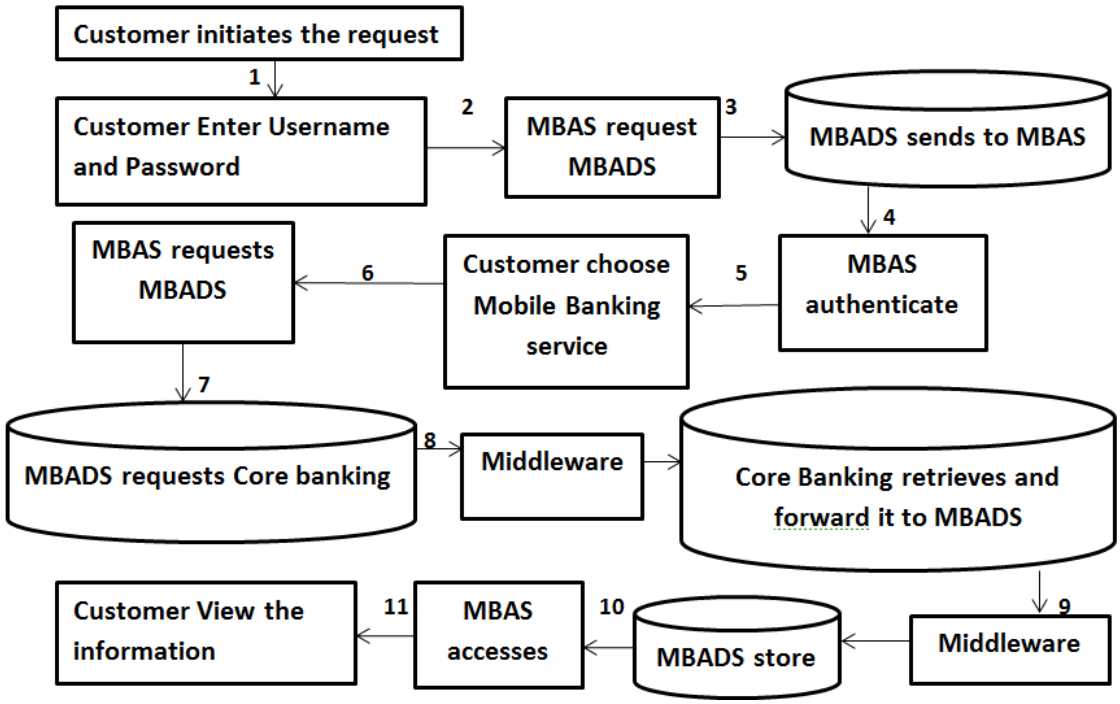

Figure 2.1 Mobile Banking transactions (Commercial Bank of Ethiopia)

1. Customer initiate access to Bank's system using a mobile banking app via the internet
2. Customer type Mobile Banking Username and password and sends to Mobile Banking Application Server (MBAS)
3. MBAS requests Username and password of the Customer from Mobile Banking Application Database Server (MBADS)
4. MBADS sends Username and password of the Customer to MBAS

5. MBAS authenticate the Customer and presents the facing page of the Customer ’s account
6. Customer chooses a Mobile Banking service say “Account Statement View” and forwards the service request to MBAS for processing
7. MBAS requests customer account information from the MBADS
8. MBADS requests customer account information from the Core banking that is accessed via the middleware
9. Core banking retrieves customer account information and forward it to the MBADS via the middleware
10. MBADS temporarily store customer account information
11. MBAS accesses the customer account information in MBADS and presents it to the customer and Customer view the information

2.7 POS Payment Machine

Many retailors use a POS payment terminal, providing the ability to receive card payments. The term Point of sale (POS) device most commonly refers to the in-store systems where customers pay merchants for goods and services. A POS is an electronic device capable of processing credit/ debit cards typically issued by banks. These devices are deployed at commercial outlets where they enable the merchant to collect cards as a means of payment for their goods or services.

POS is one of the e-payment systems introduced in Ethiopia to further the course of cashless policy. POS as an electronic payment device enables individuals to make purchases with their electronic cards. POS accepts ATM cards for payment of goods and services. The card stores account information on microchips and this microchip contains a purse in which monetary value is held electronically. The card can be used to make purchase of goods and services online, in supermarkets, shopping malls, and other market places. POS allows cardholders to have a real time online access to funds and information in their bank account through debit cards.

According to world cash report **[50]** in 2015, the world average number of POS terminals per 100,000 capita comes to 1.235. The growth rate in the availability and the use of electronic payments infrastructure and methods such as cards clearly reflects the growing relevance and popularity of electronic payments throughout the world. This is one of the drivers for change when it comes to the use of cash. The electronic payments infrastructure in a retail environment consists of cards and POS terminals. Throughout the world, card transactions are quickly becoming the most common form of electronic payments. The Figure 2.2 below shows the online POS payment machine card present purchase transaction process.

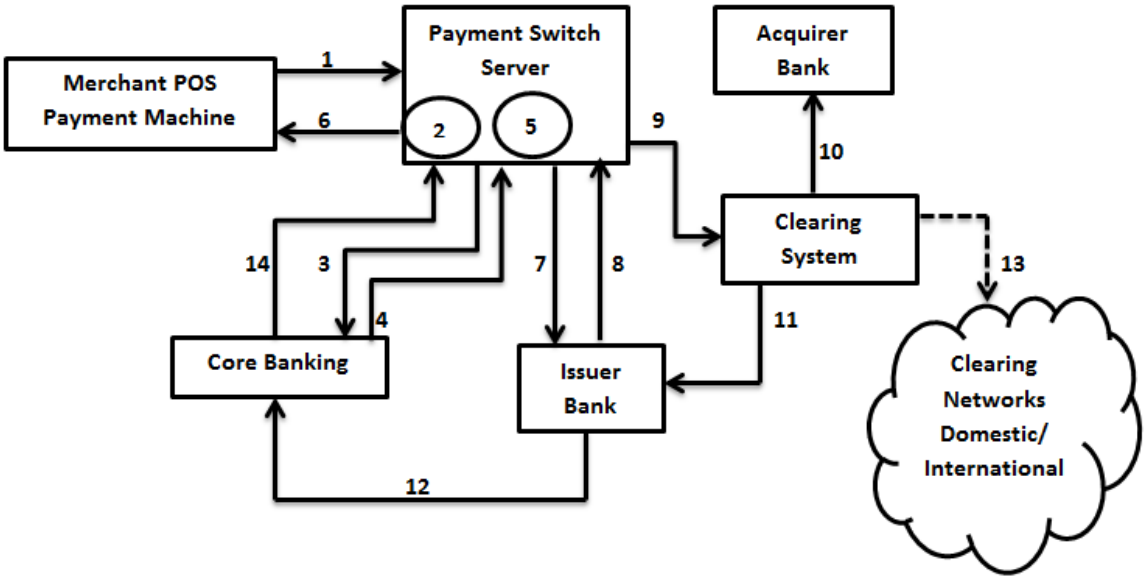

Figure 2.2 A generic, on-line PIN-based card transaction (Commercial Bank of Ethiopia)

1) Merchant POS purchase transaction request. The Payment Switch Server receives the request message from the POS device. It identifies the transaction arriving from the source endpoints. The Payment Switch Server determines the destinations based on the ATM card number prefix (Bank Identification Number) and PAN (Personal account number) length from the transaction.
2) The Payment Switch Server performs the pre-screening checks for a valid ATM card.

3) The Payment Switch Server with the destination for authorization sends the online transaction to the core banking Host interface for funds authorization against the cardholder account. The core banking Host receives the request for authorization, updates the cardholder available to spend amount and approves the transaction.

4) The core banking Host sends the successful funds authorization response. The Payment Switch Server receives the response.

5) Impacting. Before sending the response to the POS payment machine, the Payment Switch Server updates the authorization related data sources as a result of the approval.

6) The Payment Switch Server sends the authorization approval response to the POS payment machine and logs the transaction.

7) The Payment Switch Server sends an approval advice request to the Security module. The Security module manager process then reads the Security module and sends the advice message to Issuer. The Payment Switch Server saves a context record of the advice message. Issuer logs the authorization advice in order to support customer service enquiry and for subsequent authorization matching (see step 11).

8) Issuer sends an approval advice response. The Payment Switch Server then deletes the message from the context file and also from the Security module.

9) The Journal Query Process is run and processes the Extract. The Payment Switch Server writes the transaction to the extract file. This process might happen any time but more often is at the end of the day processing. When the next the clearing system batch is run the file is processed. The clearing system identifies the acquirer as on-us and the cardholder as on-us. The clearing system writes the transaction to its own archive and to the interface files.

10) The Acquirer batch is run and the file is read. The transaction is posted to the merchant account.

11) The Issuer batch is run and the file is read. The transaction is posted to the cardholder account. As part of the posting process the transaction is matched to the authorization advice received in step 7. The authorization is then deleted.

12) Issuer identifies that this transaction is to be settled externally and writes the transaction to the Transaction Extract interface file. The core banking Host reads and processes the transaction from this file. The transaction amount is booked to the cardholder account.

13) If the card that was used to carry out the transaction was a Visa card then the clearing system will create a 'Collection Only' transaction that will be included on the outgoing clearing file. Note that this feature can be switched on or off at the BIN (Bank identification number) level.

14) The core banking host sends a Positive Balance partial refresh file with updated balance information (including any known outstanding authorizations) to the Payment Switch server. The Payment Switch Server performs impacting to update its stored balance information for the card.

2.8 Summary

There is a growing literature inferring the benefits that electronic payment brings to customers, merchants, Governments and even to society.

The mobile channel represents significant opportunities; payment options for customers and streamlining processes for retailers. The viable potential and a significant growth and usage of mobile-based financial services has both opened new business opportunities for the banking companies and provided greater convenience for a payment system such as retailers that makes the purchasing process fast and reliable.

There are many new ways to pay for different products. Many of the challenges encountered by retailers nowadays show how important convenience is for customers, which is why currently most developments in the retail payments space have been about streamlining the buying process and making it quicker and safer. There are also many choices available to both customers and retailers, especially in e-payment. Use of different models such as bank, MNO and third party addressed by various technologies of card based payments, mobile based payments and others like micro payments, e-wallets: PayPal, Apple Pay, Google Pay, hello cash, M-birr, etc. All these payment solutions can have added benefits by connecting

information about a customer to transactions. In the area of retail payment system there is a possibility to improve payment system efficiency by reducing waste of time at the checkout through combining existing infrastructure of different technologies such as internet and a card payment system/electronic fund transfer (EFT). A wireless communication technology for a Mob-POP for accessing the supermarket server, a standard wired EFT communication for POS machine, a financial transaction like purchasing over internet and a network access of carrier-based mobile communication technology like GSM or CDMA as in PDAs or cellular phones; a still evolving standard called WAP (Wireless Application Protocol) infrastructure is used to support these applications constructed using web based and java development tools. There are no major changes to the underlying payment protocols and hence this method will not be discussed further.

CHAPTER THREE

3. Related Work

3.1 Overview

Electronic payment system tends to bring many electronic modes of payments through which financial institutions offer different electronic payment opportunities and services to their customers such as the credit cards, debit cards, on-line banking and mobile banking [1].

A growing technology of electronic payment dealing with the consumer payment choice for saving service time; time constraints lead consumers to be more concerned with the duration of the activity

The electronic payment literature shows that the adoption and usage of electronic payment instruments can be determined by payment instrument attributes. In this regard researches pointing out the importance of certain payment instrument attribute, including convenience, ease of use, speed, record keeping, and security, when choosing a payment method. Mobile banking is viewed as being more convenient, cheaper, and capable of providing better records as it enhances their convenience by technological enhancements.

3.2 Advancements of Retail Payment Systems

Since development is pushed by new technological possibilities, this section is organized around research on the most important technologies facilitating new payment systems at the POS payment machine.

Studies conducted have shown that the speed of a transaction, determining time spent at the counter, is one of the most significant factors determining the choice of a payment instrument [51, 52]. Thus, the time of a transaction at the check-out constitutes an important part of merchants' costs and time spent on paying and queuing implies consumers cost. It shall be noticed that the importance of the transaction speed varies depending on the sector; it is of key importance during mass events, in retail store like supermarket, in public transport or fast-food chains and less in luxury boutiques.

Recently many new solutions have been introduced, which can become competitors of cash at physical POS payment machine. They are contactless card which is issued in traditional

form, however other forms, like RFID stickers for mobile phones, wristwatches or key fobs, are also applied to a limited extent and they operate similarly to contactless cards. A payment with a contactless chip can be done by simply holding the device containing the chip in close proximity to the card-reader. The more advanced contactless connection on mobile payment technology, i.e. NFC (Near Field Communication) can also work similar to a contactless payment card. However, NFC has much more features based on mobile device. These contactless solutions are technologically mature and based on international standards. Mobile NFC payments and contactless cards use the same contactless POS machine network. Via POS machine, micropayments, internet banking, and internet shopping mall payments can all be made via NFC. Alternative solutions, which can be used in POS transactions, are remote mobile payment systems. These systems are based mostly on universal communication through the GSM mobile network (most often through SMS or USSD sessions) or mobile Internet. However, despite considerable number of remote mobile payment systems operating in the world, they are not compatible with each other [53]. With the advent of Smartphones and the multitude of apps developed for them, a new generation of 2D barcodes has arisen for identification of a certain product or product group, such as the QR-Code. These barcodes, along with the rise in mobile (smart) phone use, have already been successful in retail payment scenarios [41].

A different technology of POS system was the mobile POS (mPOS) is a smartphone, tablet or dedicated wireless device that performs the functions of a cash register or a traditional point of sale (POS) device. In fact, any smartphone or tablet can be transformed into an mPOS with a downloadable mobile app. Because mPOS systems are completely portable, they can be used anywhere in and away from the business and this has made them essential for mobile merchants. Giving staff cell phones linked with mPOS stock management systems to on time help clients to get the information they have to make their purchase [54].

On the literature reviewed from 2007 to 2016 surrounding mobile financial applications the top computer science publications across disciplines includes security and privacy, human-computer interaction (HCI), ubiquitous computing, mobile computing, networks and distributed systems, communication and signals, and computing for development, for exploring technologies that can assist banks and mobile operators in providing financial service products. These literatures were emphasised mainly areas related to a system to

avoid fraud, a mobile payment applications which can operates on a peer-to-peer network which uses fingerprints for authentication and NFC for recipient identification, branchless banking Android applications which paves the way for better security standards and analysis procedures, use NFC for mobile money systems such as contactless payment and digital wallets and a combination of mobile phone and van-operated savings and transaction accounts [11].

Castle et al. [11], suggested that the global adoption of mobile technologies has supplied an opportunity to assist the financial sector. Subsequently, mobile banking applications have achieved astounding success, quantitative data about these deployments is largely unavailable and this limited the features offered by various services.

A work done by Bansal and Singla [12], which aimed to solve the problem of the waiting time of customers in ATM queue for cash withdrawal. The authors proposed adding a new algorithm in the Mobile banking application then this enable users before they reach to ATM machine when they are in the queue they can able to start the cash withdrawal process. So that the actual ATM cash withdrawal time can be minimized. The proposed solution focused on only for cash withdrawal process which depends on a single system, bank. Saving service time by utilizing the waiting time of customers is an important phenomenon in retail store environment especially in supermarket. Payment process at the supermarket has wider than cash withdrawal. It involves and coordinates two major systems the supermarket system and the bank system for developing a successful payment process.

The growth of wireless technology has increased the number of people using mobile devices and accelerated the development of mobile service conducted with these devices. According to Juniper Research report on march 11,2018 the number of mobile banking users globally exceeds more than 1 billion by the end of 2017 [55].

There is a significant and growing demand on deploying banking and financial services over mobile networks. The services developed in recent years on mobile technology to fulfill the growing demand of mobility are providing mobile based banking and financial services. These types of applications/services include buying over mobile phone, online transaction, mobile banking, mobile e-wallet, mobile POS, mobile payment, mobile money transfer, etc. And the benefits attributed to mobile banking include but are not limited to: Portability,

Labour free, Reduced cost, Convenience, Wider customer reach, High level of security and Accessibility [56].

Several types of online payment systems have been studied by the author in [57] who classified them into electronic currency and account-based systems. In account-based systems, users are allowed to pay using their own bank accounts while the latter allows consumers to pay only with the help of some electronic currency. Both the systems provide numerous payment methods such as i) Electronic payment cards (credit/debit and charge cards), ii) Mobile payments, iii) E-wallets, iv) Smart and loyalty cards, v) Virtual credit cards, vi) Stored value card payment, and vii) E-cash.

Ruijun et al. [58] have conducted a research on Mobile payment categories by comparing the different technologies and business models available focusing on RFID and contactless payments. They have identified the problems on security of payment system, different technical standards that affecting interoperability, lack of user acceptance, i.e., not attractive to users, lack of the industry chain and profit distribution standard between the business models.

3.3 Trends of Electronic Payment System in Ethiopian Retail Store

In Ethiopia it is observed that much of all payments performed by retail customers at the retail store like supermarket have made in cash, but in recent years the improvements indicates the use of debit cards. Even though the card's use was gradually increasing, most of the transactions has made in cash. It has been seen that debit cards were used mainly for cash withdrawals, not for payments at POS terminal. Mostly occurring in supermarkets where the customer takes their products to a cashier who swipes their ATM card in the card reader. The POS machine checks the card's validity, connects to the bank that issued the card and once the payment has been credited to the account, it prints out a receipt to the customer.

In terms of technology, the payment card has undergone a considerable change. The banking sector currently using EMV (Euro pay, MasterCard and Visa) microprocessor and magnetic stripes debit cards, but the use of contactless cards, RFID (radio frequency identifier) stickers for mobile phones, NFC mobile payments and some other contactless payment devices, like wristwatches and key fobs are not yet in use. Currently mPOS technology has

advertised to banks in Ethiopia. Apart from cash and payment cards, no other payment instrument plays a significant role in the retail POS payment market. There are mobile payment applications such as M-Birr, Hello cash etc serving the users but they are not used in supermarket as a payment tool yet.

3.4 Summary

In modern e-payment systems the number of involved players is increasing. In fact, from the traditional "buyer-seller" exchange we passed already to a more complex transaction models, including also network providers, finance companies for money transactions management, generally a credit card or debit card issuing company and/or other institutions operating inside Internet. Important interoperability requirements should become in to effect. In addition, in this E-payment environment speed of execution and ease-of-use were mandatory requirements, too.

And there is an opportunity that using technologies different but they have related tasks for improving efficiency has a benefit of less time to invent and less cost for testing as well as implementing. In the context of new payment systems, e-payment in retail store from efficiency view addressing through the use of different technology means for a single purpose is still one essentially unsolved challenge. Several technical solutions have been proposed, more or less tightened to various incompatible solution models still competing among them. However, no one of this invent combined internet-card banking technology solutions emerged as a solution on the retail store as the service time saving, yet.

This thesis aims to give a combined solution for retail electronic payment system which optimizing the time spending in the checkout process for customers in a supermarket context.

CHAPTER FOUR

4. The Proposed Payment System Model

This Chapter presents the Payment System Model in Retail stores through POS terminal using Mobile Banking (PMRPMB). As supermarket is one of the retail stores, the research focused its analysis based on supermarkets. It is mainly composed of two major parts namely: Design Considerations and System Model. The design considerations Section presents various determinants for high efficient Payment system. In the system model section, components of the proposed model along with detail description and complete algorithms and flowcharts are presented.

4.1 Design Considerations

The aim of this design is to propose an efficient payment system that can yield an optimized service time saving. The main factors considered during the design are summarized below.

a. Provide the payment rails
   - Enable low latency and high transaction volumes,
   - Support all payment types: high-value payments and low-value payments, attended or unattended.

b. Cost efficient
   - Reusing the existing technology and existing implementations to minimize setup and operating costs and reduce time-to market.

c. Provide convenience and confidence to end-users
   - Allow customers to use the already existing in hand and familiarized technologies.

d. Computational Time
   - Time factors are in the center of service provisioning. As a principle, the higher the efficiency of the service provider, the faster services could be provided and the smaller service time the user could ensure.
   - In the new payment, two major techniques namely: prepayment and final payment are designed in a way they yield a better computational time. The prepayment component is employed based on minimizing waiting time in the

queue and make ready amounts to be paid. The assumption in the latter approach, final payment, is once prepayment activities done then proceed to pay in short time than the usual payment process.

4.2 System Model

In its simplest form, a payment is any exchange of value between two parties, where usually Party A offers a form of currency in exchange for a good or service provided by Party B. Enabling a convenient way to make and accept payments is a key component of financial inclusion. Among these characteristics, compared to more traditional forms such as cash and check, electronic payments can offer a superior option for both consumer and merchant. This takes the form of quickly transferring funds. Purpose of all these transformation is to save customer time. In this fast running world, banks have been left with no option but to adopt the technological changes to satisfy their customer's requirements. In this upcoming feature, the main purpose is to utilize the waiting time of customers in the queue, so that the actual checkout process time can be minimized as well as increase volume of sales of the supermarket.

Most payment systems formulated so far are developed from other preexisting approaches which are purposefully designed to solve problems of that time and scenario. For instance, POS payment machine we have been using in the supermarket for making payments with ATM card and mobile banking technology for managing personal accounts anytime anywhere is shown to be very promising and they indeed yield optimized payment method. Such systems could also be mentioned as the major contributors for the derivation of the current efficient payment system.

However, this does not necessarily that POS payment machine is suitable means of payment systems for such relatively high time consuming purchase environment like the retail store. Supermarket as it is one of a retail store in its nature, especially its time consumption during purchase process, is different from other retail stores. Among the many factors, during peak hour and holydays time spent for purchasing items in the supermarket takes much of customer time.

Intense reviews conducted on various payment methods related literatures in general and electronic payment systems models in particular revealed that in most countries of the

world, especially in Ethiopia, the absence of some service time saving components in the supermarket affects the efficiency of the service provisioning negatively. This could also be mentioned as the major reason for the unpromising efficiency of payment systems in the supermarket. In order to come up with the model, it is crucial to determine the design significant requirements. Therefore, both mobile banking services requirements and POS payment machine system services requirements are identified using review of literature and the application's nature and/or observation method.

As it is shown in Figure 4.1, the model is composed of eight components namely User, Mobile Banking System, Payment Switch System, POS Payment Machine System, Middleware/API System, Core Banking System, Supermarket POS System and Mobile Point of Purchase System (Mob-POP). The demonstration for the aforementioned diagram could be described on a piece by piece of the model. The new model is designed in a way each user is doing as a self- service.

The User initiates the request. Various requests which compose the checkout process of the supermarket are initiated in this component. Therefore, user encompasses a registered Smart Mobile phone installed with both mobile banking application and Mob-POP application. The Mob-POP system shown in Figure 4.2 is similar with a supermarket's sales application which will help customers to select items to be purchased and make ready data for next process.

The immediate accessing component next to Mob-POP system is the Mobile Banking System shown on Figure 4.3. After the selection of items to be purchased then the prepayment transaction process proceeds by the user. This is done by modifying the mobile banking application to execute the functions of POS payment machine. An invocation of mobile banking system given the initial state of the payment process employs the payment switch via the middleware/API component. The API is an interface among three components, i.e., mobile banking, payment switch and core banking.

The Payment Switch System shown in Figure 4.6 indeed used to authorize the system user as well as communicate with the core banking system for processing a transaction. A new data store will be created on a Payment Switch System, which will maintain all payment transaction created using Mobile banking System. For the payment process to become

completed the request is initiated by the state of a component called POS Payment Machine System shown in Figure 4.5. There is no need to go through all the usual steps at POS Payment Machine for making a payment. The process is done based on the information getting from both the ATM card and OTP (one time password) generated from the payment switch system.

The Core Banking System component is checking and verifying account information of the user and processes the transaction. In the last component, at the Supermarket POS System shown in Figure 4.4, a cashier confirmed sales item selected for purchasing earlier using code generated from this component with a client desktop POS device, finally change will be effected at the supermarket server.

The model has five major transaction parts and it further the process broadly parted in to two: Prepayment transaction and Final payment transactions.

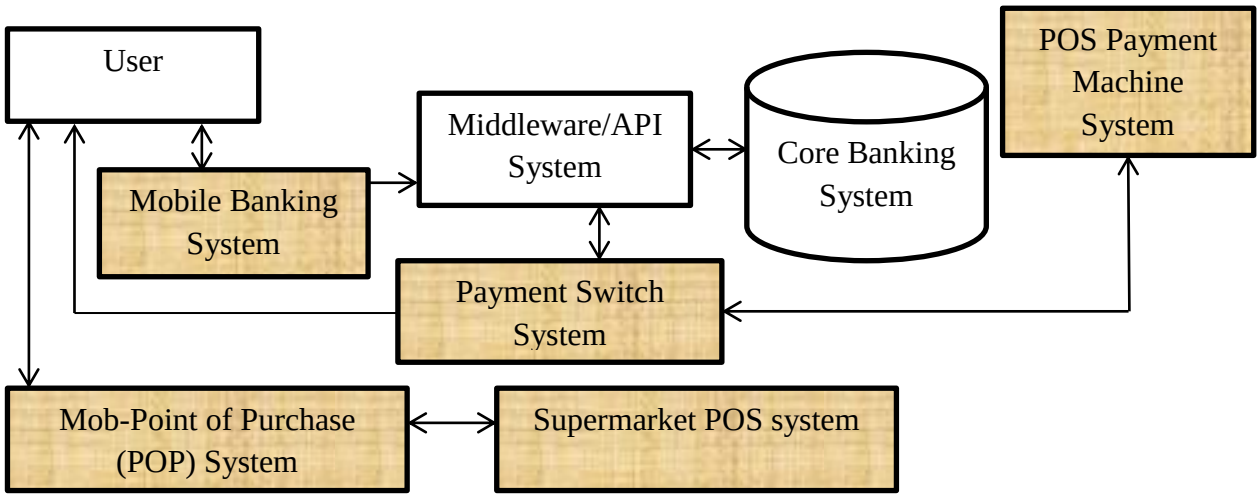

Figure 4.1: High Level Model

4.2.1 Mobile Point Of Purchase (Mob-POP) System

In order to purchase items from the supermarket the Mob-POP application shown in Figure 4.2 is designed to communicate with the Supermarket POS System shown in Figure 4.4 via the wireless network as part of the new payment system model. This feature will follow the sequence of corresponding supermarket's POS application steps, i.e., reading items, calculating its sum and then generate a transaction record, which will store on the Supermarket application server. This is shown in Algorithm 4.1 and Appendix E. As the Figure 4.2 below shows**,** Mob-POP system employed in the new model is fully dependent on the POS System used in an environment, such as a supermarket.

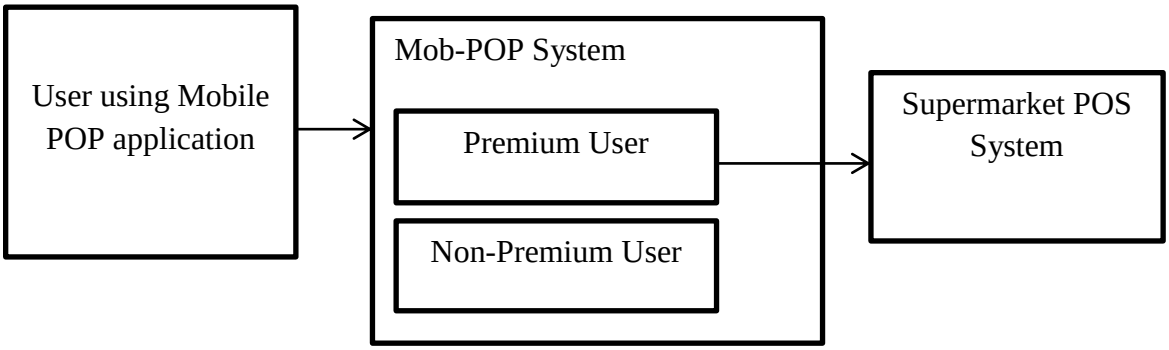

Figure 4.2: Item selection process

Algorithm 4.1: Procedure Item Scan/pick

Procedure Item Scan/pick

```
Enter MB PIN
If
    The PIN is authenticated, Then Proceed
Else
     Invalid or wrong PIN
TRY AGAIN
After n unsuccessful attempts
Alarm to user registered mobile or message to Return and
Go for revalidation process
For confirmation, verification and intimation for reset Password.
Valid = false
      Output "1. Non-Premium User"
      Output "2. Premium User"
      Output "3. Quit"
      While valid! =False
            Input option
            If option = 1 then
                  Output "Contact Non=Premium Window"
                  Else if option=2 then
                  Select=False
                While Select! = False
                  IF Adding item Then
                        OUTPUT "Pick your item"
                        OUTPUT "Enter bar code/Scan"
                        INPUT user scan barcode/ types in item code.
                        IF answer = barcode THEN
                              Output" Display item name and item cost"
                              Add item cost to 'Total item cost'.
                        End if
                   Else
                        Select=True
                   End if
                End While
                OUTPUT " Please confirm the selection"
                OUTPUT " Send code to mob POP app"
                Transaction Successful (Pending)

            Else
                  Valid=true
            End if
      End While
```

4.2.2 Mobile Banking System

Mobile banking is needed to perform efficient job in the bank system as the bank for a given mobile banking system has already assigned the required resource. A registered customer used internet for mobile banking application to transact his account remotely as shown in Figure 2.1. Various approaches could be used to improve efficiency in the supermarket though, the mobile banking component customized a new option named “Sales” that will be added in the Mobile banking application just like balance check, fund transfer etc as well as takes PIN and Price. As it is shown in Figure 4.3, it is designed to communicate with the Payment Switch System shown in Figure 4.6 via the Middleware/API as main modification for the new Payment System Model. This feature will follow the sequence of corresponding bank POS Payment machine making a payment steps and generate a transaction record, which will store on the Payment Switch server with current time stamp. In return, according to section 4.2.5 One Time Password (OTP) will be sent to the registered Mobile number, lastly which will be used to complete the transaction on a POS Payment Machine System shown in figure 4.5. This depicts on Algorithm 4.2 below and Appendix F.

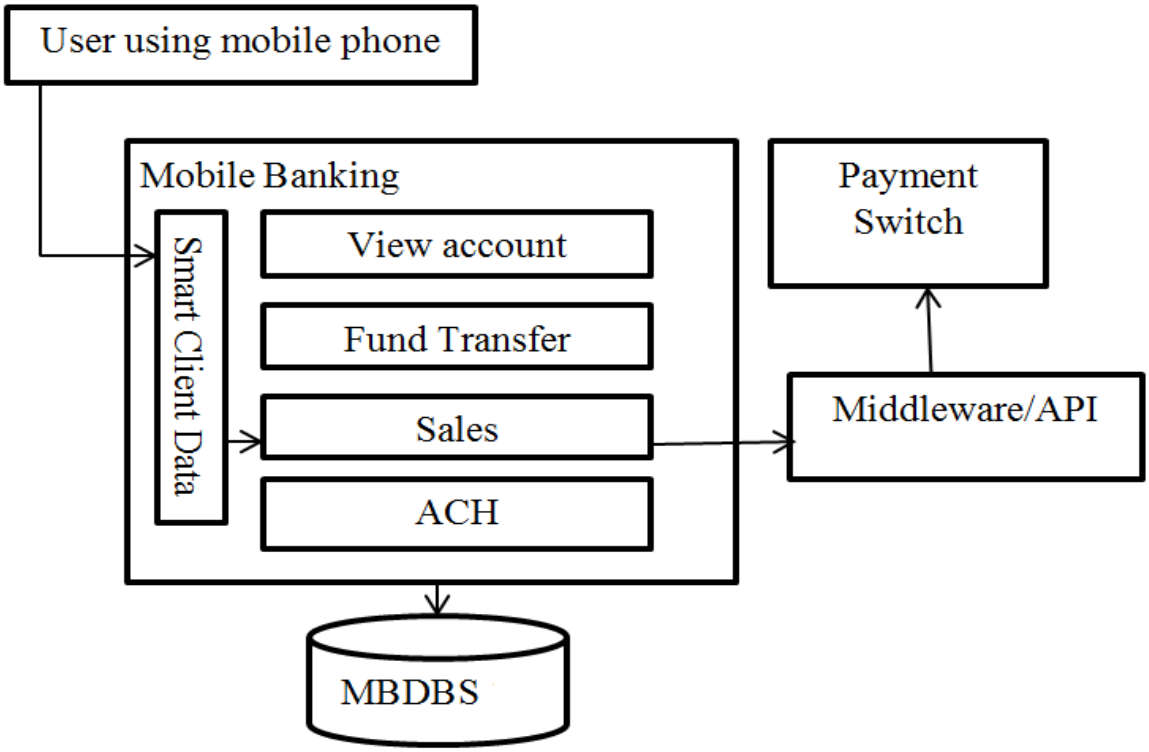

Figure 4.3: Mobile Banking payment process

Algorithm 4.2: Mobile Banking

Procedure MB

```
Enter MB PIN
If
    The PIN is authenticated, Then Proceed
Else
     Invalid or wrong PIN
TRY AGAIN
After n unsuccessful attempts
Alarm to user registered mobile or message to Return and Go for revalidation
process
For confirmation, verification and intimation for reset Password.
Valid = false
      Output "1. View Account Balance"
      Output "2. Sales"
      Output "3. Quit"
      While valid! =False
            Input option
            If option = 1 then
                  Output "Balance is" balance
            Else if option=2 then
                  If pending transaction
                        Output "Mobile Pending TxN"
                        Output "Enter amount to Pay"
                              Input amount
                        Output "Enter ATM PIN"
                              Input number
                              If correct then
                                    Select Print TxN
                                    Send OTP on a registered Mobile number
                                    TxN successful(Pending)
                              Else
                                    OUTPUT" Invalid or wrong PIN"
                                    TRY AGAIN
                                    After 3 unsuccessful attempts alarm to user
                                    registered mobile or message to Return and Go
                                    for revalidation process. For confirmation,
                                    verification and intimation for reset
                                    Password.
                              End if
                  End if
            Else
                   Valid=true
            End if
      End While
```

4.2.3 Supermarket POS System

This system is solely serves the supermarket business and it consists Client Desktop POS application, Supermarket application server and Supermarket database and there is a dedicated connection between them. On this system shown in Figure 4.4 the Supermarket Application Server is modified to generate numeric code and send to Mob-POP System shown in Figure 4.2. By doing this, added a new functionality of verification means for authorizing the transaction made by a customer. Then, cashier is expected to confirm the transaction done by a customer by entering a numeric code in to a client desktop POS application and following this the supermarket database is updated. In addition, a new temporary data store/table is required on the supermarket application server without disturbing the existing ones. This is indicated in Algorithm 4.3 and Appendix G.

As the Figure 4.4 shows the confirmation process is entirely part of the Supermarket POS system.

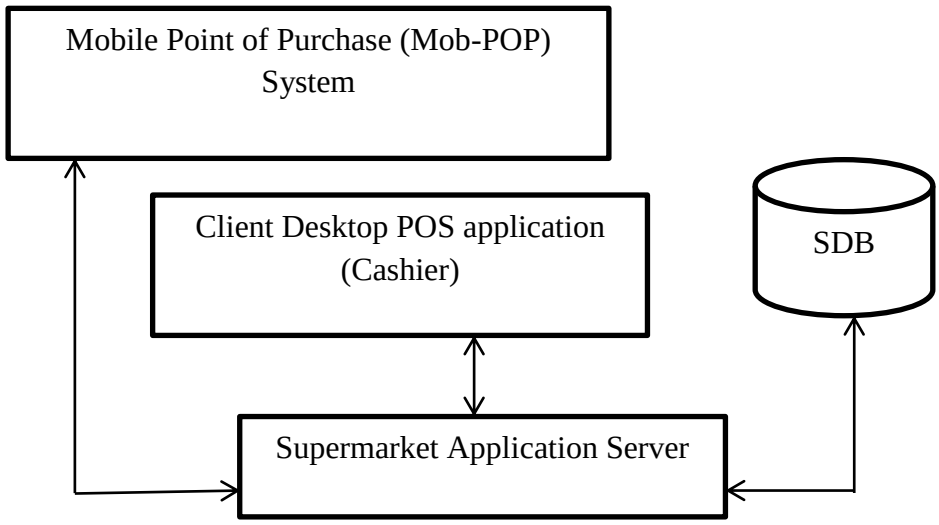

Figure 4.4: Cashier confirmation process

Algorithm 4.3: Procedure for Cashier Confirmation

Procedure for Cashier Confirmation

```
INPUT - Cashier types in code.
IF answer = code THEN
     Output: Display item name and item total cost.
     Cashier Accepted
     Go for Pay using ATM card
ELSE
     Invalid or wrong Code
TRY AGAIN
After n unsuccessful attempts
Alarm to user registered mobile or message to Return and Go for
revalidation process
For confirmation, verification and intimation to reset Password.
```

4.2.4 POS Machine Payment System

The customer initiates a payment request at a POS payment machine using ATM card. When ATM card is inserted in the POS payment machine, account information for the corresponding ATM card is retrieved from Payment Switch server as shown in Figure 4.5. After enabling this new feature, POS payment machine application will check the account information as well as pending transaction information from Payment Switch server shown in Figure 4.6. If there is any pending transaction i.e. transaction done by Mobile, then system will show the screen to enter OTP, which was sent on registered mobile number for corresponding account, to complete the transaction along with option to cancel the pending transaction and start new one. On entering the valid OTP, if it does not timeout, payment processed and transaction will be completed. Whereas on selecting the new transaction option, normal POS process will be followed. In case, there is no pending transaction for the account, existing POS payment machine application shown in Figure 2.2 will run without giving the prompt for OTP. That means there is no change for POS payment machine users,

who will not use “Sales” feature from Mobile banking, this depicts in Algorithm 4.4 and Appendix H.

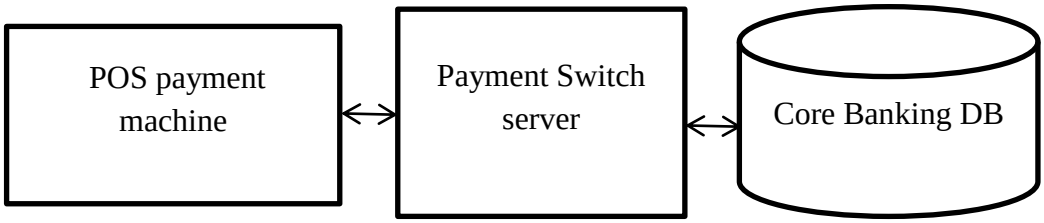

Figure 4.5: POS machine payment process

Algorithm 4.4: Procedure POS payment machine

Procedure POS payment machine

```
Output “Enter ATM card”
Input ATM card
Valid=False
If pending transaction then
      Output “1. Pending transaction”
      Output “2. New transaction”
      Output “3. Quit”
      While valid! =False
            Input option
            If option=1 then
                  Output “Enter OTP”
                  Input number
                        If correct then
                              Output “Paid and get receipt”
                        Else
                              Output “Invalid or wrong OTP”
                              TRY AGAIN
                              After n unsuccessful attempts alarm to user
                              registered mobile or message to Return and Go
                              for revalidation process. For confirmation,
                              verification and intimation for reset
                              Password.
                        End if
            Else if option 2 then
                  Cancel pending and Start new transaction
            Else
                  Valid=true
            End if
      End While
Else Normal POS operation
End if
```

4.2.5 Payment Switch System

This system is part electronic fund transfer (EFT) that is plays a major role in a Card Banking Network. On this system shown below in Figure 4.6 there is a modification to accept PIN and Price information from the Mobile Banking/ Internet Banking than it was from Card Banking/ POS Payment Machine and in return it generate OTP and sends to a register mobile number. By doing this, this system serves both Card Banking and Internet Banking at the same time. In addition, a new data store/table is required on the Payment Switch server without disturbing the existing ones. Then, customer is expected to complete the payment transaction by entering an OTP in to a POS Payment Machine System shown in Figure 4.5 and then the receipt is produced both for cashier and customer.

Basically this is the core operation and its operation distributed it to both Mobile Banking System shown in Figure 4.3 and POS Payment Machine System shown in Figure 4.5. As the Figure 4.6 below shows the Mobile Banking System and POS Payment Machine System are combined and dependent on Payment Switch System.

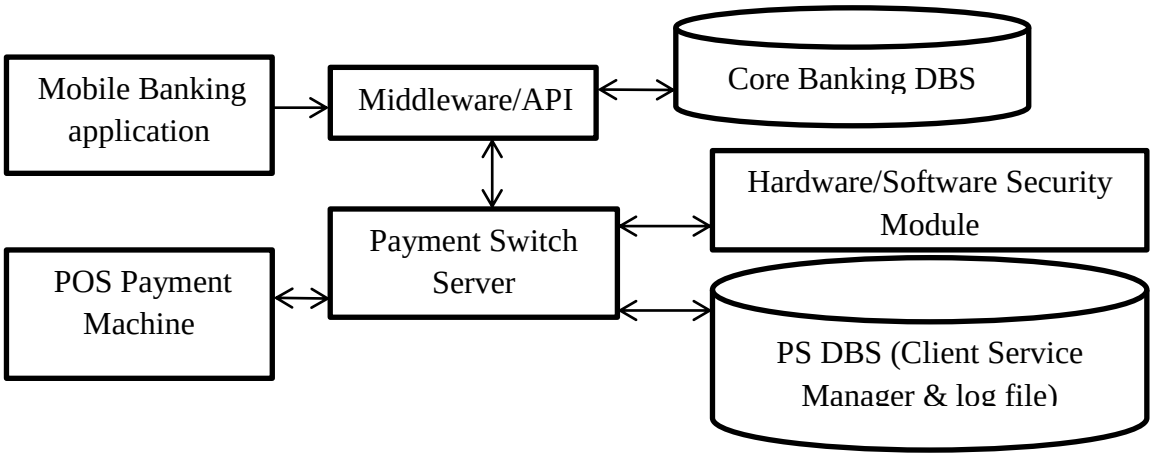

Figure 4.6: Payment Switch Process

4.2.6 Fields of the new table

In this new table, only the important fields are to be stored, mentioned in Table 4.1 and Table 4.2, which are used in a transaction. Below is the detail of table

A. Payment Switch server

The required fields which are used in a transaction are account number, amount, print, OTP and created.

a. Account Number: Primary key and cannot be null.
b. Amount: Cannot be null and should be greater than 0.
c. Print: Boolean option, by default value is 0 and 1 will be stored on selecting the Yes option for print receipt.
d. OTP: A 4 digits number is generated and stored it on server for verification.
e. Created: It is used to store the time stamp of the incomplete transaction when created. Periodically compared with current time to check if the transaction is expired or not. There is defined time to keep the transaction in pending state and if it is not completed or canceled within the defined time then delete automatically.

Table 4.1: Payment switch server table field format

Account number	VARCHAR(15) NOT NULL PRIMARY KEY
Amount	INT NOT NULL
Print	BOOLEAN (Default 0) NOT NULL
OTP	VARCHAR(6) NOT NULL
Created	TIMESTAMP NOT NULL

B. Supermarket Application server

The required fields which are used in a transaction are cart_code, user_name, total_price, txn_status, id, barcode_number, item_name and item_price

a. cart_code: Primary key and cannot be null; A 4 digits number is generated and stored it on server for verification.

b. user_name: Authorized User in to the system

c. total_price: Cannot be null and should be greater than 0.

d. txn_status: It indicate the transactionComplete/ Cancelled/ Pending

e. id :Session Id

f. barcode_number: It identify the items

g. item_name: product name

h. item_price: Unit price of the product

Table 4.2: Items table field format

Column	Type	Null
barcode_number	bigint(20)	No
item_name	varchar(20)	No
item_price	double	No

Table 4.3 User cart items table field format

Column	Type	Null
id	int(11)	No
cart_code	int(11)	No
barcode_number	bigint(20)	No

Table 4.4: user cart transaction table field format

Column	Type	Null
cart_code	int(11)	No
user_name	varchar(20)	No
total_price	double	No
txn_status	varchar(10)	No

4.2.7 Two Broad Parts of a Model

A. Prepayment Transaction

Following the selection of items to be purchased the prepayment transaction process shown in Figure 4.7 is initiated by the user. This is done by modifying the mobile banking application. It uses the price information (the total amount to be paid) as input to a Mobile Banking system shown in Figure 4.3 from the Supermarket POS system shown in Figure 4.4 using Mob-POP system shown in Figure 4.2.

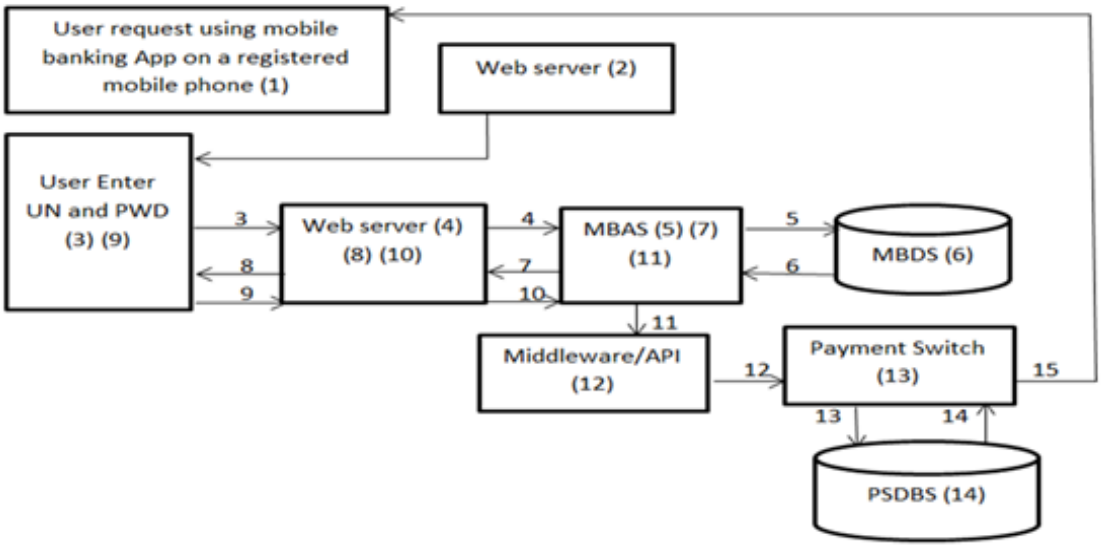

Figure 4.7: Prepayment Transaction

B. Final Payment transaction

After purchased items confirmation is done using a numeric code from a Supermarket POS system shown in Figure 4.4 using Mob-POP system shown in Figure 4.2, the Final Payment Transaction process shown in Figure 4.8 is initiated and done at the POS Payment Machine system shown in Figure 4.5 using ATM card and OTP; found from Mobile Banking System shown in Figure 4.3 as input. This is done by modifying the Payment Switch system shown in Figure 4.6.

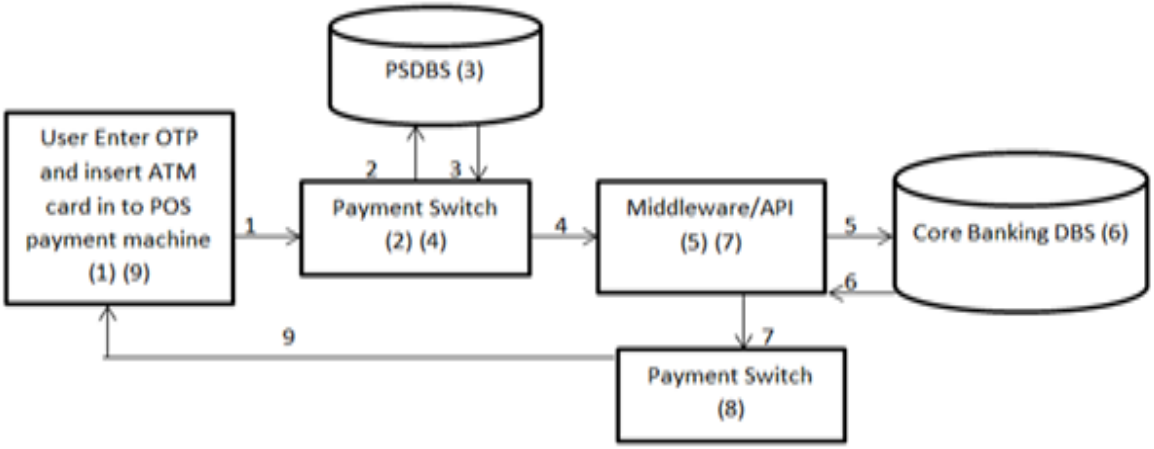

Figure 4.8: Final payment Transaction

These empower a customer to save waste of time assisted by the Proposed Payment System Model when they are both lining up in the queue waiting for their turn and collecting items for purchasing in the checkout process.

CHAPTER FIVE

5. Experimentation

5.1 Overview

This Chapter presents tools and methodologies that have been used to implement Payment System Model in Retail Stores through POS terminal using Mobile Banking. We have discussed and planned to test the experiment on a real environment that is both on Bank and supermarket, named SHOA, as the primary plan but we faced the problem such as privacy and cost. The Bank's payment switch server and POS payment machine and the supermarket POS application are vendor specific system and they requires vendor permission and costly as it requires main modification on the functionality of the systems. Thus, we used the second plan, simulation, to test the solution.

The prototype is developed based on the model represented in Chapter Four. This Chapter also discusses programming approaches and techniques used to model and manipulate entities of the payment system model.

The last topic discussed in this Chapter, experiment and evaluation, presents the efficiency of the proposed payment system model that is evaluated by undertaking experiments and expert reviews.

5.2 Scope of the Prototype

The prototype is designed to meet the basic requirements of the system model shown in Figure 4.1. Major components such as Mob-POP System, Mobile Banking System, Supermarket POS system and POS Payment Machine System are implemented and Payment Switch System function is implemented within related system. However, components less required to reveal efficiency are not implemented in this prototype as they are not mandatory for preliminary system checkup. Besides that, the prototype does not implement ATM card inserting and Payment Switch Server data manipulations.

5.3 Development Tools

The following tools are used to implement the prototype application.

5.3.1 NetBeans IDE Version 8.0.1

NetBeans is an Integrated Development Environment (IDE) and platform. It supports several programming languages, either by built-in support or by installing additional plugins.

It consists of different features source editor, compiler/an interpreter, debugger, Database management support, version control system and other tools for Object-Oriented Programming, such as Class Browser and Object Inspector needed in development. As well as it is also a platform that developers can use NetBeans' APIs to create both NetBeans plugins and standalone applications [59].

NetBeans IDE is a lot more popular with Java language and has built-in support for Java SE (Standard Edition) applications, which typically run in the user's desktop or notebook computer.

5.3.2 Java Programing Language Version 8

This version of Java is chosen because of its importance mentioned below [**60**]. The Java platform consists of:

- **Java application programming interfaces (APIs)**
  - It has libraries of compiled code that you can use in your programs.
  - It supports to add ready-made and customizable functionality to save you programming time.
- **Platform independent**
  - Java programs are run (or interpreted) by another program called the Java VM than running directly on the native operating system; the program is interpreted by the Java VM for the native operating system.

A. Development Frameworks

The prototype employs client server layered architecture to develop the application. We used Java Vaadin web framework for the presentation layer and Java Persistence API for Persistence layer.

i. Vaadin Java web framework

Vaadin is an open source web framework for rich Internet applications. It uses Java as the programming language for creating web content. Importantly the framework incorporates event-driven programming and widgets, which enables a programming model that is closer to GUI software development than traditional web development with HTML and JavaScript. The Figure 5.1 below shows the Vaadin Runtime Architecture which gives a basic illustration of the client-side and server side communications, in a running situation where the page with the client-side code has been initially loaded in the browser.

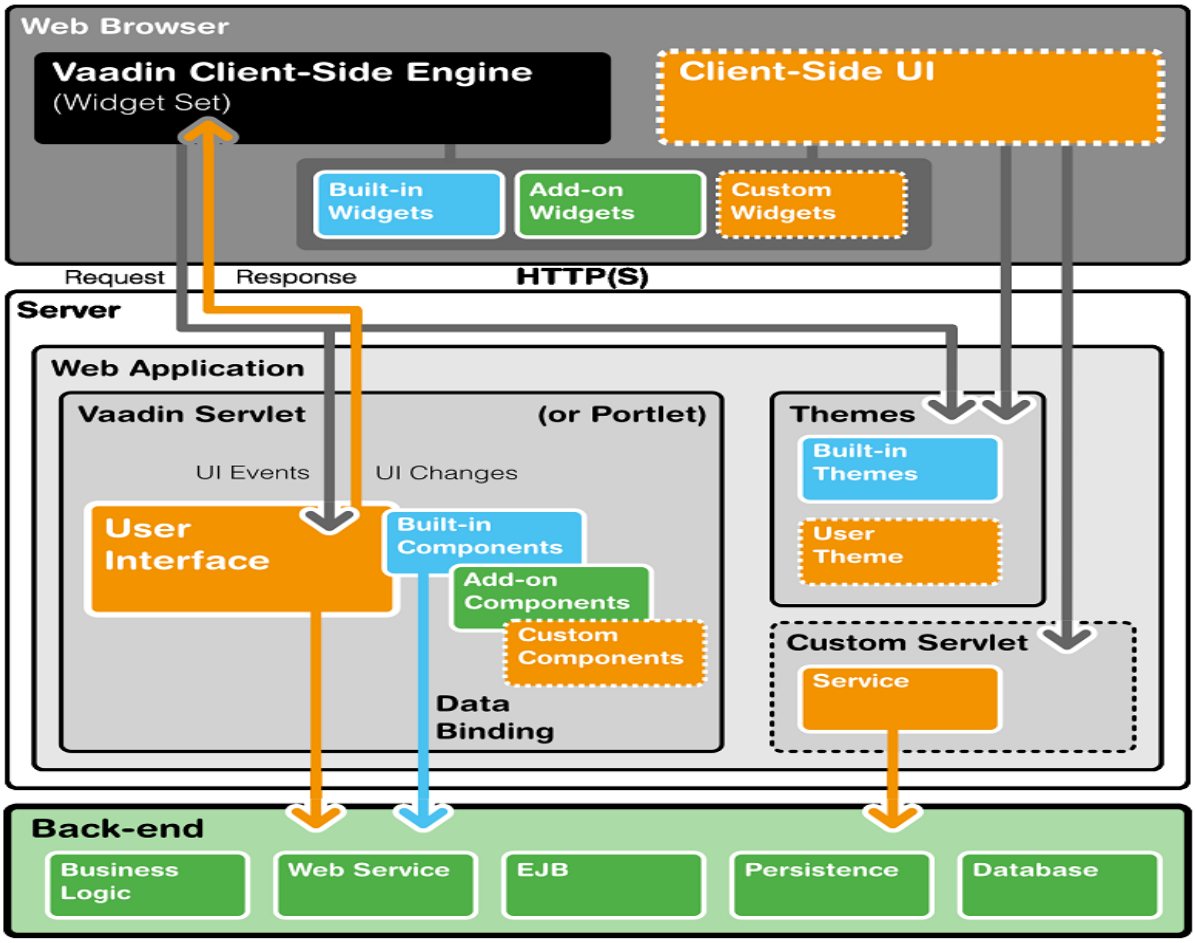

Figure 5.1: Vaadin Runtime Architecture

The salient features of the vaadin web framework architecture for development are as follows:

a. User Interface

Vaadin applications provide a user interface for the user to interface with the business logic and data of the application. Its main task is to create the initial user interface out of UI components and set up event listeners to handle user input. The UI can then be loaded in the browser using an URL, or can be embedded to any HTML page.

b. User Interface Components/Widgets

The user interface of a Vaadin application consists of components that are created and laid out by the application. Each server-side component has a client-side counterpart, a "widget", by which it is rendered in the browser and with which the user interacts. The client-side widgets can also be used by client-side applications.

c. Client-Side Engine

The Client-Side Engine of Vaadin manages the rendering of the UI in the web browser by employing various client-side widgets, counterparts of the server-side components. It communicates user interaction to the server-side, and then again renders the changes in the UI. The communications are made using asynchronous HTTP or HTTPS requests.

d. Vaadin Servlet

Server-side Vaadin applications work on top of the Java Servlet API. The Vaadin servlet receives requests from different clients, determines which user session they belong to by tracking the sessions with cookies, and delegates the requests to their corresponding sessions.

ii. Java Persistence API (JPA)

The Java Persistence API is a lightweight, POJO-based framework for Java persistence. The Java Persistence API provides Java developers with an object/relational mapping facility for managing relational data in Java applications.

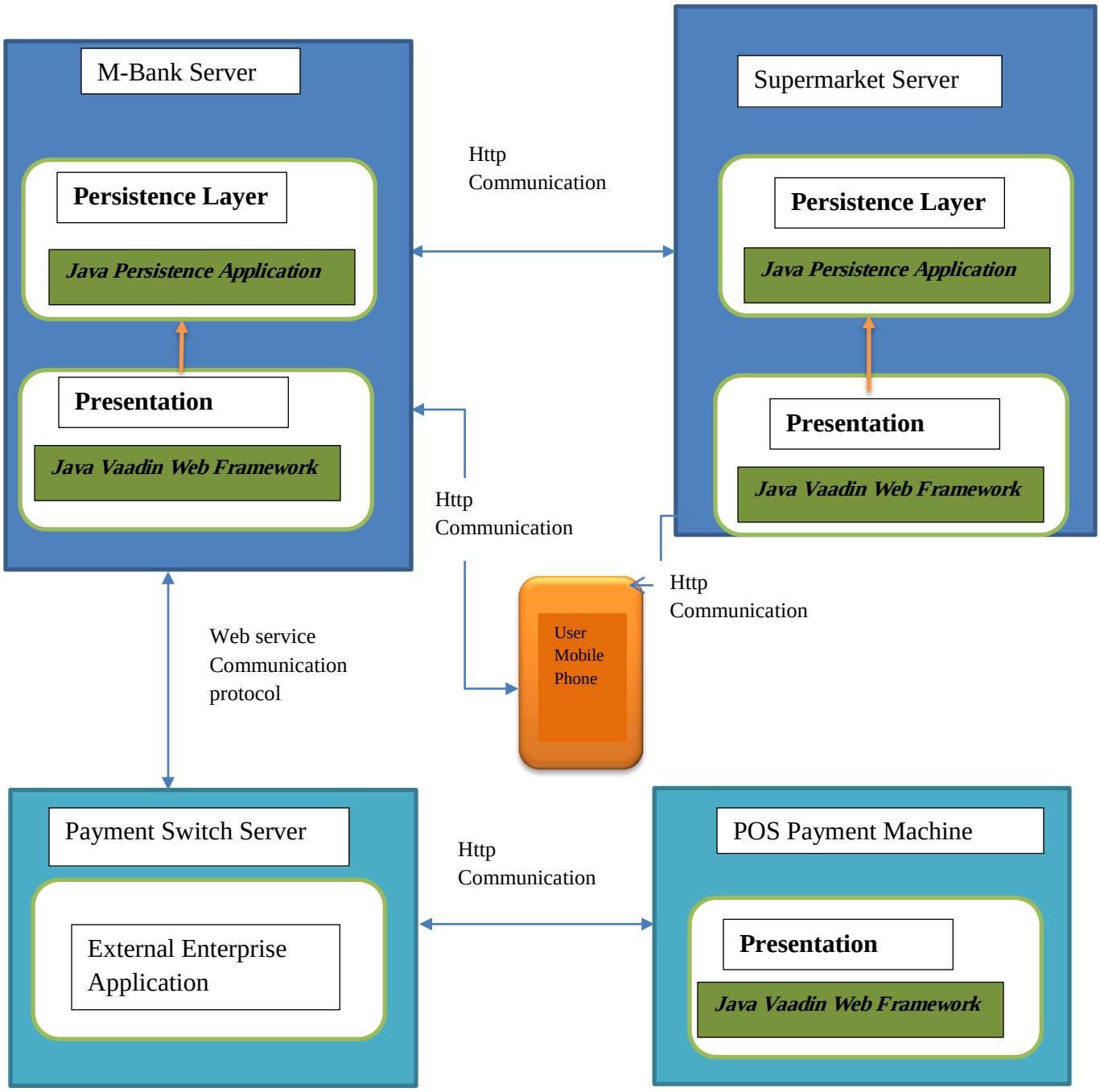

Figure 5.2: Technology Architecture of the Payment System Model

B. Database

MySQL is an open source relational database system, which is popular in web application database. It is chosen database for most of web applications because of with the following list of its most important properties [61].

- **Relational Database System**: Like almost all other database systems on the market, it is a relational database system.
- **Client/Server Architecture**: It allows a client applications can run on the same computer as the server or on another computer (communication via a local network or the Internet).
- **SQL compatibility**: It used a standardized language for querying, updating data and administration of a database.
- **Foreign key constraints**: Used to ensure there are no cross references in linked tables that lead to nowhere.
- **Programming languages**: Easily supported by many APIs (application programming interfaces) and libraries for developing MySQL applications such as C, C++, Java, Perl, PHP, and Python.
- **ODBC (Object Database Connectivity)**: Supports the ODBC interface Connector/ODBC to be addressed by all the usual programming languages that run under Microsoft Windows (Delphi, Visual Basic, java, etc.).

5.4 Prototype Development

A prototype is developed to implement the proposed Payment System. As it is mentioned in the first Chapter, this prototype implements the checkout process. And, some entities of the system are implemented as a preliminary step for fulfilling the checkout process. For instance, the item scanning for getting amount to be paid is included.

5.4.1 Mobile POP Modeling

In this phase for purchasing items from the supermarket, the first task is customers selecting item and agree on its price by reading on it using scanning which is used to capture data to send to the Supermarket POS system shown in Figure 4.4 for processing the purchase. In return, the Mobile POP application shown in Figure 4.2 receives a four digit numeric code for verification, later which will be used to confirm the transaction at the cashier. When the process of item selection is completed on Mobile, purchasing is not completed actually and there is no change in item balance; because cashier did not confirm any item yet. One must perform some abstraction of the real supermarket item collection process environment.

Modeling this environment, item selection, at least requires an efficient abstraction of entities such as desktop client POS application, supermarket application server, and mobile POS as well as wireless infrastructure.

Moreover, functionalities of the mobile POS are not included to make the simulation suitable to the proposed payment system. Specifically, only some sample list for the models are designed. The purpose of using sample list is to evaluate the proposed payment system in various stages of the checkout process. It is designed with the purpose of showing the efficiency of the proposed system by doing a cashier's activity when they are picking/ scanning selected item. Since customers are doing tasks by themselves which have been done before by a cashier, it helps to save service time. The implementation process is shown in Appendix I**.**

5.4.2 Mobile Banking Application for Processing POS Machine Functionalities

As it is mentioned earlier in chapter four and shown in Figure 4.3, the proposed system model mainly bases on the mobile banking application. It is the major component of the proposed system. In this phase both , amount; items total price to be paid found at the first phase of the checkout process and PIN values of the customer; found from issuer bank, are pass to the payment switch server located at the issuer bank; a vendor specific application server used for card payment processing using EFT network. In return, the Payment Switch System shown in Figure 4.6 sends OTP to the registered mobile. The implementation process is shown in Appendix J**.** This result is acquired when customers are lining up in the queue to a cashier by first enter in to mobile banking system as usual with the already existing infrastructure and then using a new feature added to the mobile banking to get access to the payment switch server which was normally done before by a POS machine. This minimize the time it takes than when it is done by a POS machine in a normal way.

5.4.3 Supermarket POS Confirmation process

In this phase, a list of item name, its price and total amount of available data a customer interested to buy can be accessed due to a new functionality of Supermarket POS System.

Here, Cashier is waiting for a customer only to see the items to be purchased and the corresponding amount to be paid with the purpose of to reconcile with the receipt it will get after a customer pay for the goods.

To display the items selected with its sum amount at the cashier for confirmation, the four digit numeric code is required where the process implementation is shown in Annex K. When code is entered in to the cashier desktop client POS application, selected items with its sum amount information for the corresponding code is retrieved from Supermarket POS System shown in Figure 4.4. On entering the valid code (if it does not timeout), cashier will confirm the transaction after the customer paid. Finally transaction will be completed and inventory is deducted at the supermarket application database.

For handling the transaction the new data store will store only required fields related to a sales transaction done by Mob-POP system. The size of the data store is limited, as there is only one transaction of sales can be exist per user, which is done by Mob-POP, i.e. Maximum size will be number of transactions in a supermarket and minimum is 0. Besides the pending transaction remains in the table, till it is not completed/canceled by using Mob-POP application or expired after a defined time. For the time 15 minutes looks optimal time period for expiration of pending transaction and a numeric code sent on Mob-POP application.

As a process, phase one Mob-POP and phase three; Supermarket POS Confirmation process tasks go hand in hand as both are within the supermarket POS system.

5.4.4 Payment with ATM card on a POS a machine

This component is responsible to implement user actions using ATM card and OTP when a customer comes to process the last checkout process at the POS Payment Machine System shown in Figure 4.5. Up on entering ATM card in to a POS Payment Machine System it will check the pending transaction information from Payment Switch System shown in Figure 4.6. If there is any pending transaction i.e. transaction done by Mobile, then system will show the screen to enter OTP, which was sent on registered mobile number, to complete the transaction along with option to cancel the pending transaction and start new one. On entering the valid OTP, if it does not timeout, payment processed and transaction will be completed. Whereas on selecting the new transaction option, normal POS process will be

followed. In case, there is no pending transaction, existing POS payment machine application will run without giving the prompt for OTP. That means there is no change for POS payment machine users, who will not use “Sales” feature from Mobile banking.

Basically, the process implementation is shown in Annex L. For ease of demonstration, we used a predefined amount, code (OTP) and item type in the checkout process. And as it is known, executing such type of operations must have a sufficient balance in order to complete the purchasing. Hence, this prototype implements as if customer has sufficient amount of money in its account. As a process, Mobile banking system and POS payment machine system tasks go hand in hand as both are within the Bank’s system.

5.4.5 Payment Switch Verification Process

In this phase, the PIN and Price information send to it from the Mobile Banking System shown in Figure 4.3 through internet. The Payment Switch System store temporarily and as verification sends OTP to the registered mobile number. When customer uses the OTP on the POS Payment Machine System shown in Figure 4.5 for completing the payment process, the POS Payment Machine System sends the OTP through EFT network. The Payment Switch System up on receiving OTP it directly matches from the table used for this purpose and acknowledges the POS Payment Machine System that the transaction is done.

This table/data store will store only required fields related to a payment transaction done by Mobile Banking System shown in Figure 4.3. The size of the data store is limited, as there is only one transaction of payment can be exist per account, which is done by Mobile banking application i.e. Maximum size will be number of accounts in a bank and minimum is 0. Besides the pending transaction remains in the table, till it is not completed/canceled by using POS Payment Machine System shown in Figure 4.5 or expired after a defined time. Expired time will be configurable. For the time 15 minutes looks optimal time period for expiration of pending transaction and OTP sent on registered mobile.

5.5 Test Results

We are conducted an onsite test with a laptop on Dec 20 and Dec 22, 2019. The purpose of the test was to assess the efficiency of the new payment system.

Three attendees participated in Test 1 and the other three in Test 2. Typically, a total of six participants are involved in a test to ensure stable results. Each individual session lasted approximately one hour and the test scenarios are not differed over the two test days.

In general all participants found the payment system to be clear and straightforward. Participants used electronic payment in a supermarket at least once a month to purchase items.

The test identified only a few minor problems including:

- The lack of barcode to access items.
- Confusion proceeding self-service.
- Lack of knowledge from supermarket assistance.

This document contains the participant feedback, satisfactions ratings, task completion rates, ease or difficulty of completion ratings, time on task, errors, and recommendations for improvements. Copies of questionnaires are included in the Appendix section.

Expert review of the payment system model

The experts who have skill and experience on the development and use of online payment system at the supermarket were asked to test our payment system and to suggest concrete improvements. We also asked for their opinion of the productivity of the payment system provided. Because the reactions of these experts were obtained, the agreement of other experts cannot be assumed.

The experts decided that it was possible to evaluate the payment system efficiency against the existing one such as traditional card with PIN, etc. Based on the evaluation, the experts were forward test results that were to see the efficiency of the PMRPMB. All tests were agreed with the experts, and they were the tests made to the system. In the rest, the tests effected are listed in tables below.

5.5.1 Payment System Model Test

A payment system model by combining POS machine and Mobile banking technologies for facilitate a transaction efficiently in the supermarket.

An Expert review test is intended to determine the extent an application facilitates a user's ability to complete routine tasks. Typically the test is conducted with a group of potential users using in an on-site with portable equipment. Users are asked to complete a series of routine tasks. The session captured each participant's navigational choices, task completion rates, comments, overall satisfaction ratings, questions and feedback.

Experimental Evaluation of the Payment system model

A prototype is developed on a machine which has Intel(R) core(TM) i3 Processor 2.6 GHz, Windows 7 platform and using web application.

A test experiment was set up in which participants had to use the systems to pay for a few online purchases. The system was evaluated in terms of user valuation (measured by means of the questionnaire developed for this purpose). The result of system was analyzed statistically. The expert review is held on the two groups. The two test groups are used to test all the tasks to show the efficiency of the proposed payment system. On the other hand, the efficiency of the proposed payment system is presented in comparison with the traditional/ existing payment systems used in the supermarket.

Our main hypothesis suggests that the application of our payment system model will result in a difference in the attitude of users towards the efficiency of the new system.

5.5.2. Methodology

i. Sessions

The test administrator contacted and selected participants; e-banking experts via the E-banking department and software experts from a software training institution, and all are supermarket customers. The test administrator sent e-mails to attendees informing them of the test logistics and requesting their availability and participation. Participants responded with an appropriate date and time. Each individual session lasted approximately thirty minutes. During the session, the test administrator explained the test session and asked the participant to fill out a brief background questionnaire (see Appendix A). Participants read

the task scenarios and tried to examine the efficiency of the PMRPMB/payment system model (PSM).

After each task, the administrator asked the participant to rate the efficiency on a 5-point Likert Scale with measures ranging from strongly disagree to strongly agree. Post-task subjective measures included (See Appendix B):

- How fast it was to process the checkout using the PSM.
- Ability to keep track of their location in the PSM.
- Accurateness of predicting which section of the PSM process the checkout.

After the last task was completed, the test administrator asked the participant to rate the payment system model overall by using a 5-point Likert Scale (Strongly Disagree to Strongly Agree) for eight subjective measures including:

- Ease of use
- Frequency of use
- Difficulty to keep track of system
- Learn ability - how easy it would be for most users to learn to use the application
- Checkout easing – how quickly participant could process the checkout
- Information – Getting the information I needed
- Time saving – the application efficiency would keep me coming back
- Application organization

In addition, the test administrator invited the participants' recommendations for improvement on the overall payment system model. (See Appendix C for the subjective and overall questionnaires)

ii. Participants

All participants were who have purchase experience at the supermarket. All participants had a good understanding of English.

In general, sample was well balanced in representing user categories. Within the constraints of availability and scheduling the participants were divided into two groups attempting to balance them with respect to the area of skill and experience with internet payment systems.

The participants were scheduled over the two testing dates. All of the six participants completed the test. Three participants were involved in testing on Jan. 24, 2020 and three on Jan. 25, 2020. Of the six participants, all were male.

a. Role in Payment System

Participants selected their role in the organization based on their relation to the E-banking technology, skill in software development and purchasing experience from the supermarket. Some participants were involved in multiple roles.

Table 5.1: Role

E-Banking expert	Software expert	Other Organization
2	2	2

iii. Evaluation Tasks/Scenarios

Participants were provided with a short 15-min introduction to the system. They were told that PMRPMB system for electronic payments that allows them to make payments online with a given test account. Participants were informed that the study was aimed at understanding their attitudes, opinions, impressions, and feelings about efficiency of PMRPMB. They were given instructions regarding their test tasks and attempted completion of the following tasks (see Appendix D for complete test scenarios/tasks):

Task1 – Scan and Pick items, and know its price

Task2 – Use M-Bank application to process POS machine tasks

Task3 – Confirm at the cashier

Task4 – Pay with ATM card on POS machine

iv. Procedure

During the introduction, a couple of examples were given to illustrate how PMRPMB works. Participants were told how to select products and how to make payments and they

were instructed on how to use the system. The participants were given the tasks and questionnaires in paper form and were instructed to fill in parts of the questionnaire after every task. They were allowed to ask questions whenever they could not proceed; however, they were encouraged to find a solution on their own first. The experimenter communicated with the participants from the back of them whenever it was necessary. This setup minimized the possible influence on participants by the presence of the experimenter in the test during the experiment. Participants who got confused or stuck were given about 5 min to find a solution. Then a general high-level hint was given to them, for example, where to look at the Payment System on their own, or what they could try to continue the task. If this did not help, they were finally given detailed instructions on how they could solve the problem. If the participants attempted to start filling in the questions before completing the task, for example, not making enough or any attempts to complete the task, the experimenter would ask them why they did not perform the task first. If necessary, they were given a hint on how to proceed and asked to finish the task.

v. Experimental Setup

As the new system was not in full deployment yet, the evaluation could not include actual payments. We created a working copy of a Payment System simulator for purchasing items. Participants were requested to start by picking/selecting items using the PMRPMB system to purchase goods from the supermarket. The participants used a given test code as an account for transferring money, though no real transfer of money was actually performed in our experiment. All transactions were looks realistic in that they were experienced exactly as they would be during the actual use of the system. The tests were conducted at a usability test onsite with laptop computer. The author of this paper acted as the experimenter that is facilitating the process, receiving participants, introducing the system and the tasks, and keeping observation notes. During the tests he was seated behind the participant in a way good for observation.

Participants were encouraged to relax and use the best way for them to carry out the tasks. After each task they were required to fill in a questionnaire that assessed their attitudes toward the system. When they had finished, the participants were interviewed about their experience and were invited to comment freely about the system. It took participants approximately from 1.5 to 4 min to complete the four tasks.

vi. Measures

Users' attitudes and opinions about aspects of the payment system model under test were measured by means of a questionnaire. To assess whether the application of the payment system achieved the desired effect, we compiled a questionnaire from existing standard instruments to assess the payment system model.

The questions for assessing the usability of the system are a subset of the SUS questionnaire; these questionnaires are validated tools that have been shown to be reliable and are widely used [62]. In addition, they are both quite short and generic, which helped to create a brief but comprehensive questionnaire. Answers to the questions were measured by Likert Scales (e.g., the perceived efficiency of PMRPMB was assessed on a scale with the strongly disagree to strongly agree).

vii. Limitations of the Experimental Study

When studying the use of electronic payment system for purchasing items from supermarket one always needs to address the problems that their adequacy and relevance have to be studied through their application to specific instances of the systems concerned and that their application is dependent on the interpretation of the researcher who applies them.

Our experiment could not attempt to confirm every detail of each task as this poses several methodological and practical difficulties. Thus it may be argued that our findings (positive and negative) are predicated upon the way this research applied them. For example, authentication method does not detail what this system should be and how it should be presented to users. The researcher relied on existing industrial practice, reference sources, and his own experience.

In most cases, the application of our payment system model resulted in improvements in users' time usage in supermarket. For the few cases that this did not happen, simple explanations could be that there are inherent flaws in this payment system or that this system does not create an impact large enough to affect users' purchase time, such as off-peak time.

Although the whole experiment was set up to maximize to matches to the real work context, there were still some limitations on how well the use and operation of the payment system could be simulated in a test. For example, there was no customer support line, nor a fully-

fledged Web application for help and support that could be seamlessly integrated into the PMRPMB online help system. However, these limitations that are inherent in a test experiment did not come to the top during the experiment sessions, so we argue that they do not compromise the validity of our findings.

5.5.3. Results

i. Task Completion Success Rate

All participants successfully completed all tasks.

Table 5.2: Task Completion Rates

Participant	Task 1	Task 2	Task 3	Task 4
1	✓	✓	✓	✓
2	✓	✓	✓	✓
3	✓	✓	✓	✓
4	✓	✓	✓	✓
5	✓	✓	✓	✓
6	✓	✓	✓	✓
Success	6	6	6	6
Completion Rates	100%	100%	100%	100%

ii. Task Ratings

After the completion of each task, participants rated the ease or difficult of completing the task for three factors:

- It was fast to process this checkout using the PSM.
- As I was starting process for this checkout, I was able to keep track of where I was in the PSM.
- I was able to accurately predict which section of the PSM process this checkout.

The 5-point rating scale ranged from 1 (Strongly disagree) to 5 (Strongly agree). Agree ratings are the weighted mean agreement ratings of greater than or equal to 4.0 considered as the user agrees that the checkout was fast to process, that they could keep track of their location and predict the section to process the checkout.

a. Fast in processing checkout

90% of the participants agreed it was fast to process paying with POS payment machine (mean agreement rating = 4.5) and 83% found it fast to process a modified M-banking application tasks (mean agreement rating = 4.16). In addition, 80% of participants found it fast to process confirmation at the cashier POS application (mean agreement rating = 4.0) and only 56% found it fast to process to get items and its price (mean agreement rating = 2.83).

b. Keeping Track of position in the PSM

83% of the participants found it easy to keep track of their location in the PSM while processing confirmation at the cashier POS application (mean agreement rating = 4.16) and 80% found it easy to keep track of their location while processing paying with POS payment machine (mean agreement rating = 4.0). In addition, 76% found it easy to keep track of their location while processing a modified M-banking application tasks (mean agreement rating = 3.83). However, only 63% of participants found it easy to keep track of their location while processing to get items name and its price (mean agreement rating = 3.16).

c. Predicting checkout Section

83% of the participants agreed it was easy to predict where to process to pay using POS payment machine (mean agreement rating = 4.16) and agreed it was easy to predict where to process a modified M-banking application (mean agreement rating = 4.16). However, 73% agreed that it was easy to predict where to process to confirm at the cashier POS application (mean agreement rating = 3.66) and agreed they could predict where to process to get items name and its price (mean agreement rating = 3.66).

Table 5.3 Test 1 – Mean Task Ratings & Percent Agree

Task	Fast in processing checkout	Location in checkout process	Predict Section	Overall
1 – Scan and Pick items and know its price	2.83 (56.6%)	3.16 (63.2%)	3.66 (73.2%)	3.21
2 – Use M-Bank application to process POS machine tasks	4.16 (83.2%)	3.83 (76.6%)	4.16 (83.2%)	4.05
3 – Confirm at the cashier POS application	4.00 (80%)	4.16 (83.2%)	3.66 (73.2%)	3.94
4 – Pay with ATM card on POS payment machine	4.50 (90%)	4.00 (80%)	4.16 (83.2%)	4.22

**Percent (%) = Weighted Mean Percentage*

iii. Time on Task

The testing software recorded the time on task for each participant. Some tasks were inherently more difficult to complete than others and is reflected by the average time on task.

Tasks are sequential then one task can affect others to process the transaction within time frame. Relatively task1 and 4 takes longer than 2 and 3. Task 1 required participants to process scanning items to get the items name and their unit price then calculating total amount and took the longest time to complete (mean = 46.3 seconds). However, completion times ranged from 40 (more than 0.5 minutes) to 50 seconds (approximately 1 minute).

Table 5.4: Time on Task

	P1	P2	P3	P4	P5	P6	Avg. total
Task 1	42	48	40	49	49	50	46.3
Task 2	18	22	19	19	17	18	18.8
Task 3	13	18	15	18	18	15	16.2
Task 4	26	29	25	28	32	27	27.8

iv. Errors

- Forgetting password
- Forgetting OTP
- Mismatch POS pin with OTP
- Ignoring Numeric code
- Ignoring session logout for changing items selection.

v. Summary of Data

The table below displays a summary of the test data. Completion rates and low satisfaction ratings and errors and high time on tasks are highlighted in bold.

Table 5.5: Summary of Completion, Errors, Time on Task, Mean Satisfaction

Task	Task Completion	Errors	Time on Task	Satisfaction*
1	6	1	**46.3**	**3.21**
2	6	0	18.8	4.05
3	6	0	16.2	3.94
4	6	**2**	27.8	4.22

* Satisfaction = Mean combined rating across three post-task measures: fast in processing checkout, ability to keeping track of where in the checkout process, and predicting checkout section accuracy.

vi. Overall Metrics

- Overall Ratings

After task session completion, participants rated the application for eight overall measures. These measures include:

- Ease of use
- Frequency of use
- Difficulty of keeping track of where they were in the PSM
- How quickly most customers would learn to use the application
- Processing checkout quickly
- Getting the information needed
- Relevancy of application efficiency
- Application organization

80% of the participants agreed that the application would help them to get the information they needed/ explore the information. The majority of participants (76%) agreed they could process checkout quickly and agreed that the payment system application was easy to use. In addition, 73% would learn to use application quickly and application was well organized. Even though participants' average agreement rating was 3.16, only 63% agreed they would use application frequently and the application familiarity would keep them coming back. However, 60% found it difficult to keep track of where they were in application, mean agreement rating was 3. See the table below.

Table 5.6: Post-Task Overall Questionnaire

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean Rating	Percent Agree
Thought application was easy to use			2	3	1	3.83	76.6%
Would use application frequently		1	3	2		3.16	63.2%
Found it difficult to keep track of where they were in application		1	4	1		3	60%
Thought most people would learn to use application quickly			2	4		3.66	73.2%
Can process checkout quickly			1	5		3.83	76.6%
Getting the information I needed / explore application				6		4	80%
Application familiarity would keep me coming back		1	3	2		3.16	63.2%
Application is well organized			2	4		3.66	73.2%

**Percent (%) = Weighted Mean Percentage*

CHAPTER SIX

6. Conclusion, Recommendation and Future Work

This Chapter summarizes the major findings in this research work. Moreover, the noticeable contributions of the proposed payment system and future works are outlined.

6.1 Conclusion

Purchasing items from the supermarket is characterize by checkout process that have requires more time taking activities. It is true that using a skilled with higher number of manpower in the area contributes a lot for the overall efficiency of the checkout process. However, the presence of well-trained and higher in number manpower by itself does not guarantee high in efficiency.

This research work identified combining technologies as the major contributing factors for the efficiency of the checkout process. Moreover, efficiency in the checkout process affects the volume of transaction in the supermarket. On the other hand, a checkout process with relatively saving service time has a better efficiency than those the traditional/existing time wasting system.

Consequently, after an intense review of literatures and related works we have identified time is critical during purchasing from the supermarket. Thus, we proposed efficient payment system model that could resolve the aforementioned problems.

The research work solved the aforementioned problems by combining mobile banking and POS payment machine applications in to one system architecture. The overall architecture of this work bases on a mobile banking system component which we call it ―the corner stone- of the model. This component takeover the tasks of the POS payment machine and directly accessing the payment switch server by considering the situation of the existing bank infrastructure in relation to the maximum available capacity in that system environment. The value getting from this component is managed to be used by POS payment machine components for final payment transaction.

Besides that, the service time wastage and low transaction problem is resolved by introducing self-service, a customer whom doing almost all checkout process by themselves,

using Mob-POP application; considers the capacity as well as the technology a cashier using at the supermarket, in addition to the mobile banking system role when customers are selecting items to be purchased and lining up at the queue to the cashier for processing the payment.

The proposed payment system outperforms the existing counterparts in all of the situations. Specifically, the first and second tasks are used to show how the proposed system performs efficiency in situations where the responsibilities of a cashier that item scanning and counting, calculating total amount and processing payment are takeover by these components.

The main purpose of this research is to save customer time, when they are making a purchase on the supermarket using POS payment machine, by utilizing waiting time in the checkout process queue. Normally a successful payment transaction takes 5 to 8 min, more in case of wrong attempts; but using this feature, successful transaction will be done approximately in 2 min. That means transaction of making payment using this feature will take less than half time, so there is more than 50% time saving.

Most of the participants found the payment system to be well-organized, comprehensive, clean and uncluttered, very useful and easy to use. Having a system saving service time by serving a fast checkout process that is avoiding waste of time by lining up in the queue is a key to all. Implementing the recommendations and continuing to work with customers will ensure a continued efficient payment system.

6.2 Contributions of the Research

The main contributions of this research work are summarized as follows.

- Time Saving

The major goal of this research work is to improve waste of time. Hence, this research work understood and implemented various components to achieve this goal. From an exhaustive experiment and evaluation it was possible to realize that the wastage of time of the proposed payment system is by far less than the existing/traditional cash and card payment system. Hence, we would say that the prosed payment system has a substantial contribution for the major effort to solve the aforementioned problem in the supermarket.

- High volume of sale

This research work designed various components with the intention of solving the long checkout process problem. Moreover, incorporation of the proposed payment system in a stepwise manner eased an effort to achieve this goal. As it is known, minimize the time it takes for checkout yields a better sales volume as well as it will increase deposit to banks due to increase sales volume in the supermarket. Hence, this research work also has a significant contribution in overcoming the major sales problems of the supermarket especially during holiday and peak hours.

6.2.1 Challenges

For online payments to be fruitful, it is necessarily required to have a reliable infrastructure. The payment systems supporting online transactions in a wireless environment should have a level of security equivalent to that of fixed networks. Furthermore, the upcoming online payment applications have to show compatibility with the current traditional payment infrastructure such that there is no problem in operating the existing infrastructure.

Customer's trust and confidence in the usual methods of payment make clients more opposed to use new innovations. New innovations won't rule the market until clients are sure that their privacy is ensured and satisfactory confirmation of security is safeguarded. New advances likewise need to stand the test of time so as to secure people's confidence, regardless of the fact that it is simpler to use and less expensive than the more established techniques.

In particular, technology failures can produce negative customer experiences, frustrate staff and ultimately impact on sales. At the same time as investment in Wi-Fi infrastructure is critical, ensuring that it continues to operate without failure is vital. Problems with connectivity, or loss of connection during purchasing process, or even more seriously midway through payment could result in substantial customer dissatisfaction. The limitation of reliable internet access is a crucial barrier to acceptance and continual use of e-payment services. For instance, if retailers are to use e-payment technology as an integral part of their strategies, they will need to prepare their stores with reliable Wi-Fi access as a basis of those strategies.

6.3 Recommendations

The recommendations section provides recommended changes and justifications driven by the participant success rate, behaviors, and comments. Each recommendation includes a severity rating. The following recommendations will improve the overall ease of use and address the areas where participants experienced problems or found the information architecture unclear.

Process Scan and pick items, and know its price (Task 1) and combined M-banking and POS application (Task 2)

Table 6.1: Task 2 required participants to use mobile POP application for item selection and use mobile banking application to process POS machine activities

Change	Justification	Severity
• Combine all tasks in m-banking application • Add, if any, remote access option, i.e., booking items before it is finished • Search by brand • Locate item drawer • Notify new arrival item	Participants across all tests rated the ease of the payment system is high and it becomes more appropriate when it is all tasks are included on m-banking application. Participant comments also included mode of accessing the payment system making it possible from remote and capability of booking items a more concise manner so it is easier to save time to purchase. Finding items where they are located in which drawer, identifying which one is the new item and a facility to find items based on brand activities will make it the payment system more service time saving.	medium

6.4 Future Work

The payment system proposed in this research could be used in various retail stores after a bit of configuration undertakings. In addition, various research works could use the methodology and findings of this research work. We would say the proposed payment system is fit to the current requirements of most retail stores though there are some issues that need further work. Hence, this research work presents different areas that can be further improved as well as some components that should be implemented and integrated for better functioning of the system.

- Remote booking (preordering) items

Another promising direction for future research is the development of an online booking for the fast moving items; incorporating some remote accessing technology approaches to booking (preorder) items ahead to reach at the supermarket for saving purchase time.

- Security

An interesting way for future work that would complement our results would be to model the impact of trust on the user acceptance of EPSs. This could lead to the development of validated instruments for predicting the user acceptance of EPSs, surrounding concerns such as privacy, security and usability.

- Service Level Agreement

The proposed payment system does not predict the characteristics and demand of supermarket users. It just serve customer on arrival. However, it is observed that considering the trend of purchasing per user level could help to achieve high level of service level agreement satisfaction. Hence, it would be important to incorporate a component that learns from user‘s trends and handle further purchasing demand based on users past trend. The result of this component could also be used as an ingredient in Mob-POP application.

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Appendix A – Background Questionnaire

BRIEF BACKGROUND QUESTIONNAIRE

Please answer the following questions in the spaces provided, circle or tick the most appropriate options.

1. Age:……

2. Are you: (please tick as necessary) □ Male □ Female

3. What is your professional background?

□ Software Developer

□ E-Banking Expert

□ System Administrator

□ Network Administrator

□ Database Administrator

□ Others: (please describe) _____

4. How many deliveries have you done in the last month (approximately)? _____

5. How many years of experience have you had in this current job?

□ <1 Year □ 1-2 Years

□ 2-5 Years □ 5-10 Years

□ >10 Years

6. Experience in purchasing items from the supermarket with your ATM card (optional):

□ <1 Year □ 1-2 Years

□ 2-5 Years □ 5-10 Years

□ >10 Years

Thank you for taking the time to complete this questionnaire

Appendix B – Post-Task Questionnaire

Task-1

A. How fast it was to process the checkout using the PSM.

It was fast to process this checkout using the PSM.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean Rating	Percent Agree
Participant					*		

B. Ability to keep track of their location in the PSM.

As I was starting process for this checkout, I was able to keep track of where I was in the PSM.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean Rating	Percent Agree
Participant			*				

C. Accurateness of predicting which section of the PSM process the checkout.

I was able to accurately predict which section of the PSM process this checkout.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean Rating	Percent Agree
Participant					*		

Task-2

A. How fast it was to process the checkout using the PSM.

It was fast to process this checkout using the PSM.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean Rating	Percent Agree
Participant					*		

B. Ability to keep track of their location in the PSM.

As I was starting process for this checkout, I was able to keep track of where I was in the PSA.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean Rating	Percent Agree
Participant			*				

C. Accurateness of predicting which section of the PSA process the checkout.

I was able to accurately predict which section of the PSA process this checkout.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean Rating	Percent Agree
Participant					*		

Task3

A. How fast it was to process the checkout using the PSA.

It was fast to process this checkout using the PSM.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean Rating	Percent Agree
Participant					*		

B. Ability to keep track of their location in the PSM.

As I was starting process for this checkout, I was able to keep track of where I was in the PSM.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean Rating	Percent Agree
Participant			*				

C. Accurateness of predicting which section of the PSM process the checkout.

I was able to accurately predict which section of the PSM process this checkout.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean Rating	Percent Agree
Participant					*		

Task-4

A. How fast it was to process the checkout using the PSM.

It was fast to process this checkout using the PSM.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean Rating	Percent Agree
Participant					*		

B. Ability to keep track of their location in the PSM.

As I was starting process for this checkout, I was able to keep track of where I was in the PSM.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean Rating	Percent Agree
Participant			*				

C. Accurateness of predicting which section of the PSM process the checkout.

I was able to accurately predict which section of the PSM process this checkout.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean Rating	Percent Agree
Participant					*		

Appendix C – Post-session Overall Subjective Questionnaire

1. I thought the system was easy to use
2. I think that I would like to use this system frequently
3. I found it difficult to keep track of where I was in application
4. I would imagine that most people would learn to use this system very quickly
5. I think that I would process checkout quickly
6. It was easy to find the information I needed.
7. I thought the system efficiency would keep me coming back
8. I found the various functions in this system were well integrated/organized.

Appendix D – Task Scenarios

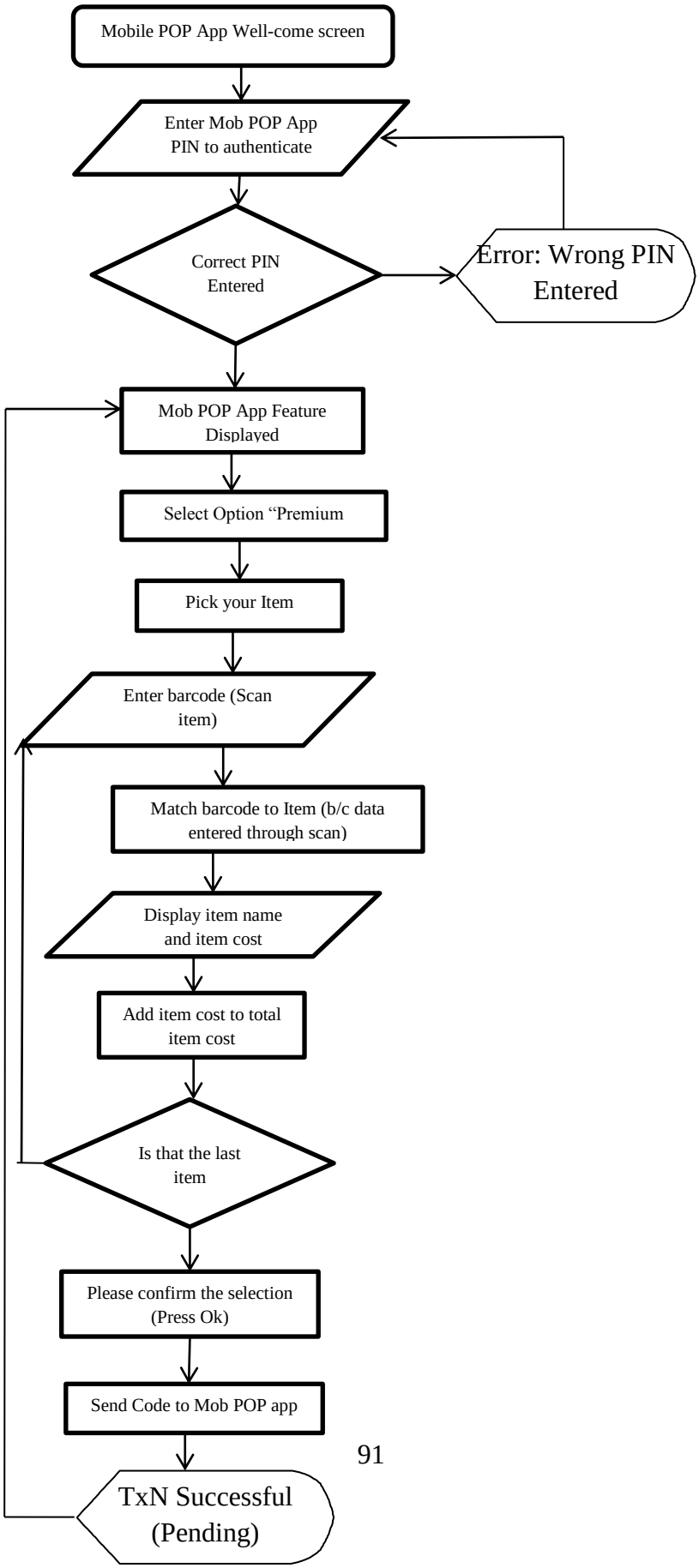
Task1: Please, using the Mob-POP app application select an item that is scan and/or pick, proceed for payment for it that you would like to purchase, get the total amount and code for confirmation.

Task 2: Please, Open M-banking application using your credentials given from your bank (here the credential is customized for the research purpose), select Sales from the menu list on the M-Banking application and do tasks that have been doing on POS machine.

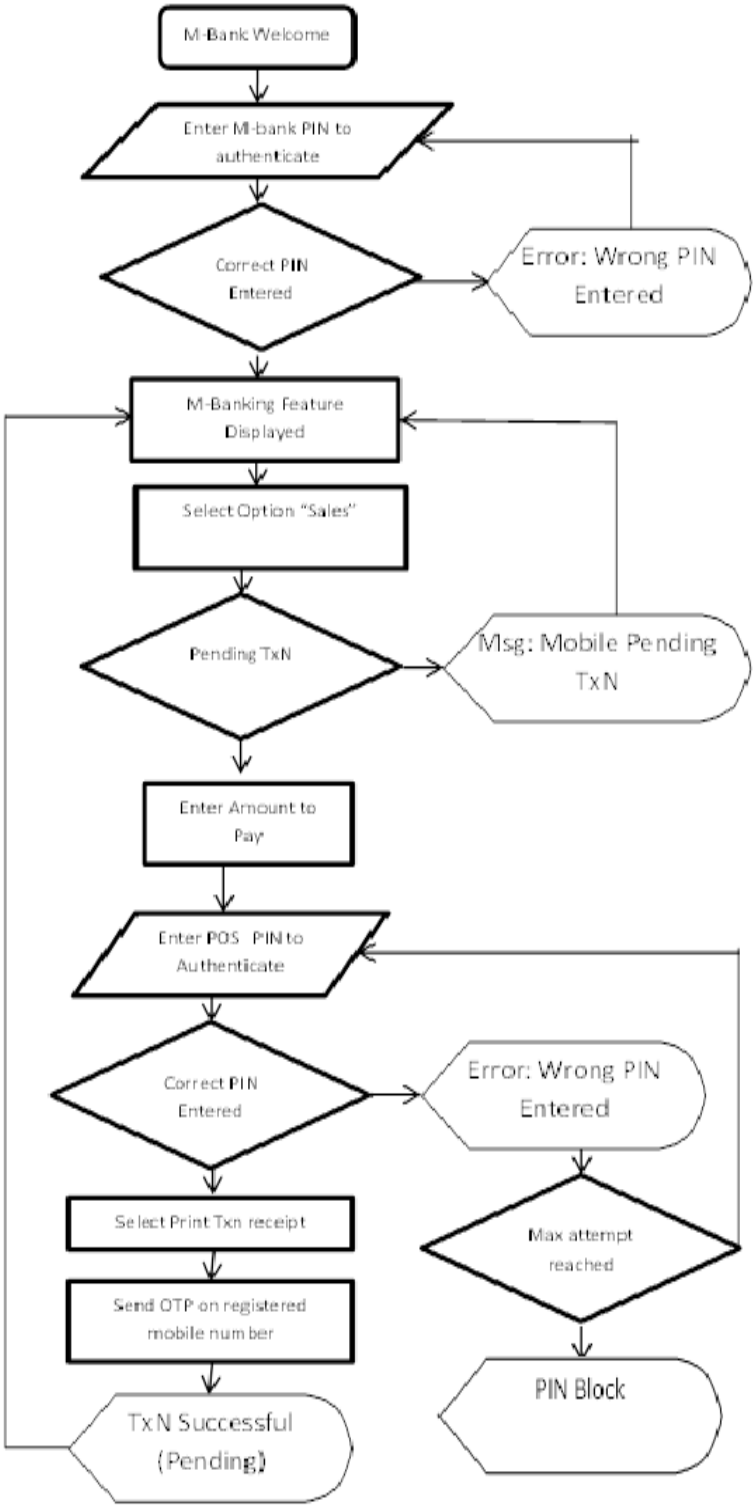
Task 3: Please, confirm selected items that you would like to purchase at the cashier using code found from supermarket application server with your MOB-App application.

Task 4: Please, pay using your ATM card at the POS machine (here ATM card and POS machine are in the form of software simulated) and get the receipt.

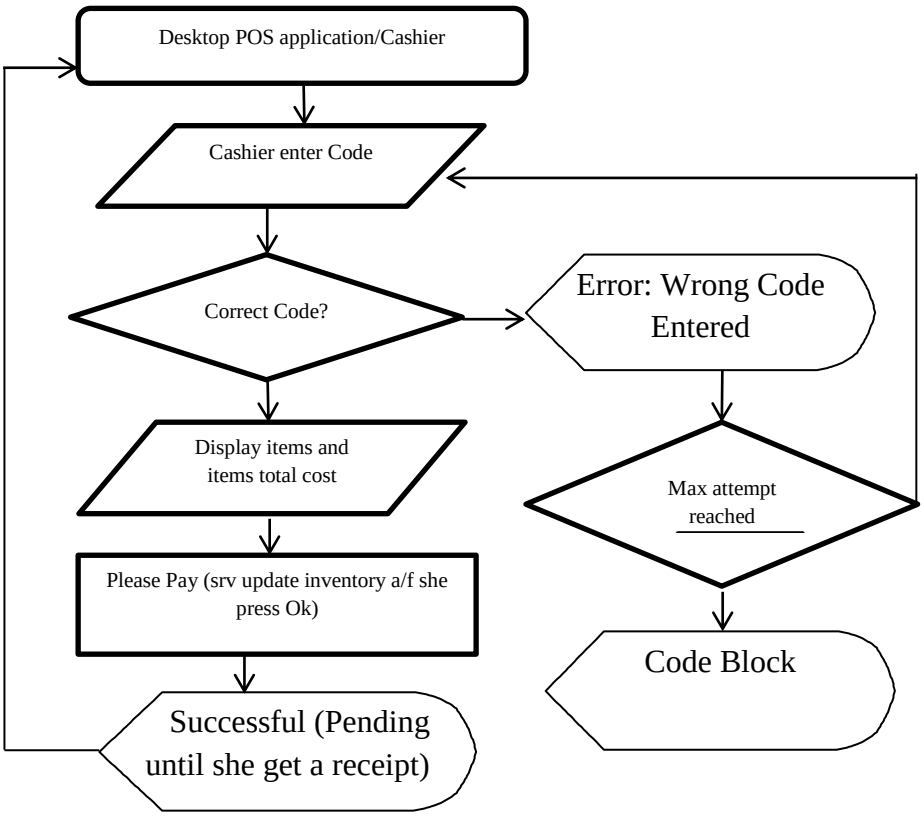
Appendix E: Procedure for Item Scan/pick



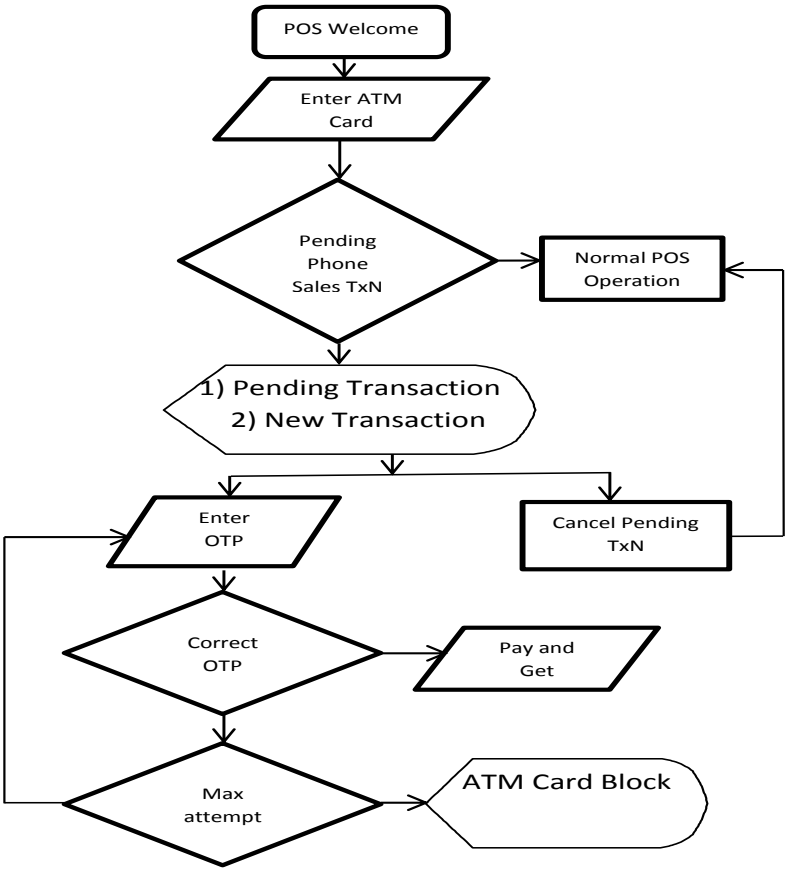
Appendix F: Procedure for Mobile Banking



Appendix G- Procedure for Cashier Confirmation



Appendix H- Procedure for POS Payment Machine



Appendix I- Mob-POP implementation process

```
public PremiumUserSection() {

    setClassName("content");
    //retrive the userCart from the session
    userCart = (CartSession) UI.getCurrent().getSession().getAttribute("userCart");

    // if there is no userCart in the session, then create one and put it on the session.
    if (userCart == null) {
        userCart = new CartSession();
        Member user = (Member) UI.getCurrent().getSession().getAttribute("authenticatedUser");
        userCart.setUserName(user.getUserName());
        UI.getCurrent().getSession().setAttribute("userCart", userCart);
    }
```

```
private void addItemToCart(Long barcodeNumber) {
    if (!userCart.isItemExist(barcodeNumber)) {
        Item item = PopRepository.getItem(barcodeNumber);
        userCart.setCartItem(item);

        Double totalPrice = userCart.getTotalPrice() + item.getItemPrice();
        userCart.setTotalPrice(totalPrice);
    }

}
```

```
private void storeCartTxn() {
    PopRepository.saveUserCart(userCart.getUserName(), userCart.getBarcodeNumberList(), userCart.getTotalPrice());

    shopperId = PopRepository.getCartCode(userCart.getUserName());
    updateComponents();

    //put shopperId in a session
    UI.getCurrent().getSession().setAttribute("shopperId", shopperId);


}
```

Appendix J- Mobile banking implementation process

```
public void validatePosPin(String value) {

    // checks if user entered pin is a valid format.
    try {
        posPin = Integer.parseInt(value);
    } catch (NumberFormatException ex) {
        Notification.show("Please enter a valid POS PIN code", 3000, Notification.Position.TOP_CENTER);
        return;
    }

    // check if pos pin exist in the bank darabase.
    if (!BankRepository.isPosPinExist(posPin)) {
        Notification.show("Incorrect POS PIN code", 3000, Notification.Position.TOP_CENTER);
    }

}

public void storeMobileSalesTxn() {
    BankMobilePaymentTxn txn = new BankMobilePaymentTxn();
    txn.setAccountNumber(accountNumber);
    txn.setAmount(amount);
    txn.setPrint(true);
    txn.setStatus("PENDING");
    txn.setCreated(new java.util.Date());
    //txn.setCreated(Date.valueOf(LocalDate.now()));

    otp = BankRepository.storeMobileSalesTxn(txn);
    if (otp != -1) {
        Notification.show("Transaction successful. Use the following generated OTP (One Time Password) to "
                + "complete your transaction. OTP = " + otp, -1, Notification.Position.TOP_CENTER);
    } else {
        Notification.show("There was a problem when completing the transaction. Please contact your system administirator.",
                -1, Notification.Position.TOP_CENTER);
    }
}
```

Appendix K- Supermarket POS confirmation implementation process

```
Double tax = userCartTxn.getTotalPrice() * 0.15;
Div taxDiv = new Div();
taxDiv.add(new Span("Tax (15%): "), new Span(tax + " Birr"));

Div totalPriceDiv = new Div();
totalPriceDiv.add(new Span("Total Price Amount: "), new Span(userCartTxn.getTotalPrice() + " Birr"));

Double total = userCartTxn.getTotalPrice() + tax;
Div totalPriceWithTaxDiv = new Div();
totalPriceWithTaxDiv.add(new Span("Total Price (including Tax) : "), new Span(total + " Birr"));

confirmBtn = new NativeButton("Confirm");
confirmBtn.addClickListener(event -> {
    PopRepository.completeCartTxn(cartCode);
    confirmBtn.setEnabled(false);
    Notification.show("Shopper Transaction completed succesfully", 5000, Notification.Position.TOP_CENTER);

});
```

Appendix L- POS Payment Machine implementation process

```
public PosMachineView() {

    Dialog posDialog = new Dialog();
    posDialog.setCloseOnEsc(false);
    posDialog.setCloseOnOutsideClick(false);

    atmCardBtn = new NativeButton("Enter ATM card in the slot");
    atmCardBtn.addClickListener(event -> {
        completeTxnBtn.setVisible(true);
        cancelTxnBtn.setVisible(true);
        otpField.setVisible(true);
        atmCardBtn.setVisible(false);
    });


    cancelTxnBtn = new NativeButton("Cancel Pending Transaction");
    cancelTxnBtn.setVisible(false);
    cancelTxnBtn.addClickListener(event -> {
        completeTxnBtn.setVisible(false);
        cancelTxnBtn.setVisible(false);
        otpField.setVisible(false);
        welcomeLabel.setVisible(false);
        BankRepository.updateTxn(Integer.parseInt(otpField.getValue()), "CANCELED");
        Notification.show("Transaction Canceled", -1, Notification.Position.MIDDLE);
    });

    otpField = new PasswordField();
    otpField.setPlaceholder("Enter OTP");
    otpField.setVisible(false);

    completeTxnBtn.setVisible(false);
```

```
    completeTxnBtn.addClickListener(event -> {
        completeTxnBtn.setVisible(false);
        otpField.setVisible(false);
        cancelTxnBtn.setVisible(false);
        welcomeLabel.setVisible(false);
        BankRepository.updateTxn(Integer.parseInt(otpField.getValue()), "COMPLETED");
        Notification.show("Transaction Completed", -1, Notification.Position.MIDDLE);

    });

    posDialog.add(new VerticalLayout(welcomeLabel, atmCardBtn, otpField, completeTxnBtn, cancelTxnBtn));
    posDialog.open();

    add(posDialog);
```

Declaration

I, the undersigned, declare that this thesis is my original work and has not been presented for a degree in any other university, and that all source of materials used for the thesis have been duly acknowledged.

Declared by:

Name: Girma Teferra

Signature: _____

Date: _____

Confirmed by advisor:

Name: Dr, Mesfin Kifle

Signature: _____

Date: _____