PesaLink Based Mobile Payment Application for Person to Business Payments

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Declaration Page

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

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Abstract

High transaction costs have continued to be of great concern for mobile payment users. The current setup of mobile payment is the provision of a wallet that can be topped up by either exchanging cash for electronic equivalent through an agent or by moving funds from a bank account into the wallet via a mobile banking application or internet banking. There is a cost incurred when moving money to a mobile wallet from a bank account to facilitate paying for utilities, goods and services. There is also a transaction fee charged by the Mobile Money Operator, this along with the bank transfer fees and taxation increases the cost of Mobile money payment transactions. The objective of this study was to research the current payment systems that are being used to make payments for goods, services and utilities along with their deficiencies, and propose an alternative solution using real-time bank-to-bank transfers through PesaLink. The focus was on enabling low-cost person-to-business payments without relying on mobile wallets, though the approach can be extended to person-to-person transactions as well. A prototype mobile payment application, developed using Agile methodology, demonstrated the feasibility of using PesaLink to eliminate the need for wallet-based transfers. Testing with sandbox bank accounts confirmed successful real-time fund transfers, reduced transaction steps, and cost-saving potential. The iterative Agile process allowed flexibility in development, accommodating changes in requirements during the project lifecycle.

Keywords: Mobile payments, real-time payments, person-to-business payments, low-cost, no-wallet, Agile methodology

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List of Abbreviations and Acronyms

ATM	Automated Teller Machine
EAPS	East Africa Payment System
EFTs	Electronic Fund Transfers
E-Money	Electronic Money
EMVCo	Euro pay Mastercard Visa Consortium
FSD	Financial Sector Deepening
GSMA	Global System for Mobile Communications
IMT	International Money Transfer
KBA	Kenya Bankers Association
KCB	Kenya Commercial Bank
KEPSS	Kenya Electronic Payment and Settlement System
KES	Kenya Shilling
KSH	Kenya Shilling
MFB	Microfinance Bank
MFI	Microfinance Institution
MPSP	Mobile Payment Service Provider
NACH	Nairobi Automated Clearing House
P2P	Person to Person
REPSS	Reginal Payment and Settlement System
RTGS	Real Time Gross Settlement
RTP	Real-time Payment
SACCO	Savings and Credit Cooperative
SIM	Subscriber Identity Module
STK	SIM Tool Kit
SWIFT	Society for Worldwide Interbank Financial Telecommunications
T+1	Transaction date plus one day
USSD	Unstructured Supplementary Service Data

Definition of Terms

Mobile payment	Refers to a method of conducting financial transactions using mobile communication technologies, where the individual initiating the payment, verifies their identity, and finalizes the transaction using a mobile device (Liu, Huang, Zhuo, Zhuo, & Li, 2023).
Mobile money operator	A company, entity or service provider that has a government-issued license to provide mobile financial and payment services through mobile devices (Denyes, et al., 2020).
Payment rails	Infrastructure that enables the flow of funds between different parties in a financial system (Central Bank of Kenya, 2022)
PesaLink	Infrastructure or platform that facilitates the movement of money between the payer bank account and payee bank account during a transaction (Nthama, 2017)
Push payment	Payment originated by the payer (Central Bank of Kenya, 2022)
Real-time payments	The sending of the payment communication and monies are made available to the payee in seconds (Bank For International Settlements, 2016).

Chapter 1 : Introduction

1.1 Background

The advancement in mobile technology and its use has encouraged innovation of various applications and processes that influence numerous industries and stakeholders. Mobile payment is one such process. Mobile payment or m-payment is the use of a mobile device to transfer funds from a buyer's mobile wallet either through a third party or directly to the seller's mobile wallet or bank account. The mobile wallet contains either the buyer's credit card details or electronic funds. In Kenya, the mobile wallet provided by mobile network operator stores electronic funds.

Telecom service companies in many developing nations offer mobile payments. Additionally, each Payment service provider is exclusively offered by one single telecom provider. M-PESA is offered primarily to subscribers of Safaricom, and Airtel Money to solely users of Airtel (Denyes, et al., 2020).

"Lipa na M-PESA" translated as "Pay with M-PESA " is the merchant payment service provided by Safaricom (Denyes, et al., 2020). The Lipa na M-PESA is part of the M-PESA mobile money application. The M-PESA application contains a mobile wallet that can be funded in two ways. One, a registered Safaricom customer can deposit cash at a Safaricom agent who then credits the amount to the customer's M-PESA Wallet at no charge (Aron & Muellbauer, 2019). Two, the customer can transfer funds from his bank account via the mobile banking application to his M-PESA wallet. The bank account owner will be charged a transfer fee by his bank. This fee may differ based on the amount being sent. The cost of transferring funds from a bank account to a mobile wallet further increases the total cost of Lipa na M-PESA merchant payments.

Customers are yet to get the full benefits of payment digitization. Some payment services have relatively high prices and levies, while others are too technical for the common user to understand. Furthermore, when institutions use payment rails, end-users are charged various fees for services. Taxation makes pricing more complicated (Cracknell, 2023). The nature of the institutions themselves may also play a role in pricing. According to the GMSA's State of the Industry Report, GSMA (2021), Mobile Money Operators rely excessively on customer fees which account for an average of 87% of company earnings.

PesaLink is a payment platform that enables customers of participating banks in Kenya to send and receive money from their bank accounts using their mobile phones, internet banking or from an ATM (The World Bank, 2021). It is not a payment service provider in the traditional sense, as it does not hold or manage customer funds. Instead, PesaLink acts as a payment switch, connecting the participating banks and enabling transactions to be processed securely and in real-time. The phrase "real-time payment" (RTP) refers to any account-to-account fund transfer that enables the instant availability of funds to the transaction's beneficiary (Liu, Huang, Zhuo, Zhuo, & Li, 2023).

PesaLink is owned and operated by the Kenya Bankers Association, a trade association that represents the interests of banks in Kenya. PesaLink offers several advantages over traditional payment methods, including lower transaction fees, faster processing times, and increased security (Nthama, 2017). KBA reports approximately Ksh. 360 billion in value was transferred since PesaLink's debut to the end of 2020, twice the value of Ksh. 180 billion reported at the end of 2019 (Cracknell, 2023).

1.2 Problem Statement

Funding the M-PESA mobile money wallet can be done at a Safaricom agent, who deposits electronic cash into a customer's wallet in exchange for physical cash equivalent or one would need to transfer money from their bank account through their mobile banking application or internet banking application into the M-PESA mobile money wallet. The relevance of bank-to-mobile transactions is expanding due to banking clients needing to top up their mobile wallets from their bank accounts. For the first option, there is an issue of having to have the physical cash equivalent and travelling or finding an agent to deposit the money into the wallet. The second option has a cost implication. The bank will charge a transfer fee based on the amount being sent from the bank account to the wallet. Once the money is in the wallet the customer will make payment for a utility or goods and services during which he will be charged a transaction fee. Therefore, the additional cost of the transfer fee charged to the customer further increases the total cost of a transaction.

1.3 Research Objectives

This study primarily aims to develop a prototype mobile payment application that enables moving money from a buyer's bank account to a merchant's bank account in real-time, eliminating the need for intermediary mobile wallet transactions.

The supporting sub-objectives are:

i. To identify the key technical challenges and barriers to using the existing payment options to pay for utilities, goods and services,
ii. To review potential solutions to overcome the challenges in the current mobile payment systems,
iii. To design and develop a mobile payment prototype solution based on PesaLink real-time bank transfer functionality,
iv. To test the prototype's ability to eliminate the need for mobile wallets in person-to-business payments.

1.4 Research Questions

The questions are:

i. What are the technical challenges and barriers to using existing payment options to pay for utilities, goods and services?
ii. What potential solutions exist to overcome the challenges in the current mobile payment systems?
iii. How to design and develop a mobile payment prototype solution based on PesaLink real-time bank transfer functionality?
v. How does the prototype eliminate the need for mobile wallets in person-to-business payments?

1.5 Justification

This research simulates a mobile payment application that provides a cost-effective way of paying for utilities, goods and services directly from a bank account. This is by eliminating the need for the transfer of funds from a bank account into a money wallet, reducing the overall transaction cost and the inconvenience of time wastage in finding an agent to top up the wallet with the equivalent amount. Being that PesaLink provides faster processing times and lower transaction costs this will not only benefit the buyer but also the merchant and organization as they will have funds in their account in a shorter time than mobile wallet money solutions currently offered by telecommunication companies.

1.6 Scope Limitation

The study will focus on payment of utilities and merchants with PesaLink transaction processing being a simulation.

1.7 Summary

In Kenya, the dominant Mobile payment platform is MPESA. This payment platform has a wallet that requires to be topped up. If funding is done from a bank account to a wallet a fee is charged, which in turn raises the total amount paid to settle a transaction. PesaLink being a real-time money transfer payment platform facilitates the movement of moeny from one account to account across banks or in the same bank at a fraction of the cost in real-time. PesaLink is currently being used by individuals and corporations to pay for government services on the eCitizen platform instantly and buy government securities on the M-Akiba mobile application. This chapter gave an overview of the MPESA mobile wallet and its drawbacks and PesaLink's real-time bank account money transfer platform.

Chapter 2 : Literature Review

2.1 Introduction

The advent of mobile payments has catalyzed a transformative wave within the realm of financial technology, reshaping conventional payment systems and introducing disruptive innovations that challenge established norms. As the digitalization of financial services continues to redefine the landscape, understanding the theoretical underpinnings, empirical foundations, and conceptual frameworks becomes paramount for comprehending the intricacies of this dynamic domain. This study embarks on a comprehensive exploration, delving into the disruptive innovation theoretical framework, the empirical landscape of current payment systems, and the conceptual framework within the context of mobile payments. Through an in-depth literature review, this study unravels the complexities surrounding the evolution of mobile payments, shedding light on the theoretical constructs guiding disruptive changes, analyzing the current state of payment systems, and conceptualizing the transformative potentials that mobile payments offer. In synthesizing these dimensions, this research aims to contribute valuable insights to the ongoing discourse in financial technology, illuminating the path forward for mobile payments in an era of relentless innovation and digitalization.

2.2 Theoretical Framework

The mobile payments landscape has undergone a profound transformation in recent years, driven by the convergence of emerging technologies and evolving consumer preferences. At the heart of this transformation is the concept of disruptive innovation, conceived by Clayton Christensen (Silva & Grützmann, 2023), which provides a compelling framework for deciphering and understanding the evolving dynamics of mobile payments. In this multifaceted sector, the transaction costs associated with mobile payments are especially notable. These costs, including fees, time, effort and other resources spent on conducting mobile transactions, are the deciding factor in the selection and adoption of mobile payment systems. The dissertation includes a theoretical framework that explores the interaction between disruptive innovation and transaction costs in the field of mobile payments. By examining the fundamentals of disruptive innovation and assessing their impact on the transaction costs borne by users, the study gives an understanding of how these forces are reshaping the mobile payments landscape. Through this theoretical perspective, the dissertation provides valuable insights for businesses, policymakers, and academics seeking to navigate the complex terrain

of mobile payments and drive innovation in a way that optimizes transaction costs and user experience.

This theoretical framework presents the possible disruptive innovation theory by first, identifying the payment instruments that currently exist in Kenya. Identify the customer segments that use the payment systems mentioned touching on the needs and preferences of the segments concerned. Provide a breakdown of the transaction costs associated with each payment system which will include; fees charged for different types of transactions, convenience in terms of ease of use and accessibility of each system for users, speed in terms of transaction processing times and user experience including the user interface, customer support and reliability of the system.

Second, apply disruptive innovation theory to identify disruptive opportunities in the context of transaction costs by answering the following questions:

i. Can one of the payment systems serve underserved customer segments more efficiently or at a lower cost?
ii. Does one of the payment systems introduce technology that can radically simplify transactions or reduce costs?
iii. Can the payment system create a new value proposition or business model that the other system cannot easily replicate?

2.2.1 Payment Instruments and Technologies in Kenya

Table 2.1 categorises payment instruments into categories; coin, paper-based and electronic-based. Coin and paper-based payments include cash and cheques while credit cards, debit cards, electronic money and account-to-account payments are electronic instruments. The entity column indicates the organisations that provide, receive and store the various payment instruments. Channels along with payment infrastructure provide a means for individual customers, businesses, corporations and government institutions to make and receive payments (Central Bank of Kenya, 2022).

Table 2.1: Payment Instruments in Kenya (Central Bank of Kenya, 2022)

Instrument	Institution	Channels	Details
Paper and Coin Instruments			
Notes and Coins	Banks IMTs SACCOs MPSPs MFIs MFBs	Agents ATMs Bank branches	Notes and coins issued by the Central Bank of Kenya
Cheques	SACCOs Banks MFBs	ATMs Bank branches	NACH electronically clears cheques on the basis of Transaction plus 1 (T+1). Ksh. 999,999 is the maximum value for every cheque transaction
Electronic Instruments			
Prepaid, Credit or Debit Cards	IMTs SACCOs Banks	POS devices ATMs Online	These Cards are used mostly for buying goods and services, and for removing money at ATMs
Electronic money (E-money)	Mobile money providers	USSD, Mobile banking. Mobile Apps, Mobile money agents SIM toolkit	PSPs are responsible for issuing mobile Money. Ksh. 150,000 is the maximum value for each transaction made using mobile money. The daily maximum value that can be transacted is Ksh. 300,000.
Account to Account also referred to as A2A	Banks SACCOs	Bank branches Internet Mobile phones RTGS	Account-to-Account transfers are made up of a number of instruments: **EFTs** are push payment, cleared via NACH. The maximum transaction value is restricted to Ksh. 999,999. **Wire transfer** push transactions done domestically or across the

			border, is mostly for large-values of Ksh. 1 million or greater, however lower values can also be settled. KEPSS settles these transactions on real-time basis. **SWIFT Cross-border payments** include EAPS for EAC payments telegraphic transfers, and REPSS for COMESA transaction payments. **Bank Person-to-Person (P2P)** is a push payment initiated by the payer. Ksh. 999,999 is the maximum value for every payment. **Intra-bank** is a push payment transaction involving moving of funds from one account to another account in the same institution. **Standing orders** are push payments done by either RTGS or EFT payments. **Direct debits** are pull payments done using RTGS or EFT payments.

Note. Adapted from National Payments Strategy 2022–2025 (p. 10-11) by Central Bank of Kenya, 2022 (https://www.centralbank.go.ke/wp-content/uploads/2022/02/National-Payments-Strategy-2022-2025.pdf). Copyright by Central Bank of Kenya.

2.2.2 Customer Segments

Kenya has a diverse range of customer segments in the mobile payments space, (Central Bank of Kenya, Kenya National Bureau of Statistics (KNBS), and Financial Sector Deepening Trust (FSD Kenya), 2022) highlights them as urban consumers, rural consumers, large corporations and corporates, students and youth, government and public sector, agriculture sector, tourism Industry and non-governmental organisations. Table 2.2 tabulates the customer segments along with their characteristics and needs.

Table 2.2: Mobile Payment Customer Segments

Customer Segment	**Characteristics**	**Needs**
Urban consumers	Residents of major cities and urban areas in Kenya, often with higher income levels	Urban consumers typically seek convenient and efficient payment methods. They value speed and ease of transactions, and many use mobile payments for various services, including transport, shopping, and bill payments
Rural consumers	People living in rural areas with limited access to traditional banking infrastructure	Rural consumers often lack access to banks, making mobile payments a vital financial service. They use mobile wallets for remittances, agricultural transactions, and accessing financial services such as savings and loans
Small and medium-sized enterprises (SMEs)	Small businesses and entrepreneurs across urban and rural areas	SMEs in Kenya use mobile payments for accepting payments from customers, managing payroll, and conducting business transactions. They value cost-effective solutions that enable easy access to funds
Large corporations and corporates	Large businesses and corporations operating across multiple sectors	These organizations often use mobile payment systems for payroll management, supplier payments, and financial management. They require secure and efficient payment solutions that can handle high transaction volumes
Students and youth	Young individuals, including students and early-career professionals	This segment values the convenience of mobile payments for peer-to-peer transactions, online shopping, and utility bill payments. They are likely

		to use digital wallets for their flexibility
Government and public sector	Government agencies and public institutions	The government often utilizes mobile payments for disbursing social benefits, and salaries, and collecting taxes. Efficiency and transparency in financial transactions are critical for this segment
Agriculture sector	Farmers and agribusinesses	This segment relies on mobile payments for buying and selling agricultural produce, accessing credit, and receiving payments from cooperatives and agricultural institutions
Tourism industry	Hotels, tour operators, and travel agencies	Mobile payments play a significant role in the tourism industry, where they are used for booking accommodations, tours, and activities, as well as making payments for services
Non-governmental organisations	Organizations involved in humanitarian and development work	NGOs use mobile payments for disbursing aid, managing donor funds, and implementing cash transfer programs, often in remote areas
E-commerce and retail sector	Online and offline retailers	Mobile payments are crucial for facilitating online shopping and in-store payments. This segment values secure and seamless payment options to enhance the customer experience

2.2.3 Transaction Costs

The manner in which various mobile money providers "frame" their costs varies. (Holloway, Rouse, & Cook, 2017) states that there are three typical formats. One is known as "slab pricing," in which all transactions falling within a certain range are subject to a flat price (though fees vary within slabs, typically in a very regressive manner). Percentage-based pricing is an alternative model in which the fee is a predetermined percentage of the total amount of money transferred. In the alternative structure, there are no fees for customers to trade money. Slab pricing is used by both Airtel and Safaricom in Kenya. They do, however, employ various transaction bands. Additionally, their pricing approaches differ qualitatively: The majority of on- and off-net transactions on Safaricom are subject to positive fees, whereas on-net transactions on Airtel are free but subject to a positive cost for off-net transactions above a threshold (Bianchi, Bouvard, Gomes, Rhodes, & Shreeti, 2023).

Let us evaluate the current transaction costs when using the dominant Lipa na M-PESA compared to the PesaLink service. Table 2.3 displays the transaction costs for the Lipa na M-PESA Paybill Standard Tariffs. The Mgao Tariff has split charges between customer and business, the Business Bouquet Tariff offers no charges to the business but the customer bears all charges while for the Customer Bouquet Tariff the business bares all charges. (M-PESA Paybill, 2023).

Table 2.3: Lipa na Mpesa Paybill Standard Tariffs (M-PESA Paybill, 2023)

Min	Max	Mgao Tariff			Business Bouquet Tariff			Customer Bouquet Tariff		
		Customer	Business	Total	Customer	Business	Total	Customer	Business	Total
1	49	0	0	0	0	0	0	0	0	0
50	100	0	0	0	0	0	0	0	0	0
101	500	5	0	5	5	0	5	0	5	5
501	1,000	10	0	10	10	0	10	0	10	10
1,001	1,500	10	5	15	15	0	15	0	15	15
1,501	2,500	13	7	20	20	0	20	0	20	20
2,501	3,500	16	9	25	25	0	25	0	25	25
3,501	5,000	16	18	34	34	0	34	0	34	34
5,001	7,500	17	25	42	42	0	42	0	42	42
7,501	10,000	18	30	48	48	0	48	0	48	48
10,001	15,000	18	39	57	57	0	57	0	57	57
15,001	20,000	19	43	62	62	0	62	0	62	62
20,001	25,000	20	47	67	67	0	67	0	67	67
25,001	30,000	20	52	72	72	0	72	0	72	72
30,001	35,000	21	62	83	83	0	83	0	83	83
35,001	40,000	23	76	99	99	0	99	0	99	99
40,001	45,000	23	80	103	103	0	103	0	103	103
45,001	50,000	24	84	108	108	0	108	0	108	108
50,001	70,000	24	84	108	108	0	108	0	108	108
70,001	250,000	24	84	108	108	0	108	0	108	108

The only transaction expenses a consumer has with Lipa na M-PESA Buy Goods are for fuel station payments. At gas stations, the customer's transaction cost is equivalent to 0.55% of any payments made above KES 200. For money collected using Buy Goods, the business owner will be charged a maximum of 0.55% and not more than KES 200 for each transaction. (Safaricom, 2023).

To use the Lipa na M-PESA services one must have electronic cash in their M-PESA mobile money wallet. Depositing cash in exchange for electronic equivalent into one's M-PESA mobile money wallet is free at any Safaricom agent. However, if you wish to transfer money from your bank account to your M-PESA wallet a transfer fee will be charged by the bank. Each bank sets its transfer fees. Kenya Commercial Bank as of December 2022 has the largest market size in the country (Central Bank of Kenya, 2022). For this purpose, we will use KCB tariffs in this study. Transfer charges of money from a KCB account to Mobile Money wallets using KCB mobile banking are indicated in Table 2.4

Table 2.4: KCB Bank to Mobile Money Wallet Charges (Kenya Commercial Bank Group, 2022)

Minimum Amount	Max Amount	Total Fees in KES (Including Excise)
1	100	0
101	500	11.90
501	1000	14.20
1001	1500	16.50
1501	2500	26.25
2501	3500	37.75
3501	5000	49.25
5001	7500	62.75
7501	20000	74.25
20001	150000	76.25

One can transfer money from one bank account to another instantly at any time of day or night through PesaLink. PesaLink transfer charges vary from bank to bank. Below Table 2.5 displays the KCB PesaLink transaction charges, all amounts are in Kenya Shilling.

Table 2.5: KCB PesaLink Transfer Charges (KCB Group, 2023)

Minimum Amount	Maximum Amount	Transfer Fees
10	1,000	0.00
1,001	5,000	36.00
5,001	10,000	48.00
10,001	50,000	63.25
50,001	100,000	96.00
100,001	200,000	120.00
200,001	999,999	240.00

Using Table 2.3 and Table 2.5 we can compare the cost of transaction between LIPA na M-PESA Paybill transactions and PesaLink transactions for payment of the same Bill amount due.

In Table 2.6 are three scenarios. One, the customer has a cash equivalent of 4199 to pay a bill using M-PESA. The cash amount is exchanged at a Safaricom M-PESA Agent and the electronic value is deposited into the customer's M-PESA mobile money wallet at no fee. The customer will be charged KES 16.00 as a transaction payment processing fee and the receiving business will be charged KES 18.00.

Scenario two, the customer has money in the bank account but not in the M-PESA wallet. He will use his bank mobile application to move the money from his account to the wallet, this will incur a transfer cost of KES 49.25. M-PESA will charge him KES 16.00 as a transaction fee to process the Paybill payment and the receiving business KES 18.00. Therefore, in the second scenario the customer incurs a total of KES 65.25 in transfer and transaction costs while the business receiving payment will be charged KES18.00.

In the final scenario, instead of the customer transferring money from his bank account to his M-PESA wallet, He would have the option of transferring KES 4199 from his account to the business account he is paying via PesaLink. The customer will incur a cost of KES 36.00. The business will not be charged for receiving these funds into their bank account. The table below summarizes the three scenarios.

Table 2.6: Bill Payment Transaction Cost Comparison

Scenario	**Bill Amount (KES)**	**Source of Funds**	**Mode of Transfer**	**Transfer Cost**	**Mode of Payment**	**Transaction charges to the customer (KES)**	**Total Amount (Bill Amount + Transfer cost +Transaction charge) (KES)**
1	**4199.00**	Cash to Mpesa wallet	Safaricom Agent	Time and cost of locating Safaricom Agent	M-PESA Paybill	**16.00**	**4215.00**
2	**4199.00**	Bank Account to Mpesa Wallet	Mobile Banking Application	**KES 49.25**	M-PESA Paybill	**49.25+16.00** Total cost **65.25**	**4246.25**
3	**4199.00**	Customer Bank Account	PesaLink Payment Switch	**KES 36.00**	The customer sends money to the Business Account	**36.00**	**4235.00**

From the table above we see the difference in transaction costs incurred to settle bill payments. Scenario one though it has the lowest transaction cost there are other costs that the customer incurs such as convenience, speed and user experience that may make scenario one not as cost effective. The customer in scenario one will need to physically locate a Safaricom agent most of whom are not open 24 hours a day. In scenario two, moving money from a bank account to an M-PESA wallet is convenient however the cost of transfer is high which further increases the total cost of a transaction. The pesaLink payment switch enables the transfer of funds from the customer's bank account to the business bank account. PesaLink tariffs are lower than the transfer and transaction costs of scenario two. From Table 2.5 we see PesaLink offers transfer of amounts between KES 10.00 and KES 1000.00 at no transaction cost.

2.2.4 Disruptive Opportunities

There are some gaps brought about by technology, regulations and restrictions in cost that exist in payment processing within the financial industry in Kenya (FSD Africa, 2018). These gaps provide an ongoing opportunity for disruptive innovation. Figure 2.1, though originally published in 2018, remains a useful visual summary of the prevailing challenges across various payment channels, including mobile wallets, bank transfers, and merchant payment platforms. While the fintech landscape has evolved, particularly with the rise of real-time settlement platforms like PesaLink, many of the issues highlighted in the Figure 2.1, such as high transaction costs, lack of wallet interoperability, and delays in EFT/RTGS, remain relevant today in 2025. This continued relevance reinforces the need for alternative payment solutions that can eliminate intermediaries, reduce costs, and offer real-time transactions, as proposed in this study.

PesaLink may provide a solution to these gaps. As indicated in Table 2.5 using PesaLink one can transfer between KES 1.00 and KES1000.00 to an account without being charged transaction fees with the PesaLink having the largest transaction limit of KES 999,999.00 that can be sent in a single transfer transaction. Table 2.6 shows that the cost of transactions charged by PesaLink is almost half of the cost incurred by users who do Bank-to-Wallet transfers at a high fee.

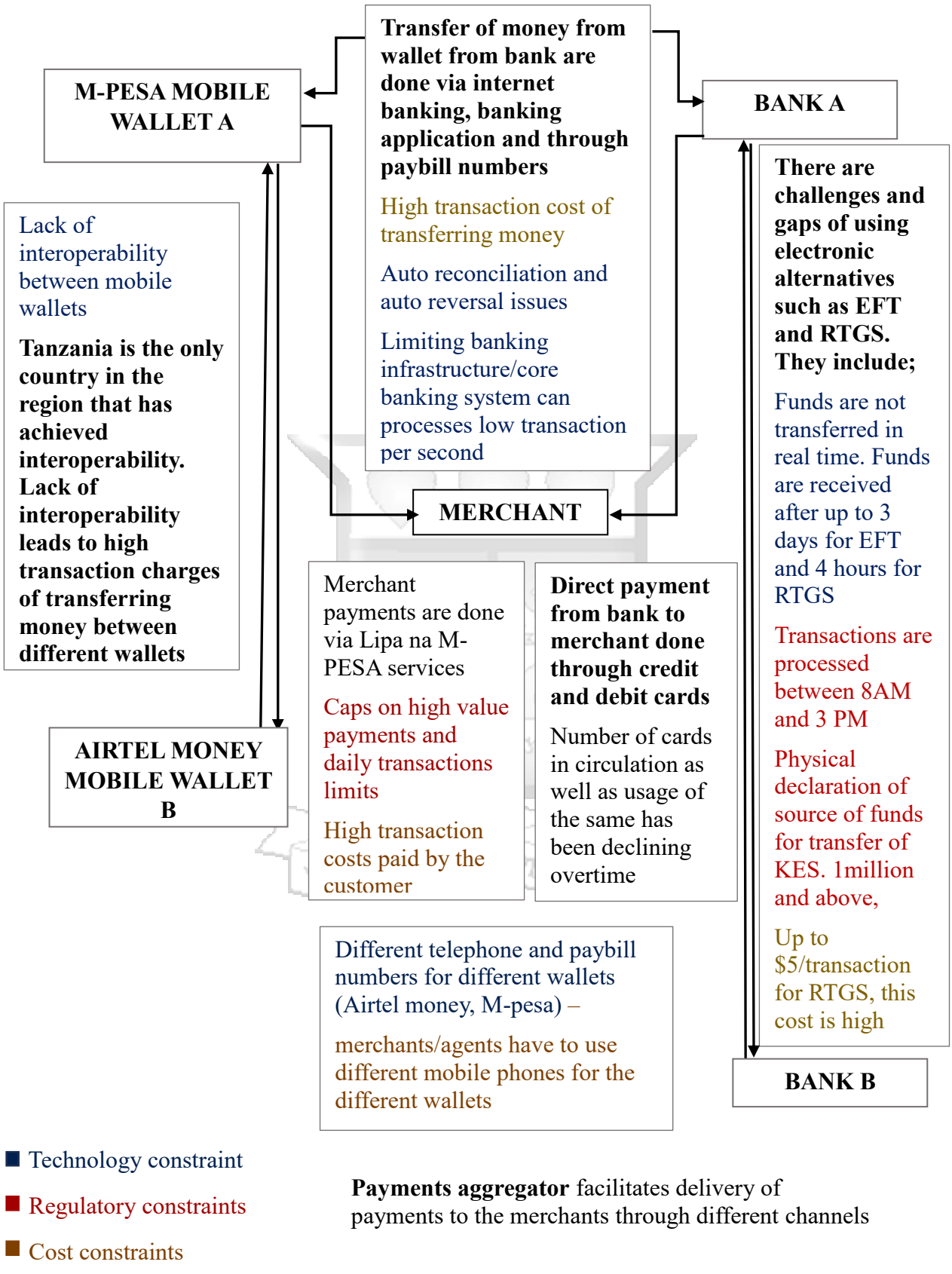

Figure 2.1: Existing Gaps in Payment Processing (FSD Africa, 2018)

2.3 Empirical Framework

Consumers currently have a variety of methods to make payments for goods, services and utilities. What follows is a review of the payment methods and solutions that are currently available in the Kenyan market and the gaps identified in these methods and solutions.

2.3.1. Cash Payment

April 10, 1967, marks the beginning of Kenya's printing and minting of its currency (The Central Bank of Kenya, n.d.). Cash payments are often preferred for their perceived convenience, accessibility, and anonymity. The stark reality is that 80 per cent of the money that flowed throughout the Kenyan economy in 2019 was in cash while money transferred digitally was the remaining 20 per cent. Cash is used to pay for utilities, goods and services on site. The customer must have the physical cash amount to be able to make payment. The Covid-19 increased the demand for cashless payments (Denyes, et al., 2020).

2.3.2. Credit and Debit Cards

Debit and credit cards are used in card-present transactions and online transactions. The Credit card payment process for card-present transactions involves several steps, as generally outlined below (EMVCo, 2023).

Step 1: Card Authentication

The customer inserts the card into the EMV-enabled terminal. The chip on the card is read at the terminal and the card's digital signature is verified using a public key infrastructure system.

Step 2: Cardholder Verification

The cardholder will enter a pin associated with the card to verify the identity of the cardholder.

Step 3: Transaction Authorization

After successful authentication of the card and positive verification of the cardholder, the terminal will transmit a transaction authorization request to the card issuer. The issuer in turn checks for the availability of funds on the card and approves or declines the transaction

Step 4: Transaction Completion

Once the transaction is approved, the terminal will generate an authorization code and send it to the card issuer for verification. On successful verification of the authorization code by the card issuer a response is sent back to the terminal that the transaction is complete. The terminal prints a receipt.

Visa has worked with Kenyan banks to offer both Credit and Debit cards to customers (McCurdy, Simone, Herrera, & Heckathorne, 2018). These cards can be used to make merchant payments at point-of-sale terminals. Most banks offer Visa debit cards to their customers when they open a bank account for a one-time fee which varies from bank to bank. Some banks charge a fee for Visa debit card payments done at the point-of-sale terminal. According to KCB Group (2023), there is no charge for Visa debit cards at the point-of-sale terminal for KCB Visa Debit card holders, but a fee of 6.25% of the transaction fee is charged by Standard Chartered bank at the point-of-sale for their VISA Debit Card holders (Standard Chartered Bank of Kenya, 2023).

Visa credit cards offered by Kenyan banks attract various costs including annual fees and minimum interest fees. To qualify for a credit card, depending on the banking institution, one would provide up to 6 months' bank statements and a recent pay slip with a range predetermined by the bank. For example, for a KCB Classic Visa Card, would require self-employed individuals to provide bank statements covering the last six months, demonstrating an account turnover within the range of Kes. 20,000 to Kes. 49,999, While salaried applicants must submit bank statements for the previous three months along with their most recent pay slip, which should reflect a minimum net salary within the same range (Credit Cards in Kenya, Best Credit Card, Visa Card - KCB Kenya Website., n.d.).

2.3.3. Mobile Banking Applications

Most banks offer a mobile banking application through which customers can access financial services in addition to USSD. Smartphone users are the ones who primarily use this (FSD Africa, 2018).

Mobile banking applications offer customers the ability to pay for utilities from within the mobile banking application. The number of merchants one can pay for utilities is very limited. KCB Mobile banking application enables its customers to pay for electricity for postpaid customers, television subscriptions for DSTV, GoTV and Start Times, Nairobi water and Jambo Jet bills (KCB, n.d.). Absa Mobile application allows for payment of Electricity for both Postpaid and Prepaid and Multichoice television subscriptions (ABSA, n.d.). Family Bank of Kenya's PesaPap mobile banking application enables its customers to make utility payments for Electricity, Tax, Nairobi city council payments, television subscriptions: DSTV and GOTV and Internet subscriptions to JTL and Zuku (Family Bank Limited, n.d.). Standard Chartered Bank of Kenya's mobile banking application utility payments are limited to DSTV,

GOTV, JTL, Start times, Zuku, Nairobi water, Airtel and Telkom postpaid. For merchant payments Standard Chartered mobile banking application only has LittlePay listed as a merchant (Standard Chartered Kenya, n.d.).

For one to make use of any mobile banking application for merchant payments, it is a requirement that one has an account with that bank and downloads the application on one's smartphone. Each bank has a predetermined way of onboarding a customer before they can use the mobile banking application.

2.3.4. Mobile Payment Applications

2.3.4.1 T-Kash

T-Kash is a mobile financial service owned by Telkom Kenya Limited. The service enables customers to deposit money into their wallets through an authorized Agent (Telkom Kenya, n.d.). As of June 2022, the wallet can be topped up from a customer's KCB and Standard Chartered Bank Account (Kivuva, 2022).

To pay for goods or services at the till using the T-Kash mobile application the mobile user will select the Buy Goods option, then select between "T-Kash Till Number" or "MPESA Till Number", the user will then enter the corresponding till number and the amount. The user will be prompted to confirm the transaction. Once the user confirms positively, they will be asked to enter their T-Kash PIN. The user will then receive an SMS message with the status of the transaction (Telkom Kenya, n.d.).

To pay for utility bills using the T-Kash mobile application the mobile user will select the Buy Goods option, then select between "T-Kash Paybill" or "MPESA Paybill", the user will then enter the corresponding Paybill number, the account and the amount. The user will be prompted to confirm the transaction. Once the user confirms positively, they will be asked to enter their T-Kash PIN. The user will then receive an SMS message with the status of the transaction (Telkom Kenya, n.d.).

2.3.4.2 Airtel Money

Airtel Money is owned and provided by Airtel Kenya Limited. Topping up the Airtel Money wallet can be done by exchanging cash for the electronic equivalent at an Airtel Money Agent or by transferring money from a bank account through mobile banking or an internet banking application to the Airtel Money wallet. According to Airtel Kenya Limited (n.d.), there are 14 banks where one can transfer money as long as the Airtel

Money user is registered by the respective bank to transact via mobile banking or Internet banking. This transfer from the bank account to the wallet incurs a transaction fee charged according to the amount transferred.

Safaricom (n.d.), has allowed Lipa Na M-PESA Merchant interoperability across all networks, allowing clients from Airtel Money and T-kash to make transactions to any Lipa Na M-PESA Buy Goods. From the Airtel Money application or USSD platform an Airtel subscriber can Pay for goods and services by selecting the Buy Goods option on their Airtel Money mobile application and then selecting to use Airtel Money till or M-PESA Till, once the user enters the respective till number and then the amount. After the user confirms the transaction a message with the status of the transaction is sent to the user.

For bill payments, the Airtel subscriber can select the Pay Bill option from their Airtel Money mobile application and enter the Airtel Paybill option then enter the Airtel Pay bill number, account or reference number and finally the amount. The user will be prompted to confirm the transaction details and a message with the transaction status will be sent to the user. To use the LIPA Na M-PESA Paybill service from the Airtel network the Airtel subscriber is required to dial the USSD number *222# and once the M-PESA Pay Bill option is chosen the user is routed to the M-PESA Pay bill platform. Once redirected to the M-PESA USSD platform the user will key in the M-PESA Paybill number, account number and amount. The user will then confirm the transaction details and a transaction status message will be sent to the user.

2.3.4.3 M-PESA

Launched in 2007 by telecommunication giant Safaricom and Vodafone M-PESA has evolved beyond the basic provision of Person-to-Person money transfer. Lipa Na M-PESA which is part of the M-PESA Mobile application allows a customer to settle payment for goods, services and utilities. Lipa Na M-PESA can either be used in the store for in-store purchases or remotely to pay bills such as electricity and school fees. For bill payments, the customer can access the “Pay Bill” option from the M-PESA mobile application or STK menu, they then enter the “Pay Bill” number, the account or reference number then the amount. The customer then confirms the transaction and awaits a confirmation message. For merchant till payments, the customer will select Buy Goods from the M-PESA menu then enter the merchant till number followed by

the amount. Once the customer confirms the transaction details both wait for a message confirming the status of the transaction. The merchant also receives a message on the status of the transaction. (Safaricom, 2023)

2.3.5. PesaLink

Launched in 2017 by the Kenya Banker's Association, PesaLink is a real-time service that is accessible 24/7 to all users who have a bank account. The service allows you to send a maximum of KES.999,999.00 per transaction from one bank account to another. The user's mobile number is used as a unique identifier as it is mapped to bank account numbers on the backend. This enables the routing of transactions and also makes it easy for the system to know what other accounts are linked to the given mobile number. This also prevents the user from disclosing their account number (Amayo S. A., 2019).

The Integrated Payment Service Limited was formed by the Kenya Bankers Association to operate PesaLink. Apart from person-to-person instant payments, there are other services offered through PesaLink these are Person-to-Government payments and Bulk payments. The Government of Kenya has provided its citizens with an electronic platform, eCitizen, where they can access government services such as the renewal of driving licenses, passport applications, and business registration among other services (eCitizen, n.d.). PesaLink is one of the modes of payment that is available for a person to pay for a service (Kute, n.d.).

M-Akiba Bond is a retail Bond issued by the Government of Kenya. The bond offering is available exclusively on mobile phones. A bank account holder can use their mobile banking application and through PesaLink purchase this bond (CDSC, n.d.). The bulk payments service offered by PesaLink enables the sending of mass payments within the same day clearing and settlement. All the instructions of corporate and institutional customers are electronically captured and presented to PesaLink for processing (Kute, n.d.).

2.4 Research Gap

The limitations of using cash include the customer having to be physically present at the merchant's shop to be able to make payment. The number of goods or services one can purchase is dependent on the amount of cash the customer has at hand. The probability of losing cash through theft or loss is high, cash at hand does not earn interest or enable a digital footprint which would encourage fraudulent payments being made through the anonymous use of cash

for such transactions (Denyes, et al., 2020). For the merchant storage and securing cash at the store is costly (Deloitte LLP, 2019).

Similar to Cash the use of Credit and Debit cards for payment requires that the cardholder be physically present at the store unless the items being purchased are available at an online store where payment can be done virtually. As indicated in (Credit Cards in Kenya, Best Credit Card, Visa Card - KCB Kenya Website., n.d.) there are conditions that one must meet to be able to acquire a credit card. These conditions may not be possible for a majority of the population. Some fees need to be paid for a credit card holder to continue to use the credit card. Another drawback to the use of credit and debit cards that affect the merchant is the transaction acquiring banks charge the merchant approximately 2.5 per cent of the transaction value and take several days for the merchant's bank account to receive the money the customer paid (Denyes, et al., 2020).

Mobile money payments to merchants are capped on a daily transaction limit of Kshs. 300,000 with the maximum amount per transaction being Kshs. 150,000 (FSD Africa, 2018). This only favours low-value transactions and limits merchant sales. Customers who top up their mobile money wallet from their mobile banking service to make a payment using their mobile money application will end up being charged a transfer fee by their bank and a transaction fee by the mobile money operator which makes the total transaction cost of payments higher.

There are limitations in bank-to-wallet transfers as the number of banks that one can transfer money from is limited depending on the mobile wallet one is using. As of 2022, for Telkom's T-kash one can only transfer money from KCB and Standard Chartered Bank into the mobile wallet (Kivuva, 2022). This leaves the T-Kash mobile money user to find a Telkom Money agent to top up their mobile wallet.

2.5 Conceptual Model

The conceptual model shown in Figure 2.2 shows the main components and actors involved in facilitating a real-time, wallet-free, person-to-business mobile payment using the PesaLink infrastructure.

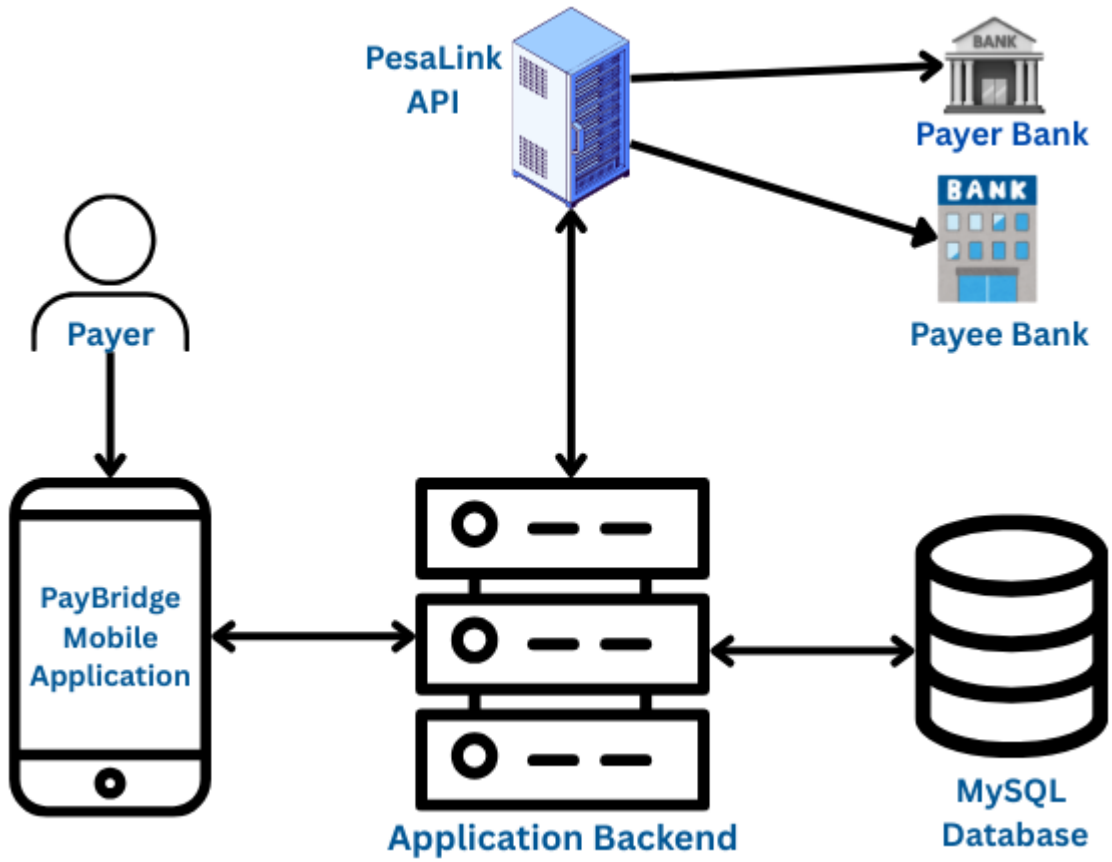

Figure 2.2: Conceptual Model

In the model, the payer initiates a payment request via the PayBridge Android application. This request is securely transmitted to the application's backend, which performs necessary validations, generates a secure signature, and submits the payment request to the PesaLink API.

Once received, the PesaLink system routes the request between the payer's bank and the payee's bank, ensuring real-time processing of the transaction. If the transaction is successful, the payee receives the funds instantly in their bank account. A confirmation message is sent back to the user through the application, completing the transaction cycle.

The conceptual design removes the need for an intermediary mobile wallet, thereby reducing transaction costs, shortening payment time and simplifying the user experience. It emphasises efficiency, security, and compliance with existing banking protocols.

2.6 Summary

Disruptive innovation as discussed in the theoretical framework represents the fundamental idea that certain concepts and technologies in the financial payments space have the potential to disrupt current payment methods.

The key concepts that would drive the need for innovation within the payments space are discussed in the empirical framework. The methods of payment discussed were innovative for their time meeting some gaps including customer needs not being met or even due to regulatory drawbacks in the predecessor innovations.

The drawbacks and limitations discussed in the empirical framework can be grouped into three major gaps of payment systems; Cost constraints, technological constraints and regulatory constraints. These gaps provide for disruptive innovation opportunities within the payments industry.

2.6.1 Cost Constraints

The current methods of funding the mobile money wallet incur a cost of money and convenience. This is evident in the high cost of transferring money from a bank account into a mobile money wallet and the inconvenience of having to carry physical cash and looking for a mobile money agent who can deposit the electronic equivalent of the physical cash into a mobile money wallet. The other cost incurred by the customer is the charges deducted from the mobile money wallet to process the mobile payment transaction. On the other hand, merchants are not spared, they are required to remit a fee for receiving payments from their customers.

2.6.2 Technology Constraints

Merchant and utility bill payments cannot be auto-reconciled or auto-reversed; it currently takes a couple of days for a customer to get a refund for an erroneous transaction done via mobile money payment applications.

When a customer pays the merchant, the merchant does not receive his funds into his bank account immediately instead he has to wait a couple of hours for the funds to reflect into his account after he has received a payment received message on his phone.

2.6.3 Regulatory constraints

Currently, mobile money payment applications are restricted through regulation to have a maximum balance of KES 500,000 stored in the mobile money wallet and, a maximum daily transaction value of KES. 500,000 and a maximum amount per transaction of KES. 250,000.

For other electronic payment methods such as EFTs and RTGS, a time limit on when transactions can be processed is fixed between 8 am and 3 pm and any funds to be transferred that are 1 million and above need their source to be physically declared before the transaction can be initiated.

2.6.4 Alternative Hypothesis

The gaps mentioned above provide the opportunity for innovation within the mobile payment space to resolve or, at best, reduce the effects of high transaction costs and provide convenience. These innovations must work within regulatory boundaries while improving convenience for both payers and merchants. One such innovation is the use of real-time payment systems like PesaLink, which eliminates the need to first transfer funds from a bank account into a mobile wallet, a process that often incurs additional charges and delays.

In this study, a prototype solution is proposed to demonstrate a more efficient method of payment, directly from the customer's bank account to the merchant's bank account using PesaLink. This is expected to reduce transaction costs while providing real-time fund availability for merchants.

Alternative Hypothesis (H1): Disruptive innovations in real-time payment systems positively impact transaction cost reduction.

While this hypothesis is stated broadly, it is important to note that the study specifically tests this claim using PesaLink as the representative case of a disruptive real-time payment innovation in the Kenyan context. As such, the generalizability of the hypothesis is limited to systems that share key characteristics with PesaLink, namely, bank-to-bank, real-time, API-driven infrastructure. Broder validation would require testing multiple systems across different markets.

Chapter 3 : Research Methodology

3.1 Introduction

This chapter describes the methodology and application of Agile principles across the stages of requirements gathering, design, implementation, and testing within the research domain. A section dedicated to data collection and data analysis methods is also included. By embracing the principles of Agile, this research methodology not only promises a more responsive and flexible approach to the research process but also underscores the importance of maintaining the highest standards of validity, reliability, and ethical integrity throughout the journey of academic inquiry.

This study evaluates the alternative hypothesis through the design, development, and testing of a prototype mobile payment application that integrates with the PesaLink API. While the hypothesis refers broadly to "disruptive innovation," this research focuses specifically on one such innovation, the PesaLink real-time payment infrastructure. As such, the findings are context-specific and demonstrate the potential impact of real-time, wallet-free payment systems on transaction cost reduction within the Kenyan mobile payments landscape. Broader generalisation to other systems or markets would require comparative studies involving multiple platforms or geographies.

3.2 Software Development Methodology

The study will make use of the Agile software development methodology. Figure 3.1 shows each step of the Agile software development life cycle process. This methodology promotes the adoption of changes without undue risk to the process or the need for extensive rework, which minimizes overhead in the software development process (Alsaqqa, Sawalha, & Abdel-Nabi, 2020). The agile methodology is iterative and incremental, each defined step of the software development process is carried out in a series of tiny iteration cycles (Jain, Sharma, & Ahuja, 2018).

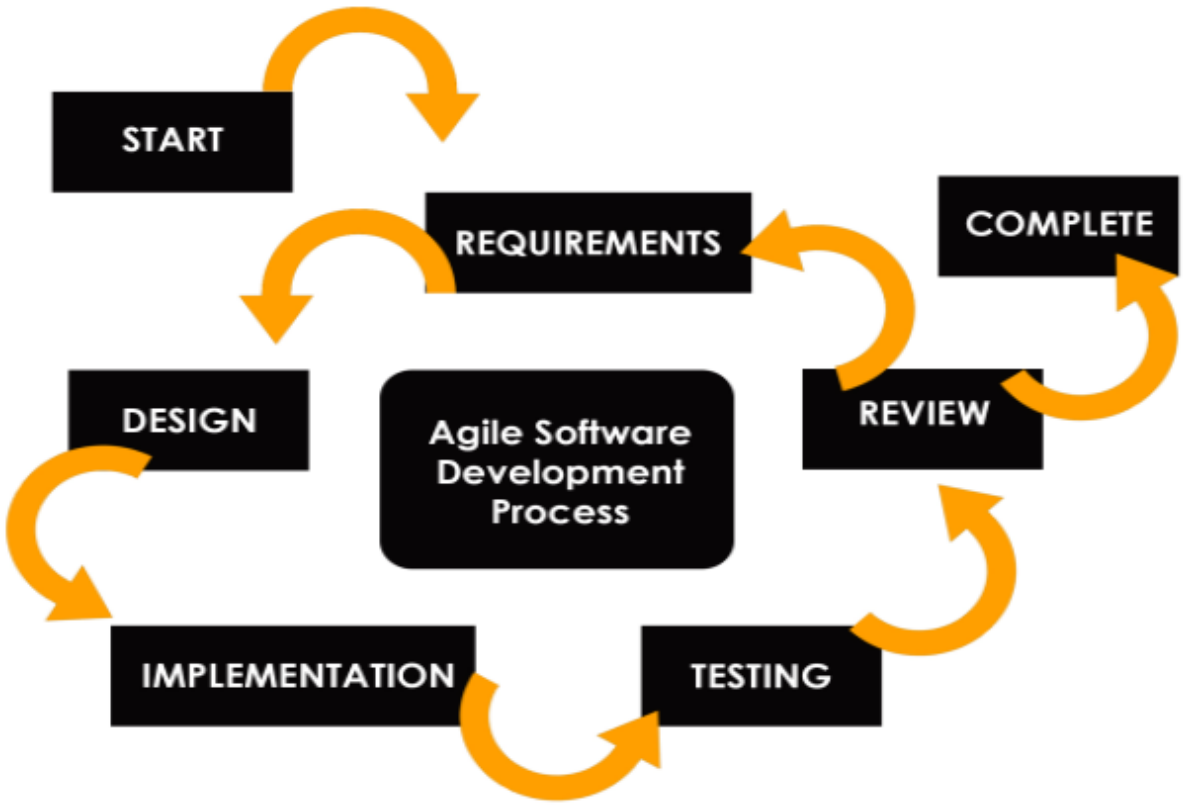

Figure 3.1: Agile Software Development Process (Neelu & Kavitha, 2020)

3.2.1 Requirements Gathering

The requirements of the solution to be developed were drawn from the examination of the existing mobile money payment systems along with their strengths, shortcomings and limitations. Apart from the literature that was reviewed in chapter two, the Firsthand experience of the researcher using some of the existing mobile money payment systems to make utility, goods and service payments was part of the requirements gathering process. A questionnaire as shown in Appendix E was sent out online and the analysis of the responses brought out additional requirements, system processes to be implemented, system interfaces to use for communication, and solution constraints along the functional and non-functional specifications.

3.2.2 Design

The object-oriented design (OOD) approach was used to convert the requirement analysis and specification documentation into design objects. The design objects included interface and database structure objects. Wireframes were used as visual representation of the interfaces that were to be implemented. Entity relationship diagrams (ERD) model the entities that constituted the database including relationships

between entities. For the illustration and documentation of the message sequence between processes sequence diagrams have been provided. The messages include those sent during the payment request, validation, payment confirmation and receipting

3.2.3 Implementation and Unit Testing

The software specification from the system design phase contains the modules that were implemented in this phase. Development of the mobile application was done using the Android Studio platform. The Android studio platform contains the necessary libraries and Software development kit tools of various versions to facilitate development. JSON was used to provide the communication interface between the client side of the Android application and server-side PHP scripts. Communication between the mobile application and the PesaLink API was through REST technology. The database management system used for the storage of data is the open-source, cross-platform MySQL. Documentation within the code was done at the unit development stage by use of code comments

3.2.4 Testing

The modules developed into small units of code were subjected to unit testing to ensure that they meet functional specifications before the unit modules were added to the system. In this phase, testing was done to ensure that the units integrated work seamlessly and that the features specified in the component design were implemented in the correct modules. The system tests were carried out to assess whether the features in the system specification have been delivered and test the usability of the system, ease of use and efficiency of system processes.

3.3 Data Collection Methods

The questionnaire in Appendix E was prepared and distributed electronically using Google Forms application. The questionnaire was used to gather information on the ease of use, transaction costs, convenience and acceptance of mobile payment platforms. The responses to the questionnaire was analysed during the data analysis stage.

3.4 Data Analysis

3.4.1. User Story Mapping

The key user actions were extracted from the questionnaire responses, the pain points and feature needs were mapped out and user stories developed based on respondent preferences. Finally, the test cases developed based on the pain points from the questionnaire responses.

3.4.2. Story Decomposition

The user stories were broken down into smaller, manageable tasks or sub stories. This facilitated the identification of detailed requirements and corresponding cases for individual components of a user story.

3.4.3. Continuous Refinement

This analysis method allowed for the refining of requirements based on ongoing feedback and insights from stakeholders. This facilitated the evolution of requirements and test cases throughout the project

3.4.4. Feature Mapping

This was conducted by identifying features and their relationship to user stories and requirements. Consequently, it enabled a holistic view of both functional and non-functional features making it easy to prioritize the associated requirements.

3.5 Validity and Reliability

This was done by conducting thorough tests on the finalized proposed prototype solution to ensure the validity of the solution. Furthermore, the validity of this study was ascertained by ensuring a review of the latest literature and appropriate Application Programming Interfaces (APIs) were used to achieve the intended research objectives

3.6 Ethical Considerations

Before answering the questionnaire, the potential participant was informed of its purpose. Answering the questionnaire was on voluntary basis only after consenting to participating. A copy of the participant information sheet and consent form is available in Appendix D.

Chapter 4 : Data Analysis and Interpretation

4.1 Introduction

This chapter presents the analysis of the responses collected through the use of a questionnaire. The purpose of this analysis was to evaluate how respondents are using the predominant mobile money payment application LIPA Na M-PESA and find out their pain points and willingness to try a different solution along with features they would want as part of the new mobile money payment application.

4.2 Data Analysis

The questionnaire used in Appendix E was designed using Google Forms and analysed using the Google Forms analysis platform. A total of 35 respondents completed the questionnaire.

4.2.1. Respondent's Account Top-Up Methods

The respondents were asked what method they use to top-up their M-PESA mobile money wallet. As shown in Figure 4.1, 68.6% of the respondents top-up from their bank account while 31.4% deposit cash to their phone through an M-PESA agent.

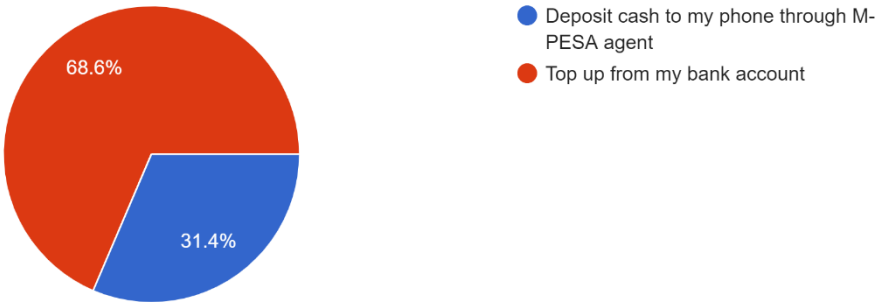

Figure 4.1: Analysis of M-PESA Top-up Methods

A follow-up question was asked to those who top-up from their bank account, how often do they use this method to top-up? 38.2% of respondents use this top-up method once or more times per week, 35.3% use it every time they need to use M-PESA, 20.6% once a month and the remaining 5.9% once a day as shown in Figure 4.2.

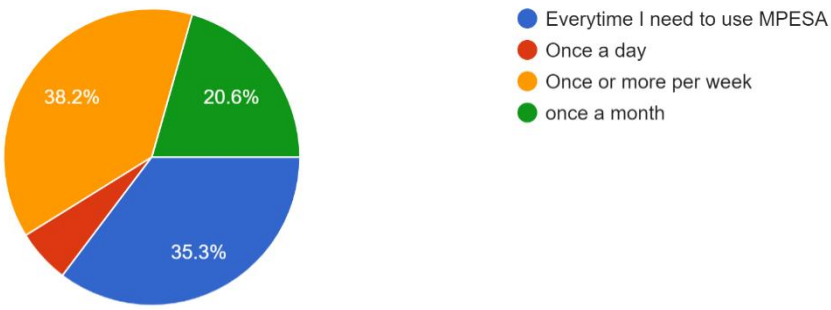

Figure 4.2: Frequency of Bank to M-PESA Top-Up Method

4.2.2. The Use of Lipa Na M-PESA Services

Respondents were asked which Lipa Na M-PESA service they frequently use 88.6% of respondents use Buy Goods service, 40% use Paybill and 14.3% of the respondents use Pochi la Biashara as shown in Figure 4.3.

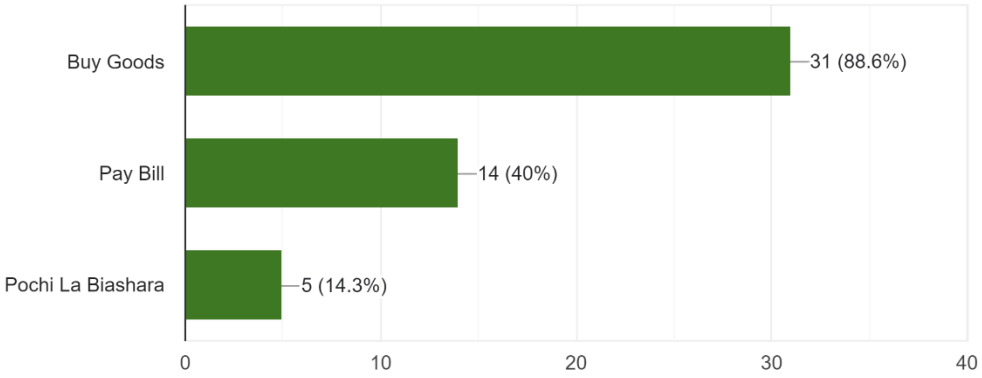

Figure 4.3: Use of Lipa Na M-PESA services

4.2.3. Cost and Fees

Respondents were asked how they felt about the fees associated with transferring money from their bank account to their M-PESA account. Figure 4.4 shows that 85.3% of the respondents felt that the fees charged were high, 5.9% felt the fees charged were low and 8.8% were not charged transfer fees by their respective bank.

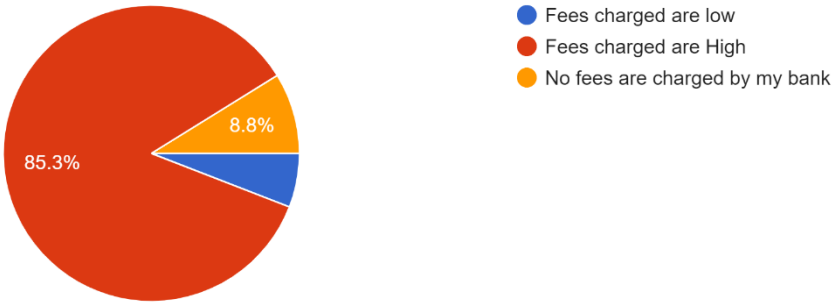

Figure 4.4: Bank Account to Mobile Money Transfer Fees

The second question concerning cost and fees was how respondents felt about transaction fees charged when using Lipa Na M-PESA to pay for utilities and bills. 60% of the respondents felt that the fees charged were high while 40% felt the fees were low as shown in Figure 4.5.

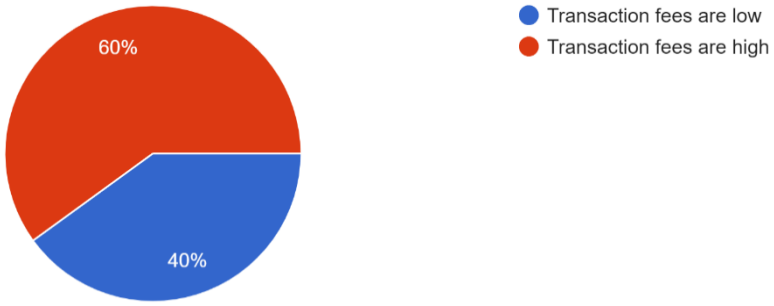

Figure 4.5: Lipa Na M-PESA Transaction Fees

4.2.4. Speed and Reliability

Figure 4.6 shows the responses of the respondents concerning their satisfaction, on a scale of 1 to 5, with the speed and reliability of Lipa Na M-PESA. 45.7% of the respondents are very satisfied, 28.6% are highly satisfied, 20% are moderately satisfied, 2.9% of the respondents rated their satisfaction as low and another 2.9% of the respondents as very low.

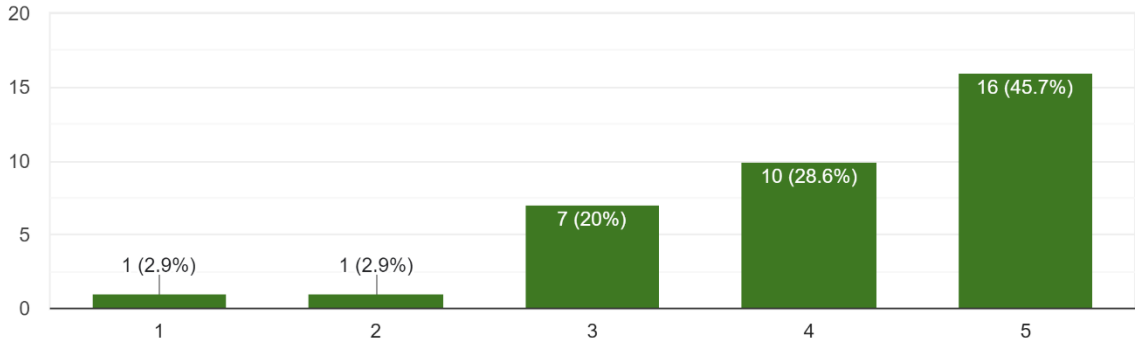

Figure 4.6: User Satisfaction with Speed and Reliability of Lipa Na M-PESA

4.2.5. Reliability

Respondents were asked if they have ever been affected by M-PESA service being unavailable. 94.3% of respondents have been affected by M-PESA unavailability while only 5.7% have not been affected as shown in Figure 4.7.

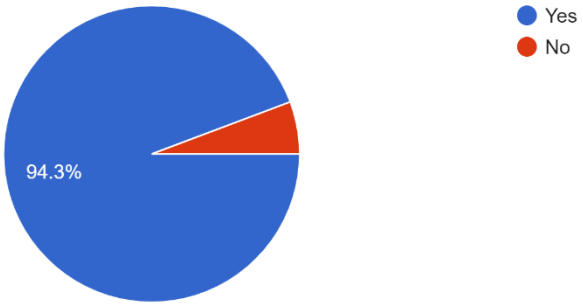

Figure 4.7: Respondents Affected by M-PESA Unavailability

4.2.6. Respondents Willing to Try the Prototype Solution

Figure 4.8 shows that 82.9% of the respondents were willing to try a new mobile payment application that would allow them to make mobile money payments straight from their account without having to transfer money to the mobile wallet.

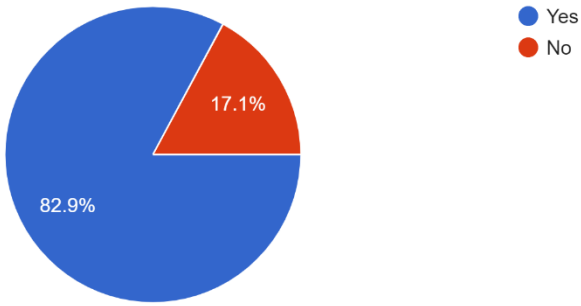

Figure 4.8: Respondents Willing to Try a New Mobile Payment Application

4.2.7. Operating Systems

Figure 4.9 shows the smartphone operating systems in use among the respondents. 85.3% of respondents have smartphones that run on the Android operating system, and 17.6% own IOS-powered smartphones.

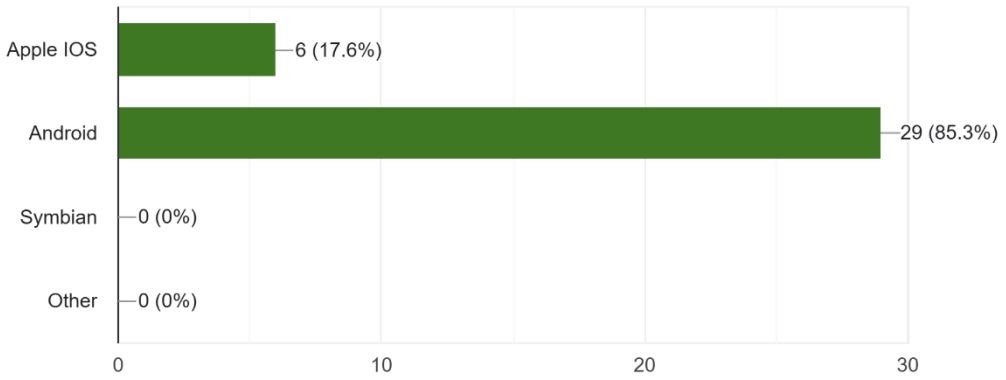

Figure 4.9: Smartphone Operating Systems in use

4.2.8. Suggested Features

The respondents were asked an open-ended question about what features they would like added to the new mobile money application. Their responses are listed below.

i. Features that guarantee security and protection of personal data. Provide insights on spending habits weekly.
ii. Not imputing the Paybill no as it can be confusing or hard to read at times
iii. Sharing bank app option
iv. No fees
v. There should be more than one bank option
vi. Locked Savings Account
vii. Buying data directly from the bank
viii. A chance of not imputing the pay bill number, it is sometimes easy to mix up
ix. Low Charges
x. Use of a universal 'card' or 'token' linked to my mobile wallet; which I can use to pay at any payment point for P2P, P2B, P2M, etc...
xi. No downtime
xii. Identification of recipient for the Paybill option before payment and an option to cancel which is a feature missing in the M-PESA Paybill option if you make an error in any data input you have to follow up with respective banks for yourself.
xiii. Ability to track expenditures by category: savings, food, transport etc.
xiv. Simple, reliable, and very clear error recovery paths. Proven and trusted provider.
xv. More detailed expenditure analysis that helps budgeting.
xvi. Automatic Email or SMS notification of a transaction done whether successful or not
xvii. Proof of payment link that displays a printable document.
xviii. Free Lipa Na M-PESA services
xix. Biometric login
xx. Shorter customer journey. Probably where I just give the seller my number (or an identification code of sorts) and they prompt payment so I just put in my PIN.
xxi. QR code payments. Where I can scan from an application, just put in the amount and pin.

xxii. No need for an internet connection to process.

4.3 Interpretation of Responses

From the analysis, it is evident that the respondents found the cost of transferring money electronically from their banking application to M-PESA high. It was also noted that this method of electronically funding the M-PESA wallet from a bank account was frequently used by the respondents. This highlights an opportunity for a mobile money payment application that would allow for electronic payment directly from a bank account feasible and ideal. This would eliminate the cost of transfer of funds as a user will pay directly from their bank account instead of having to fund a mobile wallet to complete a payment transaction.

4.4 Summary

The responses gathered from the questionnaire informed the need for a solution that would cut costs incurred during payment of transactions from a mobile money wallet. A majority of the respondents were open to trying out a new mobile money payment application with some even suggesting features they would like included in the new application.

Chapter 5 : System Design

5.1 Requirement Analysis

The requirements were collected from Mobile money application users through the use of a questionnaire that was distributed electronically. The responses from the form were carefully analysed to identify the needs of potential application users. The results of the analysis were divided into functional and non-functional requirements.

5.1.1. Functional Requirements

These refer to the specific features and capabilities that the application must provide to meet the users' needs. The functional requirements include User registration and authentication, bank account management, payment initiation, transaction authorization, transaction recording, and payment status notification.

User registration and authentication involves registering users for the service in a secure manner. Bank account management involves allowing individual users to add and manage their bank accounts. Payment initiation enables a user to make payments to businesses seamlessly. Transaction authorization provides a secure authorization process to confirm a transaction. Transaction history, records completed transactions that are to be made available to users. Payment notification users are notified of successful and failed transactions.

5.1.2. Non-Functional Requirements

The non-functional requirements focus on how well the system performs its functions. They aid in improving the user's experience. Performance in terms of low latency and high responsiveness for real-time transactions. Scalability is where the design of the system as a whole should accommodate growth in the number of users and increasing transaction volumes. Reliability looks at how the system can maintain high availability to ensure that the payment system has little to no downtime. Compliance with financial regulations to ensure the financial application complies with industry standards. Interoperability focuses on whether the application can be installed and function on the required Android platform which is the popular platform amongst respondents. Data backups and recovery implements regular data backups and reliable recovery mechanisms in case of system failures.

5.2 System Architecture

Object-oriented architecture was used to design the proposed mobile application prototype. This type of architecture allowed the division of the application into individual reusable and self-sufficient objects. These reusable objects are described below.

5.2.1. Mobile Application

This includes a frontend interface that enables a user to interact with the application. The user can initiate payments, view transaction history and manage bank accounts. The components that make up the mobile application are the user interface layer which handles the presentation layer of the mobile application including login, transaction initiation, transaction history and bank account management interfaces.

The Application Logic Layer manages the core application logic which includes validating user inputs, processing payment requests and communicating with the business logic layer. The application layer implements business rules such as security checks.

The business logic layer handles business-specific rules, processes, management of user accounts and transactions. This layer interfaces with external systems for additional business services.

5.2.2. Payment Gateway

This is the PesaLink Switch API that acts as the intermediary between the mobile application and the banking payment system to facilitate secure communication and transaction processing. The gateway handles encryption and decryption of sensitive data during transmission.

5.2.3. Database Management System

Stores and manages user account information, transaction records and other critical data ensuring data integrity, and security while supporting efficient data retrieval.

5.2.4. Security Layer

Implements security protocols for data encryption. Monitors and logs security-related events.

5.3 Use Case Diagram

The actor is the User who uses the mobile application to pay for goods, services and utilities. The other actor is the PesaLink API. The PesaLink API is the link or gateway between the mobile application and the PesaLink real-time switch. Figure 5.1 shows how the actor interacts with the prototype system.

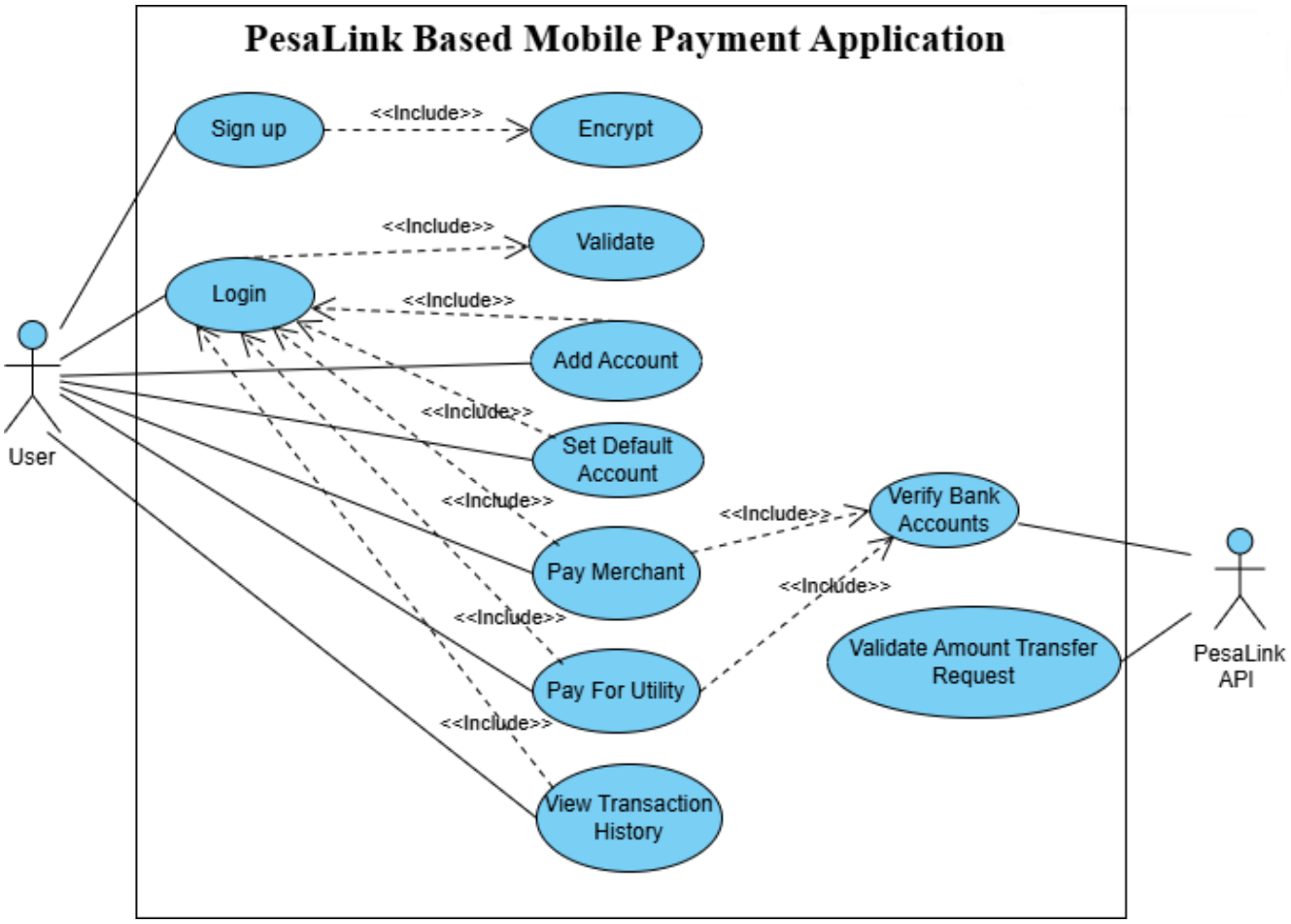

Figure 5.1: Use Case Diagram

5.3.1. Use Case Description

The use case description of the major features of the PesaLink-based mobile application is detailed below. Table 5.1 outlines the sign-up steps, Table 5.2 the login procedure.

Table 5.3 details the add bank account use case. Table 5.4 outlines the set default bank account use case. The last two tables Table 5.5 and Table 5.6 outline the pay merchant and pay for utility payment process respectively.

Table 5.1: Description of the Sign-up Use Case

Use Case name	Sign up
Actors	User
Description	Allows users to sign up on the mobile application
Preconditions	The user has access to the mobile application. The user is not registered on the system
Postconditions	The user's registration information is successfully stored in the system.
Normal Flow	1. The user opens the mobile money application. 2. The user selects the "Sign Up" option. 3. The user enters personal details such as name, mobile number and email address. 4. The user creates a secure password for the account. 5. The user details are stored in the system. 6. A new account for the user is created. 7. Confirmation of successful registration is displayed to the user.
Alternative Flows	3a. Existing User: If the entered phone number is already registered, the system prompts the user to log in or recover their account. 6a. Validation Error: If any of the entered information is invalid or incomplete, the system notifies the user to correct the errors.
Exceptions	8. Registration Failure: If there is an error during the registration process (e.g., database error, system failure), the system displays an error message and prompts the user to try again later.

Table 5.2: Description of the Login Use Case

Use Case name	Login
Actors	User
Description	Allows registered users to log into the mobile money application.
Preconditions	The user has registered on the mobile money application.
Postconditions	The user is successfully authenticated and gains access to their account.
Normal Flow	1. The user opens the mobile money application. 2. The user selects the "Login" option. 3. The user enters their registered phone number. 4. The user enters their password. 5. The user submits the login credentials. 6. Mobile application service verifies the credentials. 7. If the credentials are valid, the user is granted access to the dashboard.
Alternative Flows	4a. Forgotten Password: If the user forgets their password, they can select the "Forgot Password" option and follow the password recovery process.

	6a. Invalid Credentials: If the entered credentials are incorrect, the system notifies the user and prompts them to re-enter the correct information.
Exceptions	8. Login Failure: If there is an error during the login process (e.g., network error, server error), the system displays an error message and prompts the user to try again later.

Table 5.3: Description of the Add Account Use Case

Use Case name	Add Account
Actors	User
Description	Allows registered users to add their bank account and set the default bank account
Preconditions	The user has registered on the mobile money application and has a bank account that is registered to use PesaLink
Postconditions	The user has added his bank account number
Normal Flow	1. The user opens the mobile money application. 2. User Logs into the system 3. The user enters chooses the bank and adds the account number.

Table 5.4: Description of the Set Default Account Use Case

Use Case name	Set Default Account
Actors	User
Description	Allows registered users to set the default bank account
Preconditions	The user has registered on the mobile money application and has a bank account that is registered to use PesaLink
Postconditions	The user has set the default account successfully
Normal Flow	1. The user opens the mobile money application. 2. User Logs into the system 3. The user sets one bank account from the added accounts to be the default account.

Table 5.5: Description of the Pay Merchant Use Case

Use Case name	Pay Merchant
Actors	User and PesaLink API
Description	Allows registered user to pay for goods and services using a seller's till number.
Preconditions	The user has an active bank account with sufficient balance that is registered to use PesaLink
Postconditions	Payment is successfully processed and reflected in both sender's and receiver's bank account balances.
Normal Flow	1. The user selects the bank account to use in the payment process, otherwise the default bank account is used

	2. User enters the business bank account number. 3. The user enters the amount. 4. The user confirms the transaction. 5. PesaLink API verifies the user's and seller's accounts. 6. PesaLink API initiates amount transfer request 7. PesaLink API sends confirmation of successful payment displaying it to the user. 8. Transaction details are updated in the user's transaction history.
Alternative Flows	5a. Account Verification Failure: If the user's account cannot be verified or there is a connection issue, an error message is displayed, and the transaction is aborted. 6a. Insufficient Balance: If the user's account balance is insufficient, the system notifies the user and the transaction is aborted.
Exceptions	2. Invalid bank account number: If the entered bank account number of the recipient is invalid or not registered, the system prompts the user to enter a valid number. 7. Transaction Cancellation: If the user cancels the transaction before confirming, the system aborts the transaction and returns to the previous screen.

Table 5.6: Description of the Pay for Utility Use Case

Use Case name	Pay for Utility
Actors	User and PesaLink API
Description	Allows registered users to pay for utilities.
Preconditions	The user has an active bank account with sufficient balance that is registered to use PesaLink
Postconditions	Payment is successfully processed and reflected in both sender's and receiver's bank account balances.
Normal Flow	1. The user selects the bank account to use in the payment process, otherwise the default bank account is used 2. The user enters the bank account number of the biller 3. The user enters pay bill account number 4. The user enters the amount. 5. The user confirms the transaction. 6. PesaLink API verifies the user's and biller's account. 7. PesaLink API initiates amount transfer request 8. PesaLink API sends confirmation of successful payment displaying it to the user. 9. Transaction details are updated in the user's transaction history.
Alternative Flows	5a. Account Verification Failure: If the user's account cannot be verified or there is a connection issue, an error message is displayed, and the transaction is aborted. 6a. Insufficient Balance: If the user's account balance is insufficient, the system notifies the user and the transaction is aborted.

Exceptions	2. Invalid bank account number: If the entered bank account number of the recipient is invalid or not registered, the system prompts the user to enter a valid number. 7. Transaction Cancellation: If the user cancels the transaction before confirming, the system aborts the transaction and returns to the previous screen.

5.4 Sequence Diagram

Figure 5.2 illustrates the interactions within a PesaLink based mobile payment system, covering key functionalities such as user authentication, bank account management, merchant and utility payments, transaction history retrieval, and logout. It showcases how the mobile application communicates with the backend and external PesaLink API to process user requests securely and efficiently. The diagram also highlights error handling mechanisms, including login validation and payment failure responses, ensuring a seamless user experience. This is a clear illustration of how the system behaves showing the sequential flow of communications between the user, mobile application, backend system, and external API.

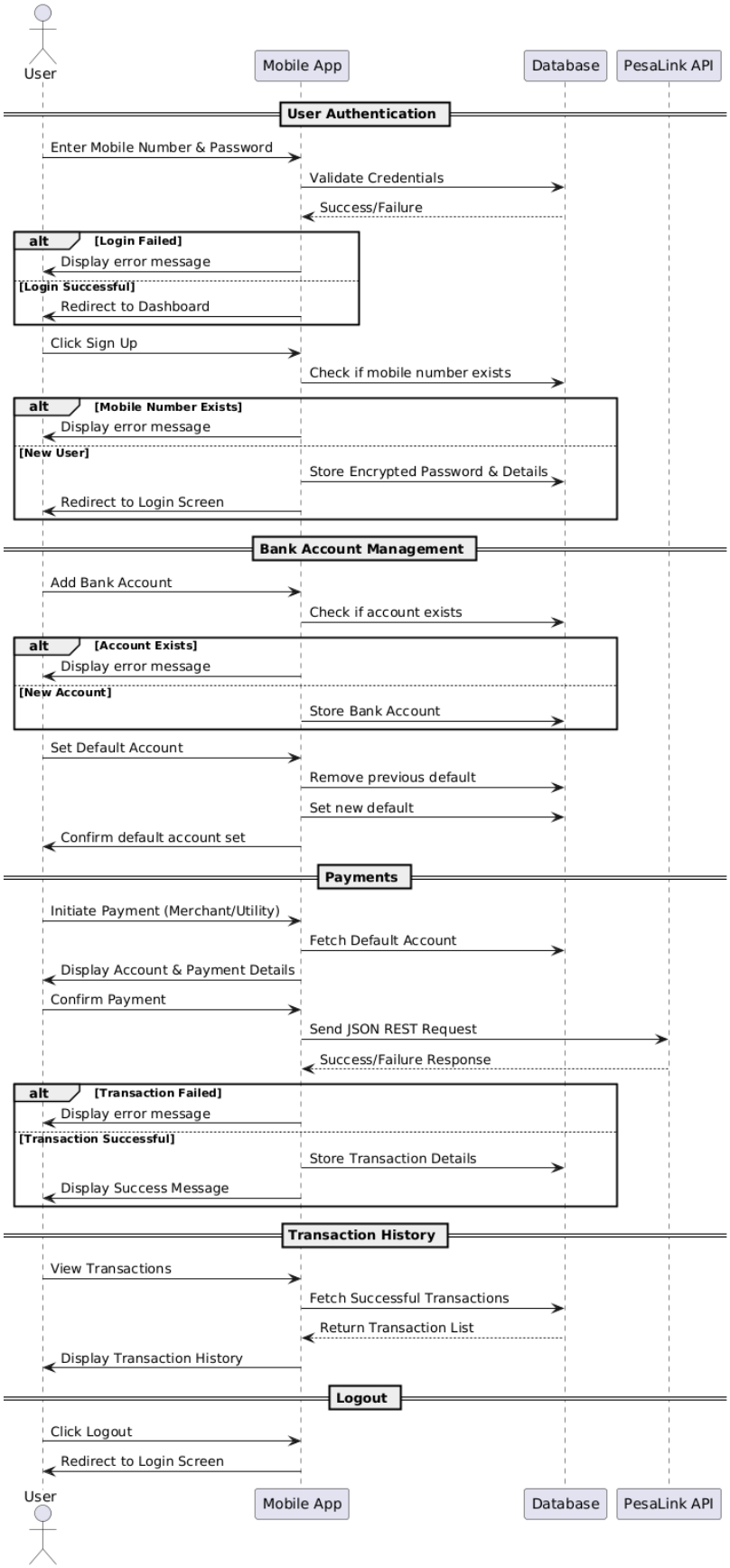

Figure 5.2: Sequence Diagram

5.5 Class Diagram

The class diagram in Figure 5.3 is a visual representation of the structure and the relationships between classes.

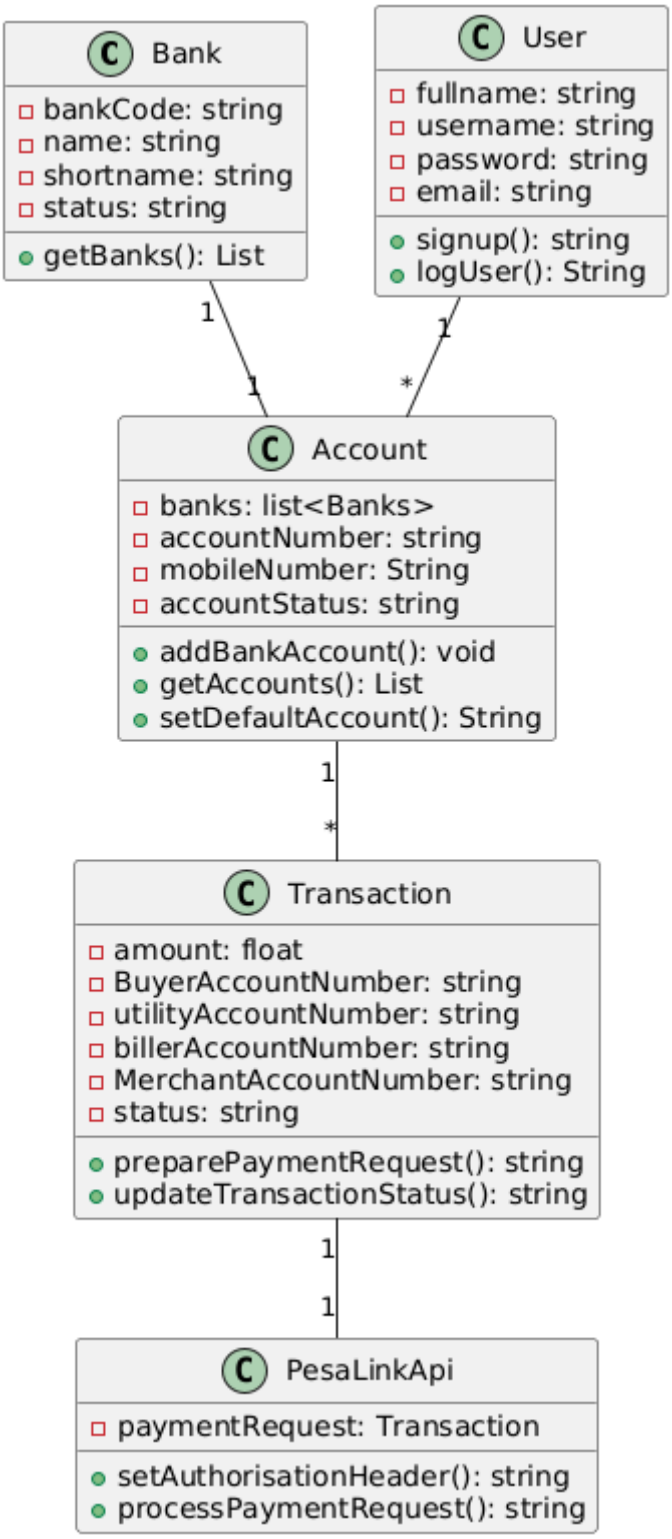

Figure 5.3: Class Diagram

5.6 Entity Relationship Diagram

Figure 5.4 is the visual representation of the relationship between entities in the database.

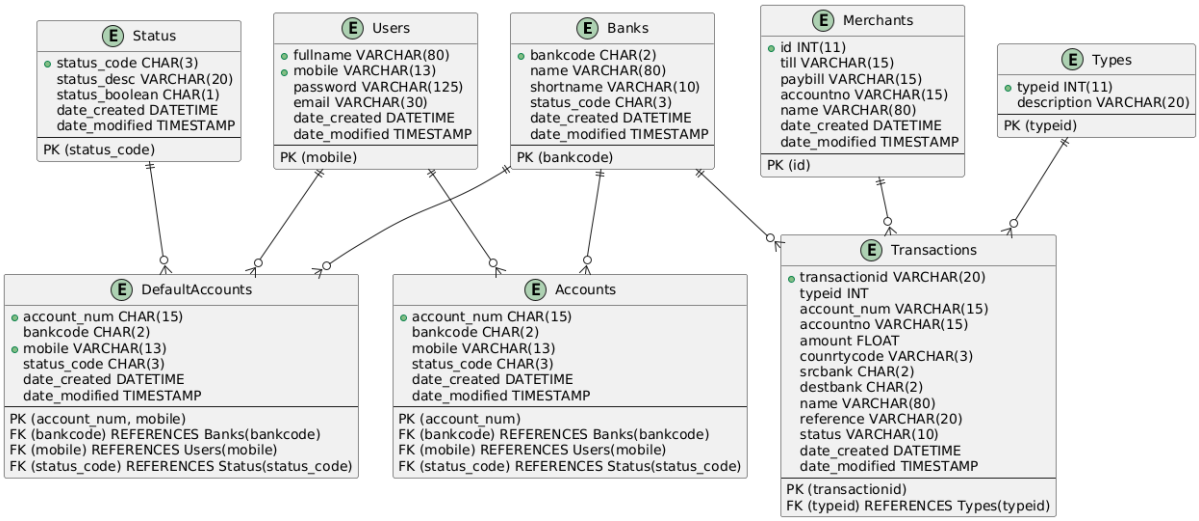

Figure 5.4: Entity Relationship Diagram

Table 5.7 contains the list of tables in the database along with an overall description of what data each table holds.

Table 5.7: Database Tables

Table	Description
accounts	Contains all bank accounts that are added and maintained by a user
banks	Holds all bank details such as bank codes, bank names
default_accounts	Contains accounts that have default status corresponding to mobile number
merchants	Holds merchant account number and name
status	Contains status codes that describe different statuses such as enabled, disabled and default
transactions	Holds all transaction details sent to the PesaLink API and the status of those transactions
types	Contains the various types of transactions such as Paybill transaction and Till transaction
users	Holds data about all users of the mobile application

5.7 Database Schema

The database schema tabulated in the tables below defines the structure of the database. The database table columns their data types and constraints are included in the schema.

Table 5.8: Status Table

Column Names	Data Types	Constraints
status_code	char(3)	Primary Key
status_desc	varchar(20)	
status_boolean	char(1)	
date_created	Datetime	
date_modified,	Timestamp	

Table 5.9: Banks Table

Column Names	Data Types	Constraints
bankcode	char(2)	Primary Key
name	varchar(80)	
shortname	varchar(10)	
status_code	char(3)	Foreign Key
date_created	Datetime	
date_modified	Timestamp	

Table 5.10: Users Table

Column Names	Data Types	Constraints
fullname	varchar(80)	
mobile	varchar(13	Primary Key
password	varchar(125)	
email	varchar(30)	
date_created	Datetime	
date_modified	Timestamp	

Table 5.11: Accounts Table

Column Names	Data Types	Constraints
account_num	char(15)	Primary Key
bankcode	char(2)	Foreign Key
mobile	varchar(13)	Foreign Key
date_created	Datetime	
date_modified	Timestamp	

Table 5.12: Default Accounts Table

Column Names	Data Types	Constraints
account_num	char(15)	Primary Key
bankcode	char(2)	Primary Key, Foreign Key
mobile	varchar(13)	Foreign Key
status_code	char(3)	Foreign Key
date_created	Datetime	
date_modified	Timestamp	

Table 5.13: Types Table

Column Names	Data Types	Constraints
typeid	int(11)	Primary Key
description	varchar(20)	
date_created	Datetime	
date_modified	Timestamp	

Table 5.14: Transaction Table

Column Names	Data Types	Constraints
transactionid	varchar(20)	Primary Key
typeid	Int	Foreign Key
account_num	varchar(15)	
accountno	varchar(15)	
amount	float	
counrtycode	varchar(3)	
srcbank	char(2)	
destbank	char(2)	
name	varchar(80)	
reference	varchar(20)	
status	varchar(10)	
date_created	Datetime	
date_modified	Timestamp	

5.8 Wireframes

Wireframes were used to model the user interface. Figure 5.5 shows the Login page and an option to create an account is provided on the login page for a user who has not signed up to use the mobile application. Clicking on the sign-up link will open up the Sign-up screen.

The Welcome screen has the default bank account, if no account has been maintained then no bank account will be displayed. The welcome screen has buttons that give the user access to other functions they can perform within the application and these are add a bank account, set default bank account, pay bill, pay merchant till, view transaction history and Logout button.

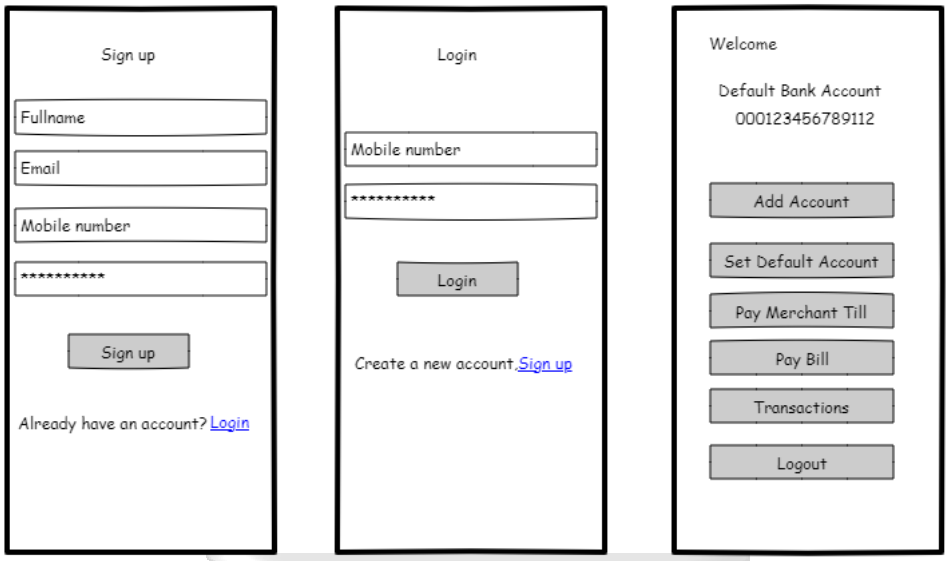

Figure 5.5: Login, Signup and Welcome Page

Figure 5.6 displays the screens that allow a signed-in user to manage their bank accounts.

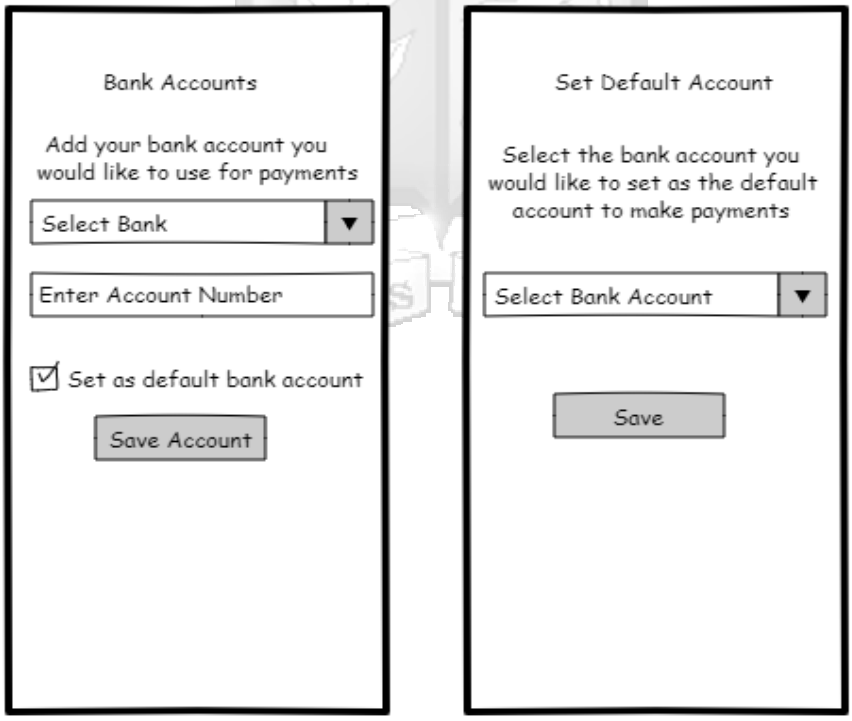

Figure 5.6: Bank Account Maintenance Screens

Figure 5.7 is the wireframe of the Pay Bill screen which will enable the user to Pay for utilities.

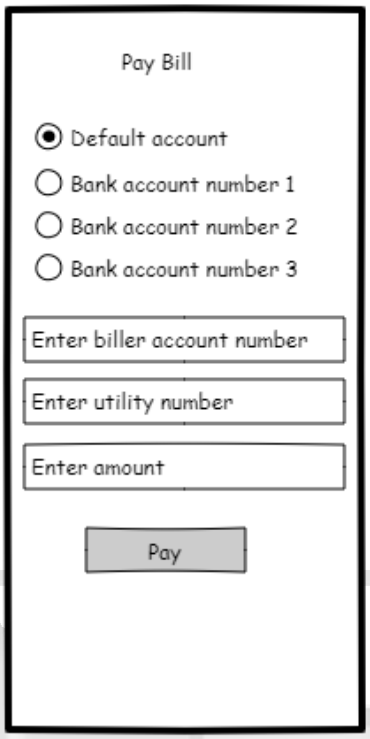

Figure 5.7: Pay Bill Screen

Figure 5.8 is the wireframe of the Pay Merchant Till screen which will enable the user to Pay for goods and services at the till on-site or remotely.

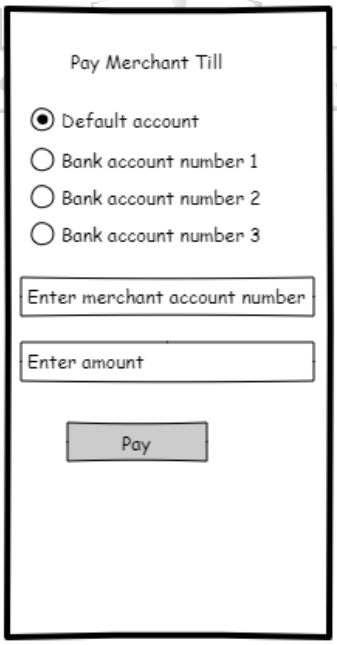

Figure 5.8: Pay Merchant Till Screen

Chapter 6 : System Implementation and Testing

6.1 Introduction

The main aim of this research was to develop a mobile money payment application that made use of a real-time payment gateway like PesaLink. This chapter lays out how the development of this prototype was achieved and how the prototype underwent testing.

6.2 System Implementation

The Android based prototype is named PayBridge. Apart from the use of Android for the development of the mobile application, Java Script Object Notation, PHP and Rest API were also used. A PesaLink API was integrated into the application to be able to simulate this payment gateway's capabilities of transferring money from a buyer's bank account to a merchant's bank account. MySQL database management system was used to store data.

6.3 Mobile Application

The PayBridge mobile money application prototype enables a user to register, sign in and add and set their default bank account from where funds will be used to pay for bills and the purchase of goods and services, the user will be able to simulate payments for utilities, goods and services.

The mobile application can be installed on an Android mobile phone. A user is required to sign in to the application before they can have access to the rest of the functionalities offered on the application. If a user has not does not have a user account on the application, they can simply click on the word Sign-up located below the Login button. The sign-up screen allows the user to register with their full name, email address, mobile number and password. Once the user registers and logs in the welcome screen is displayed.

The welcome screen displays the default bank account but for first-time users, this is left blank.

The screen contains various options for functionality, these are:

i. Add Bank Account: This functionality enables the signed-in user to add one or more of their bank accounts so that funds can be used to make mobile money payments.
ii. Set Default Account: Here the user can set one of the added bank accounts as the default bank account to be used during payment.
iii. Pay Merchant Till: Here the user enters the merchant's bank account number and amount due as shown in Figure 6.1Figure 5.8, then click the pay button. The payment

gateway will process this payment request and respond with a status as to whether the payment transaction was a success or a failure and if failure an appropriate message will be returned by the payment gateway to the mobile application.

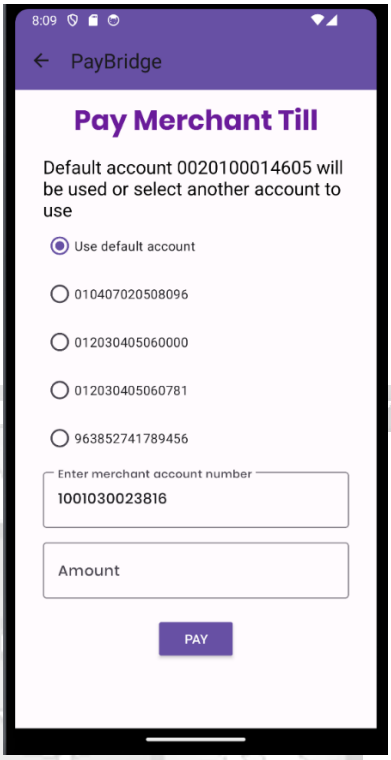

Figure 6.1: Pay Merchant Screenshot

iv. Pay Bill: This functionality provides the user with the capability to pay for bills such as electricity or paid subscriptions such as internet or television by simply providing the biller's bank account number, the user's subscription account number in case of subscriptions or meter number in the case of electricity and the amount due as shown in Figure 6.2, then click on the continue button.

This information is then passed to the payment gateway which lies between the banks and the mobile application. The PesaLink payment gateway will process the payment and respond as to whether the payment transaction was a success or a failure. If the transaction fails the payment gateway will provide a reason why it failed.

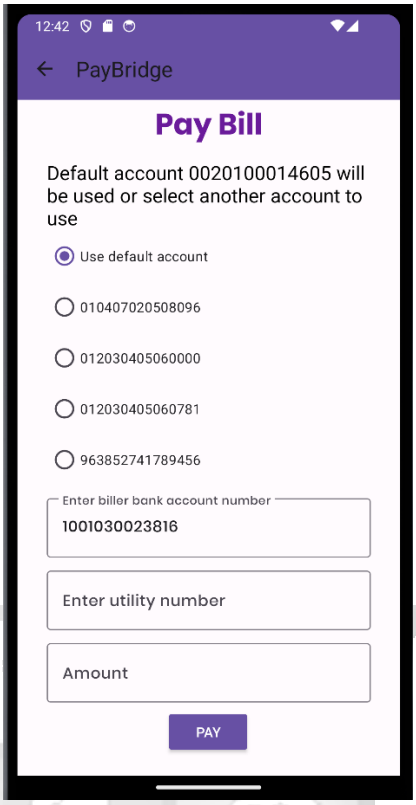

Figure 6.2: Pay Biller Screenshot

v. Transaction history as shown in Figure 6.3: Here the user can view successful payments that they have made.

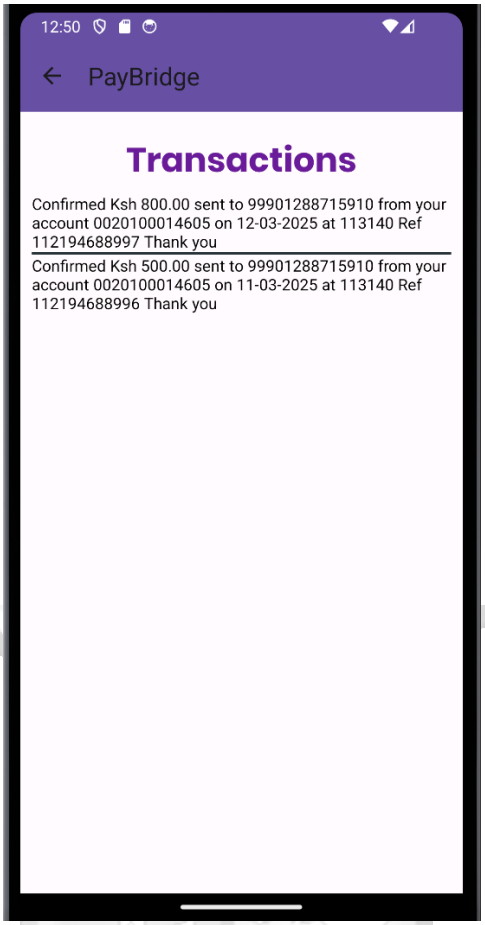

Figure 6.3: Transaction History Screenshot

6.4 System Testing

The testing phase was done to confirm the successful implementation of the mobile payment prototype application, validating its capability to effectively address the identified problem statement of facilitating real-time payments from the payer bank account to the payee bank account.

6.4.1. Functionality Testing

The test cases in Table 6.1 were used to test each function of the prototype to verify performance was as expected.

Table 6.1: Prototype Mobile Application Functional Test Cases

Module	Test Case	Results	Verdict
User registration and authentication	Verify that users can successfully register with valid credentials	The user's registration entries are saved to the database	Okay
	Confirm that registered users can log in securely with their credentials	The application verifies that the user's login details are correct before allowing access to the system	Okay
Add bank account	Ensure that a user can add his bank account, selecting the bank where account is and adding the account number	The application selects a list of banks that a user can select from and provides a means to add the account which is successfully stored in the database	Okay
Set default account	Ensure that users can select the source account from a list of added bank accounts which funds will be debited	The application allows the user to set a default account which will be the source of funds to be transferred	Okay
Payment initiation	Verify that the user can initiate payment transaction by entering the recipient's bank account number and amount to be transferred	The application provides an interface on which the user can type in the recipient's or payee's bank account number and the amount that is to be transferred and in the case of utility payments the system allows a user to enter the utility account. The system verifies the information and initiates payment instructions	Okay
Real-time fund transfer	Verify that users receive immediate feedback regarding the success or failure of the funds transfer	The application displays the confirmation message and transaction status to the user	Okay
Transaction history	Ensure that users can view transaction details. Including transaction reference, timestamp and recipient information	The application displays the user's transaction history including details such as date and time, transaction reference number and recipient details.	Okay

6.4.2. Compatibility Testing

Compatibility tests carried out on the prototype to ascertain that its functions were done seamlessly across different devices and the various Android operating system versions. Table 6.2 tabulates tests done on different devices having different specifications, while Table 6.3 contains the results of tests done on different Android operating system versions.

Table 6.2: Android Device Compatibility Tests

Device Compatibility Testing			
The objective was to test whether the prototype application would perform consistently across various Android devices with different specifications such as screen sizes, resolutions and hardware capabilities.			
Test case: Verify that the prototype's user interface elements adapt well to the different screen resolutions and aspect ratios without distortion or overlapping			
Device	**Screen size**	**Display**	**Compatible**
Tecno Pouvoir 4 Pro	7 inches	720 x 1640 pixels	Yes
Samsung C9 Pro	6 inches	1080 x1920 pixels	Yes
Samsung J	5.5 inches	720 x 1280 pixels	Yes

Table 6.3: Android Operating System Tests

Operating System Compatibility Testing	
Tests were carried out to check the compatibility of the application to different versions of the Android operating system commonly used.	
Test Cases: Test the prototype mobile application on the various versions from older versions to the latest version of the Android operating system	
Android Version	**Prototype Compatibility**
Android 6.0 API level 23 and below	No
Android 7.1 API level 25	Yes
Android 8.0 API level 26	Yes
Android 8.1 API level 27	Yes
Android 9 API level 28	Yes
Android 10 API level 29	Yes
Android 11 API level 30	Yes
Android 12 API level 31	Yes
Android 12 API level 32	Yes
Android 13 API level 33	Yes

6.5 System Validation

The problem statement that was driving this study was, that funding the M-PESA mobile money wallet can be done at a Safaricom agent, who deposits electronic cash into a customer's wallet in exchange for physical cash equivalent or one would need to transfer money from their bank account through their mobile banking application or internet banking application into the M-PESA mobile money wallet. The relevance of bank-to-mobile transactions is expanding due to banking clients needing to top up their mobile wallets from their bank accounts. For the first option, there is an issue of having to have the physical cash equivalent and travelling or finding an agent to deposit the money into the wallet. The second option has a cost implication. The

bank will charge a transfer fee based on the amount being sent from the bank account to the wallet. Once the money is in the wallet the customer will make payment for a utility or goods and services during which he will be charged a transaction fee. Therefore, the additional cost of the transfer fee charged to the customer further increases the total cost of a transaction.

The solution prototype developed in this study made use of a PesaLink Application Program Interface that enabled a payer through the prototype to initiate a payment transaction to transfer funds due to the payee from the buyer's bank account to the payee's bank account. The PesaLink API which technically is a gateway between the prototype mobile payment application and PesaLink registered banks in Kenya, performs some validations and sends the instruction request to the buyer's bank to transfer funds to the seller's bank account. The respective banks send a response to the PesaLink API along with the status of the transaction request, which in turn the PesaLink API makes this response available to the prototype for the end user to stay informed. This results in not only eliminating the need for the transfer of funds to a wallet which was at cost to the buyer but enables the seller to receive funds into his account without delays.

Chapter 7 : Discussion of Results

The primary objective of this study was to develop a prototype mobile application that eliminates the need for transferring funds from a bank account to a mobile wallet. Instead, it enables the direct transfer of funds from the buyer's bank account to the merchant's bank account using PesaLink's real-time payment infrastructure.

The four sub-objectives of the study were as follows and the results in relation to each are summarised below:

i. To identify the key technical challenges and barriers to using the existing payment options to pay for utilities, goods and services:

   The study found that most mobile payment solutions in Kenya rely on wallet-based systems such as M-PESA, which incur multiple fees, including bank-to-wallet and wallet-to-merchant charges. Additional barriers identified include daily transaction limits, delayed settlement, and lack of interoperability between wallets and banks.

ii. To review potential solutions to overcome the challenges in the current mobile payment systems.:

   The literature review revealed the potential of real-time interbank payment systems like PesaLink, which can process transactions instantly and at lower cost. The review also supported the use of APIs to integrate banking infrastructure directly into third-party applications, eliminating the wallet step entirely.

iii. To design and develop a mobile payment prototype solution based on PesaLink real-time bank transfer functionality:

   A prototype named PayBridge was developed using Agile methodology. It was designed for Android and used Equity Bank's PesaLink sandbox API to simulate real-time, direct transfers between test bank accounts. The system included basic authentication, input validation and secure communication and protocols, including RSA signatures and JSON access tokens.

iv. To test the prototype's ability to eliminate the need for mobile wallets in person-to-business payments:

   The prototype successfully processed multiple fund transfers from simulated payer to payee accounts. Transactions were completed in real-time with confirmation messages

returned to the user. Test logs confirmed that transfer requests and responses conformed to API specifications.

Compared to similar systems implemented in countries like India, Unified Payments Interface or Singapore's PayNow, PayBridge shares the same core principle: real-time, account-to-account transfers without an intermediary wallet. However, the Kenyan context still lacks such consumer-facing implementations. This research is amongst the first to simulate a working prototype using Kenya's PesaLink API for person-to-business payments, making a novel contribution to local mobile payment innovation.

In conclusion, the prototype meets the study's main objective by enabling a user to transfer funds directly from their bank account to a merchant's bank account without going through a mobile wallet. This reduces overall transaction costs and delays, and offers an efficient alternative for mobile payments in Kenya.

7.1 Validating the Alternative Hypothesis

H1: Disruptive innovations in real-time payment systems positively impact transaction cost reduction.

Real-time payment systems like the one used in this prototype facilitate instantaneous transactions, removing the requirement for intermediaries and lowering processing time. This efficiency can significantly cut down on transaction costs. The prototype eliminates the need for intermediaries such as mobile wallets instead facilitating a straight-through flow of funds from the payer bank account to the payee bank account.

Chapter 8 : Conclusions, Recommendations and Future Work

8.1 Conclusion

The primary objective of this study was to develop a prototype mobile payment application that enables the transfer of money directly from a buyer's bank account to a merchant's bank account in real time, thereby eliminating the need for intermediary mobile wallet transactions.

This objective was successfully achieved through the development of a mobile payment prototype named PayBridge, which integrates with the PesaLink API. The application allows a payer to initiate a funds transfer from their mobile device, which is processed directly through the PesaLink network. The API handles authentication, communicates with both the payer and payee banks, and returns a success or failure response based on transaction validity. In successful cases, the payee receives the funds immediately with full transaction details.

The originality of this research lies in its focus on removing the dependency on mobile wallets, currently the dominant channel for digital payments in Kenya, and providing a real-time, low-cost, bank-to-bank payment alternative. By reducing the number of steps and eliminating wallet top-up charges, the prototype offers a more efficient and affordable option for person-to-business payments.

The value of this research is twofold: it offers practical proof of concept for stakeholders interested in next-generation payment systems, and it contributes to ongoing discussion about cost reduction and interoperability in mobile financial services. Additionally, the system benefits not only the payer through reduced transaction costs but also the merchant, who receives funds instantly and can access them immediately for reinvestment or use.

8.2 Recommendations

Although the prototype developed in this study is not a commercial product, it provides a functional proof of concept for a real-time, wallet-free mobile payment solution in Kenya. Currently, the system integrates with the PesaLink API made available by Equity Bank, enabling simulated transactions between test accounts.

To extend its applicability beyond the Equity Bank sandbox, the prototype could be integrated with the PesaLink API provided by Integrated Payment Services Limited, a subsidiary of the Kenya Bankers Association. This version of the API supports transactions across multiple banks in Kenya, making the solution scalable for a wider national deployment.

A central mobile payment application such as this prototype, if formally adopted and enhanced by stakeholders like the KBA, would be more efficient and user-friendly than having each bank develop its own payment application.

The current prototype was developed for Android due to its widespread use among the study's respondents. However, to improve accessibility and inclusivity, future iterations of the application should also target other platforms such as Apple IOS.

8.3 Future Work

Apart from the prototype being implemented for other mobile platforms or mobile operating systems, some functionality was not implemented in the prototype that would improve user satisfaction and these are:

8.3.1. QR and NFC Capabilities

Rather than a user having to enter the business bank account, the user can simply scan a QR code or scan an NFC to automatically read into the application the business bank account and amount due from the business point of sale or online store. All the user would have to do is enter their password or PIN to confirm the payment details of the transaction.

8.3.2. USSD

The development of a USSD version of the mobile payment application would enable users to access the functionality of this prototype without the need for an internet connection

8.3.3. Payment Data Analytics

Create a module that would provide a user with insights on the payments they made, so they can see how much they spend in a specific business for example a supermarket, or how much they spend on transport, eating out or ordering in. The options and possibilities for analysing this data is numerous.

8.3.4. Security

Currently, the prototype requires a password to access the application to perform payment. The payment request sent to PesaLink API requires an authorization token along with a signature for the data to be verified for security purposes. There is a need

for more research to be done in the area of securing real-time mobile payment applications and transactions.

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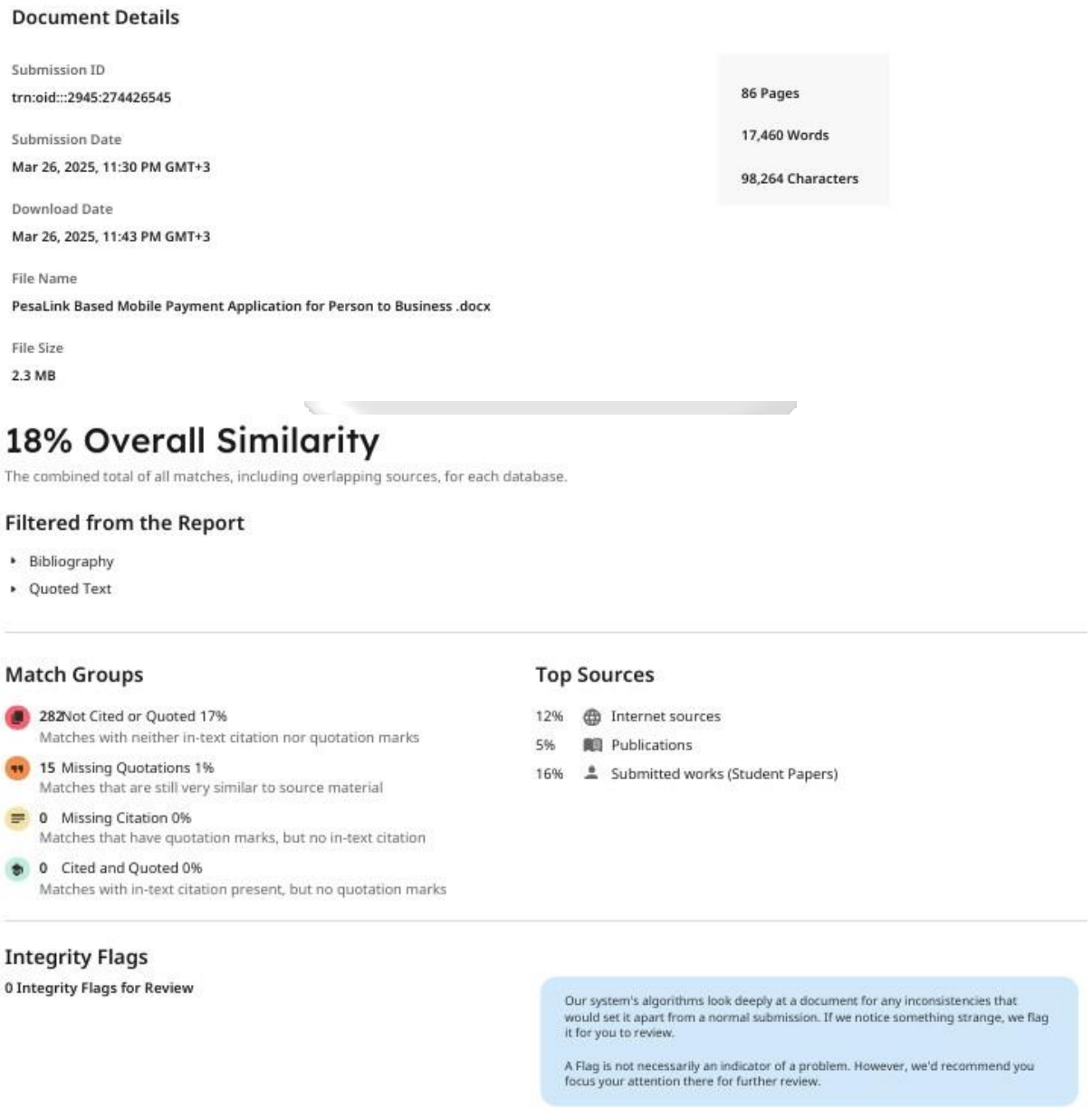
Appendices

Appendix A: Similarity Report



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Appendix B: Ethical Clearance

Strathmore UNIVERSITY

7th March 2025

Ms Mwalagho Marline,
Marline.Mwalagho@strathmore.edu

Dear Ms Mwalagho,

RE: PesaLink Based Mobile Payment Application for Person to Business Payments

This is to inform you that SU-ISERC has reviewed and **approved** your above **SU-masters** proposal. Your application reference number is **SU-ISERC2718/25**. The approval period is from **7th March 2025 to 6th March 2026**.

This approval is subject to compliance with the following requirements:

i. Only approved documents including (informed consents, study instruments, MTA) will be used.
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by SU-ISERC
iii. Death and life-threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to SU-ISERC within 72 hours of notification.
iv. Any changes anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to SU-ISERC within 72 hours.
v. Clearance for the export of biological specimens must be obtained from relevant institutions.
vi. Submission of a request for renewal of approval at least 60 days prior to the expiry of the approval period. Attach a comprehensive progress report to support the renewal.
vii. Submission of an executive summary report within 90 days of completion of the study to SU-ISERC.

Before commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology, and Innovation (NACOSTI) https://research-portal.nacosti.go.ke/ and obtain other clearances needed.

Yours sincerely,

Mr Ambrose Rachier,
Chairperson; SU-ISERC

Ole Sangale Rd, Madaraka Estate. PO Box 59857-00200, Nairobi, Kenya. Tel +254 (0)703 034000
Email admissions@strathmore.edu www.strathmore.edu

Appendix C: Research Work Plan

Activity	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6
1. Proposal Development & Approval	✔					
a) Develop a research proposal	✔					
b) Submission to ISERC for ethical approval	✔					
2. Literature Review	✔	✔				
3. Study Preparation		✔				
a) Development of data collection tools		✔				
b) Pretesting and refinement of tools		✔				
4. Data Collection			✔			
a) Recruitment of participants			✔			
b) Conducting surveys/interviews			✔			
5. Data Analysis				✔		
a) Data cleaning and organisation				✔		
b) Identifying key insights for prototype				✔		
6. Prototype Development					✔	
a) System design based on collected data					✔	
b) Mobile application development					✔	
c) Testing and refining the prototype						✔
7. Report Writing & Dissemination					✔	✔

a) Drafting the research report					✔	
b) Submission of final report to ISERC						✔
c) Presentation of findings to stakeholders						✔

Appendix D: Participant Information Sheet and Consent Form

Participant Information Sheet

Title of the Study:

PesaLink-Based Mobile Payment Application for Person-to-Business Payments

Invitation to Participate:

You are invited to participate in a research study by Marline Mwalagho from Strathmore University. This study has been reviewed and approved by the Institutional Scientific and Ethical Review Committee (SU-ISERC). The study aims to explore how PesaLink (a real-time payment system that allows users to send and receive money between bank accounts in Kenya) can facilitate direct person-to-business payments without the need for a mobile wallet, reducing transaction costs. There is no funding attached to this study.

What Participation Involves:

If you agree to participate, you will be asked to:

Complete an online questionnaire that collects data about your experiences with current mobile payment platforms. This will take approximately 10 minutes.

(Optional) Participate in two prototype review sessions where you will be able to test the developed prototype and provide feedback. Each session will take approximately 20-30 minutes.

Data Collection and Use:

The questionnaire will collect information about your experiences with mobile payments but will not require financial details. Your email address may be collected to send you follow-up communication if you opt into additional research activities.

The collected data will be used solely for research purposes and will remain confidential.

Data will be securely stored on a password-protected computer and will be deleted after five years upon completion of the study.

Confidentiality:

All responses will be anonymized, and no personally identifiable information will be shared publicly. Only the researcher and authorized personnel at Strathmore University will have access to the raw data. If the study results are published, no identifying details will be disclosed.

Voluntary Participation and Withdrawal:

Your participation is entirely voluntary. You may withdraw from the study at any time without providing a reason, and any data collected before your withdrawal will not be used in the study.

Potential Risks and Benefits:

There are no known risks associated with participating in this study. Your participation may help improve mobile payment systems and lead to the development of more efficient and cost-effective payment solutions.

Contact Information:

For any questions regarding the study, you can contact:

Marline Mwalagho

mmwalagho@gmail.com

Strathmore University

Consent Form

Title of the Study:

PesaLink-Based Mobile Payment Application for Person-to-Business Payments

Principal Investigator and Contact Information:

Marline Mwalagho

Strathmore University

mmwalagho@gmail.com

Introduction and Purpose of the Research:

This research seeks to explore the potential of using PesaLink (a real-time payment system that allows users to send and receive money between bank accounts in Kenya) for person-to-business payments, reducing transaction costs and improving efficiency. You are being invited to participate as a user of mobile payment platforms.

Description of Participation Activities:

Completing an online questionnaire (10-15 minutes)

(Optional) Participating in prototype review sessions (20-30 minutes each)

Research Participation:

This study seeks individuals who actively use mobile payment platforms for transactions.

Potential Risks and Discomforts:

There are no known risks associated with participation in this study.

Potential Benefits:

Your participation will contribute to research on mobile payments and may lead to more cost-effective transaction solutions.

Confidentiality:

Your responses will remain confidential. All collected data will be stored securely and anonymized before publication.

Authorization:

By signing this form, you authorize the use of your responses for this research while ensuring confidentiality.

Compensation:

There is no compensation for participation in this study.

Voluntary Participation and Withdrawal:

Participation is voluntary, and you may withdraw at any time without consequences.

Withdrawal from the Study:

If you choose to withdraw, please notify the researcher. Any data collected before withdrawal may be excluded upon request.

Cost/Reimbursements:

There are no costs or reimbursements associated with participating in this study.

Ethics Review Contacts:

If you have any concerns or questions about the ethical aspects of this study, you may contact:

Strathmore University Institutional Scientific Ethics Review Committee (SU-ISERC)

Address: Strathmore University Administration Block, Phase 1

Email: ethicsreview@stathmore.edu

Telephone No.: +254 730734418

Participant Consent Statement:

I, _____, voluntarily agree to participate in this research conducted by _____.

The research project has been explained to me, and I understand that it seeks information about _____.

I understand that I will be given a copy of this signed Consent Form.

Name of Participant: _____

Signature: _____

Date: _____

Name of Witness: _____

Signature: _____

Date: _____

Person Obtaining Consent: _____

Signature: _____

Date: _____

Appendix E: Data Collection Tools

Mobile Money Payment Questionnaire

Thank you for taking time to fill out this questionnaire. The requested information is required for the purpose of academic study only and will be considered private and confidential. This survey aims to find out how the M-PESA Mobile Application is currently being used to aid in the payment of goods, services and bills. Your feedback will be highly appreciated.

* Indicates a required question

Email*

Your email

1. By participating in this Mobile Money Payment Questionnaire, you acknowledge that your responses will be collected for research and analysis purposes. Your participation is entirely voluntary, and you have the right to withdraw at any point during the survey without providing a reason. The information you provide will be kept confidential and used solely for the intended research purposes. Your personal details will not be shared with any third parties, and the data collected will be anonymized to ensure your privacy. If you have any concerns or questions about the survey, please contact mmwalagho@gmail.com. Your completion of this questionnaire indicates your informed consent to participate.

Do you consent? *
- ◯ Yes, I consent
- ◯ No, I do not consent

2. Which method do you frequently use to top-up your M-PESA account? *

- ◯ Deposit cash to my phone through M-PESA agent
- ◯ Top up from my bank account

3. If you top up your MPESA account from your bank account, how often do you use this method?

- ◯ Every time I need to use MPESA
- ◯ Once a day
- ◯ Once or more per week
- ◯ Once a month

4. How do you feel about the fees associated with transferring money from your bank account to your M-PESA account?

- ◯ Fees charged are low
- ◯ Fees charged are High
- ◯ No fees are charged by my bank

5. How often do you use Lipa Na M-PESA to perform transactions? *

- ⬭ Daily
- ⬭ Weekly
- ⬭ Not at all

6. Which Lipa Na M-PESA options do you frequently use? *

- ☐ Buy Goods
- ☐ Pay Bill
- ☐ Pochi La Biashara

7. On a scale of 1-5, how satisfied are you with the speed and reliability of LIPA Na M-PESA? *

	1	2	3	4	5	
Not satisfied	⬭	⬭	⬭	⬭	⬭	Very Satisfied

8. How do you feel about the transaction fees you are charged when using LIPA Na M-PESA to pay for utilities/bills? *

- ⬭ Transaction fees are low
- ⬭ Transaction fees are high

9. Have you ever been affected by MPESA service being unavailable? *

- ⬭ Yes
- ⬭ No

10. Would you consider trying a new mobile payment application that would allow you to pay for goods, services and bills straight from any of your bank accounts without needing to transfer money to a mobile money wallet? *

- ⬭ Yes
- ⬭ No

11. What features would you like added to the new mobile money application?

12. Do you have a smartphone? If yes select your platform

- ⬭ Apple IOS
- ⬭ Android
- ⬭ Symbian
- ⬭ Other