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**Mobile application for filing of and payment for intellectual property rights using QR  
code: case of Kenya industrial property institute**

**Andati Eric Maloba**

**Submitted in partial fulfilment of the requirements for the Degree  
of Master of Science in Information Technology**

**Faculty of Information Technology**

**Strathmore University**

**Nairobi, Kenya**

**June, 2018**

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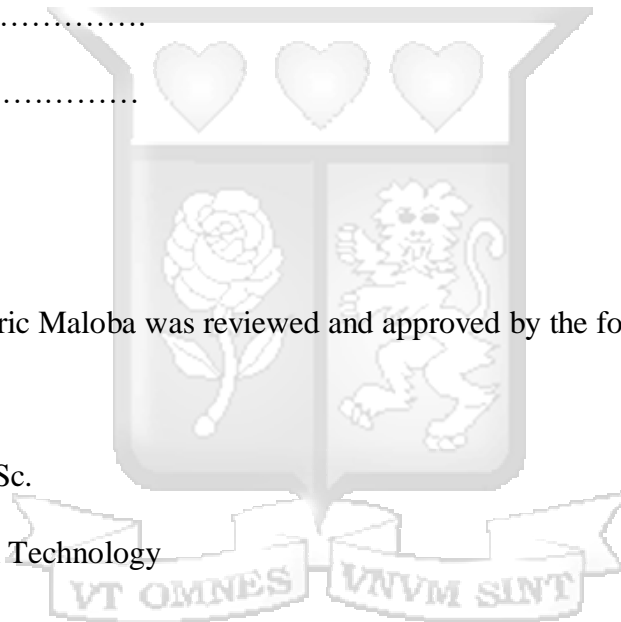
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## Dedication

Dedicated to my mum and dad –my source of inspiration, my family (Joy and baby Vicky) –  
my greatest supporters!



## Acknowledgements

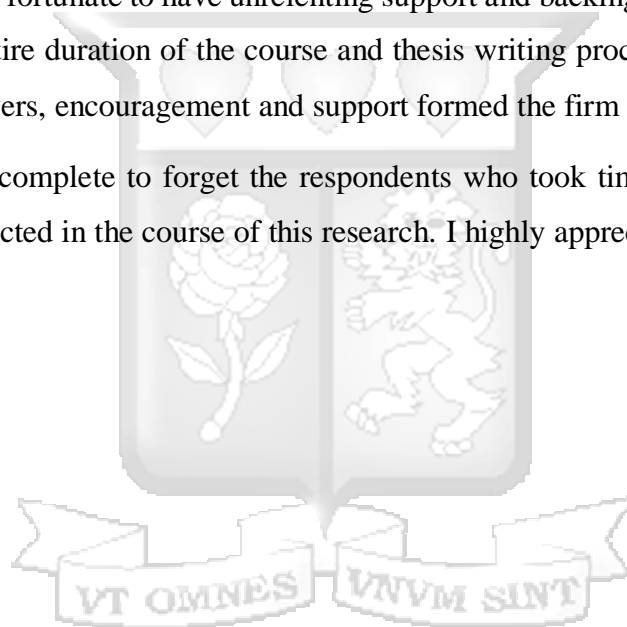
It is my heartfelt gratitude to almighty God for making it possible for me to complete this thesis. To Him I give glory!

In a big way, I am indebted to my research supervisor Prof. Ismail Ateya for his constructive criticism and recommendations he tirelessly gave towards improving this thesis. It was his patience, scholarly guidance, and reading many an inferior draft and correcting them at various stages that made it possible to complete the thesis in the prescribed time.

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Lastly, it would be incomplete to forget the respondents who took time to participate in the survey that was conducted in the course of this research. I highly appreciate them.



## **Abstract**

Ensuring secure transmission of sensitive data and payment of transaction fees has been one of the challenges affecting customers and businesses. Intellectual Property (IP) field is one such area that has faced such challenge. Over the years, IP has grown in importance, attracting greater interest and increased need by inventors and other IP rights holders to seek protection of their inventions and other IP rights. To ensure protection of these rights, applicants are required to file their applications at IP offices and remit various fees during the examination process, as well as pay annual maintenance fee for the protection to remain valid. While filing for IP rights, applicants face security challenge, as their IP data can be intercepted while in transit or be exposed to third parties thus compromising their inventions. In addition, while making payment of IP fees, they face challenges such as delayed transactions and platform incompatibility. On the other hand, IP offices are susceptible to loss of revenue as a result of less-than-secure payment methods used. Hence, this study aimed at establishing how proximity/contactless technology could be incorporated into mobile-based devices to support secure mobile filing of and payment systems for IP rights. This research therefore proposed a process to develop a QR code-based mobile application that would facilitate speedy and secure filing and transmission of IP data as well as settlement of payments by IP rights holders to IP offices. Consequently, a functional mobile application that can generate a QR code, post the same to a remote server and make payment by scanning a QR code is presented. Additionally, a simple web page is provided to present the submitted information which has been encoded in QR format. Data collection was achieved by means of questionnaires and review of secondary data sources. The study was conducted in line with ethical practices as specified by the University rules and regulations.

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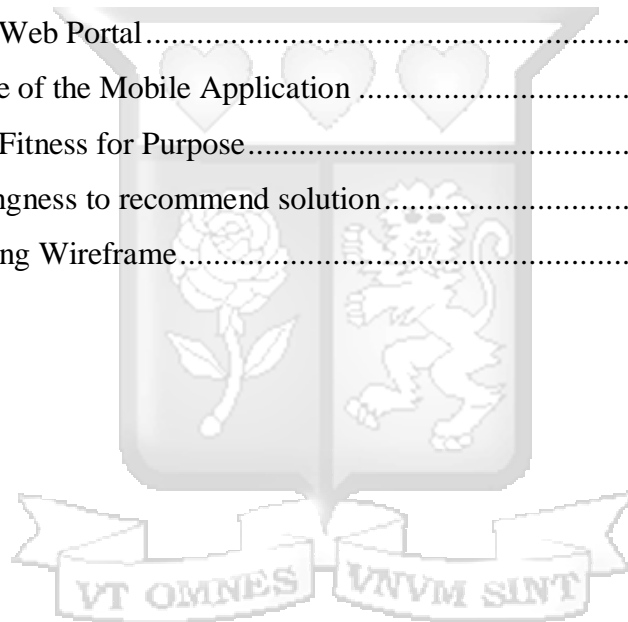
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## Abbreviations/Acronyms

<b>B2B</b>	-	Business to business
<b>B2C</b>	-	Business to customer
<b>DFD</b>	-	Data Flow Diagram
<b>EMV</b>	-	Europay, MasterCard and Visa
<b>HTTP</b>	-	Hypertext Transfer Protocol
<b>IP</b>	-	Intellectual Property
<b>IPR</b>	-	Intellectual Property Rights
<b>KIPI</b>	-	Kenya Industrial Property Institute
<b>NFC</b>	-	Near Field Communication
<b>PIN</b>	-	Personal Identification Number
<b>POS</b>	-	Point-of-sale
<b>QR</b>	-	Quick Response
<b>RFID</b>	-	Radio-frequency identification
<b>SMS</b>	-	Short message service
<b>UPC</b>	-	Universal Product Code
<b>URL</b>	-	Uniform Resource Locator
<b>WAP</b>	-	Wireless Applications Protocol

## Definition of Terms

- Contactless Payment** - A payment method that allows consumers to purchase products or services securely using debit, credit or smartcards (Smart Card Alliance, 2007).
- Intellectual Property** - A works or inventions resulting from one's creativity including manuscript, design, for which one has rights and for thus may apply for a patent, copyright, trademark, etc. (Wekesa & Sihanya, 2009).
- Mobile payment** - Payment whose initiation, authorization and confirmation of exchange of financial value in return for goods and services is handled by mobile device (Kumar, Rabara & Martin, 2009).
- Proximity** - Mobile phone-initiated payment made to a merchant that involves waving an NFC technology-enabled phone that near a point-of-sale device (Cheney, 2008).
- QR Code** - a bar code technology comprising of two dimensions of black modules arranged in a square grid on white background, enabling user to scan the codes and link with the mobile device to the Web address and access the information. (QR Code Essentials, 2011).
- RFID technology** - A communication technology that uses radio waves for storing and retrieval of data from identification chips (Briseno et al., 2012).
- Universal Product Code** - A widely barcode symbology for tracking trade items in stores, comprising of 12 numeric digits, uniquely assigned to each trade item chips (Briseno et al., 2012).

# Chapter 1: Introduction

## 1.1 Background of the Study

World Intellectual Property Organization (WIPO) defines Intellectual property (IP) as “creations of the mind, such as inventions; literary and artistic works; designs; and symbols, names and images used in commerce” (“What Is Intellectual Property?”, n.d.). Wekesa and Sihanya (2009) define Intellectual property Rights (IPRs) as legal instruments that offer protection for creations of the mind which have commercial value, such as inventions, literary and artistic works. This protection affords the creator the right to prevent infringement of the creations hence protecting them against unauthorised use of their property for a limited period. Thus, IP can be categorised into two groups, viz: Industrial Property which comprises of functional commercial innovations such as patents, utility models and industrial designs; and Artistic and Literary works which comprises of copyright and cultural creations.

Fink (2000) observed that IPRs are a crucial pillar for scientific and economic development, as they provide incentive to individuals or corporates to invest time and knowledge in research activities. Fink (2000), further notes that protection of IPRs bestows investors with exclusive right to exploit their invention for specified period of time. Hence the need for legal enforcement of these exclusive rights.

IP plays an important role in a country’s economy and hence have contributed significantly to Kenya’s economy. A study by Nyariki et al. (2009) found that in 2007, the copyright based industries contributed more than 5% to the country’s Gross Domestic Product (GDP) and over 3% to employment. Further, they established that effective protection and enforcement of IPR attracts foreign direct investment, promotes innovation and benefits the consumers. The collections made by the Music Copyright Society of Kenya (MCSK), in the country increased from US\$ 125 000 per annum in 2008 to US\$ 2 250 000 in 2012, 5% of the royalties earned by the members of MCSK was remitted to the government as with-holding tax.

In an endeavour to protect IPR, Kenya has enacted various laws including the Industrial Property Act (2001) that provides for patents and industrial designs, the Trade Marks Act that provides for trademarks and service marks, the Copyright Act that provides for protection of original literary and artistic expression that is fixed in a tangible form and the Seeds and New

Plant Varieties Act that provides for protection of plant breeders' rights. Each of the above laws establishes an IP office.

Kenya Industrial Property Institute (KIPI) is a body corporate charged with the granting of patents, industrial designs, utility models and registration of trademarks. Inventors and IP right holders are required to file their applications at the Institute ("Kenya Industrial Property Institute-About Us", 2018). However, the process of filing of and paying for intellectual property rights in Kenya is done using rather inappropriate and unreliable procedure predisposing the IP rights owners to a potential loss of their IP application for protection leads their inventions exposed to theft as well as leading to loss of revenue for the government.

In the recent past, information communication technology (ICT) has moved to occupy a central place in economies, with most modern industrial production and commercial transactions becoming relying heavily on ICT infrastructure and platforms. Hence the opportunity to leverage on ICT and mobile payment technology for effective Intellectual Property administration. Mobile telephony has witnessed unprecedented growth in the recent past in Kenya, making mobile applications ubiquitous hence a part of the cashless economy.

The advancement in mobile technology, buttressed by the proliferation of smartphones among the population, has created the need to leverage on technology to improve service delivery. Innovation in service delivery is essential to a productive, high-performing public service, the public sector being the largest service provider, as any incremental improvement in public service will impact positively millions of Kenyans. Thus, deployment of a mobile application would be well suited for the scenario highlighted herein as it would greatly facilitate the secure filing of IP rights as well as ensure secure and efficient fees payment transaction process (Ondrus & Pigneur, 2007).

## **1.2 Problem Statement**

That the importance and stature of IP has been rising over time is not doubt, even as it has continued to attract greater attention, leading to an increased need for inventors and other IP rights owners to file their applications with IP offices in order to protect their rights. Fagrell (2010) posits that, mobile has become part of an overall trend in society towards mobility, as, thanks to new technology, people are able to work from any location. With the continued rise in popularity of m-commerce, m-payment has become a key facilitator of business transactions between consumers and merchants (Ondrus & Pigneur, 2007).

There are challenges that the IP office as well as applicants of IP rights face when they are filing applications as well as making payments. These include potential loss or interception of sensitive IP data as it is being sent to the IP office, cases of payments for IP being wrongly assigned to wrong application numbers, as well as inefficiencies and loss of revenue by IP offices as a result of less-than-secure payment methods used. Those paying fees to the IP office face inconveniences such as making bank deposits and then having to wait as the IP office has to track their payments, before processing their applications. This is a somewhat slow process that delays conferment of their IP rights. In addition, cases of applicants colluding with bank clerks to issue fake deposit slips and presenting them to the IP office have also been reported.

Literature has revealed that whereas a wide range of mobile payment solutions and systems exist, few have been done on secure and cost effective mobile systems for use in IP offices to file for IP rights as well as for the IP rights holders to pay the fees. Hence the need to leverage technology and develop a mobile application that will facilitate speedy and secure filing of IP rights and settlement of payments by inventors and other IP rights owners to IP offices. The mobile application could then be used to generate a QR code, post the same to a remote server and make payment by scanning a QR code.

### **1.3 Research Objectives**

- i. To identify the information requirements and characteristics of mobile payment systems;
- ii. To determine possible challenges in filing of and payments for IP fees;
- iii. To review existing mobile payment models, frameworks and technologies;
- iv. To develop a secure mobile IP filing and fee payment prototype incorporating QR code;
- v. To test the developed system.

### **1.4 Research Questions**

- i. What are the characteristics and data requirements of mobile payment systems?
- ii. What challenges are likely to be faced when filing for IP and making fee payment at IP office?
- iii. How do the existing models, frameworks and technologies handle IP filing and fee payment?
- iv. How can a mobile solution incorporating QR code be developed to facilitate secure IP filing and payment of fees?
- v. How will the developed system be tested?

## 1.5 Justification of the Study

According to Gill (2002), “research findings should add to the general body of knowledge without necessarily being of value to the community”. Thus, in essence, research should be devoted to problems judged to be important and of practical application. Kothari (2004) sums up this by stating that the business and government have been becoming complex hence helping in shining the spotlight on use of research in solving operational problems. Hence, in line with research best practices, a research study aims to address societal problems as well as contribute to the body of knowledge in the field of ICT by providing a process to design and create a mobile based artefact that supports incorporation of secure payment technologies into mobile payments.

This study proposes a secure mobile payment application that will facilitate speedy and efficient way through which members of the public can settle the requisite fees at the IP offices. This will ensure the protection of the rights owners’ IPR and enable them to claim the priority. This mobile application will also go a long way in safeguarding the government from potential loss of revenue and provide audits of cash collected daily.

The key role played by IP in the growth of nation’s wealth and economies is enormous. Indeed studies have shown companies are turning to IP to create a competitive advantage over their competitors, with many major companies across the globe using IP as a strategic tool for both domestic and global market share (Fink, 2000). Cognisant of the crucial role of IP in an economy, the government of Kenya (GOK) in its medium term framework, recognises the need to employ the most creative and innovative ways to address challenges that are facing the public service. Thus, a resultant mobile payment application will be in line with GOK’s vision and hence have an impact on the number of IP applications filed at the IP office, as it would create a nice working environment and streamline the operations of IP office.

Furthermore, reviews of literature have revealed that, in Kenya, academic research on use of proximity/contactless systems in mobile payments has been modest, perhaps because the technologies are somewhat not fully mature, hence a cloud of uncertainty still hangs with regard to their future evolution. This therefore provides a strong basis for research that will consolidate empirical data.

## **1.6 Scope/Delimitations**

While several forms of Intellectual Property exist hence different IP offices, this research was limited to secure mobile fee payment system at KIPi. Since KIPi administers patents and trademarks –the core of IP-, it has a well-established and vibrant IP regime that would adequately represent the other IP rights agencies. This offered a good platform that enabled the researcher to conduct a well-informed research and develop the application. In addition, KIPi's location in Nairobi provided the researcher with a more convenient location.

The main limitation of this study was that, it was based on one case organization. As Kothari (2004) observes, case studies suffer from the limitations associated with generalizing study results on the basis of a small sample size. In addition, Kenya's IP regime is wide and encompasses a number of players, hence making it quite hard to carry out a research on filing and payment systems for the entire IP sector. Consequently, this research's findings were greatly dependent upon the data availability with reference to time and accessibility.

## **1.7 Thesis Outline**

This thesis comprises of seven chapters. Chapter one sets the background for the study, encompassing the research problem and highlights the significance of the study, research questions, objectives and the scope of the study are presented. Chapter two presents a detailed literature review -theoretical and empirical- and hence the identification of existing research gaps with regards to the research topic. Chapter three presents the research methodology used, describing data collection and analysis, research design and sampling criteria. Chapter four discusses the research findings and data analysis of the research survey that was undertaken, as well as system design. Chapter five describes how system implementation and testing were carried out. Chapter six discusses the research findings and achievements in relation to the research objectives, and showcases how the developed solution compares with existing systems. Finally, chapter seven offers conclusions and gives recommendations for future research.

## **Chapter 2: Literature Review**

### **2.1 Introduction**

According to Meredith (2011) strong and effective IP regime contributes towards enabling firms to acquire a competitive streak in terms of marketing of new goods and services in the increasingly evolving knowledge-based society, even as competition moves from the brick and mortar to service oriented. Protection of IP gives the owner exclusive right over his new invention for limited period of time to exploit his invention in specific field of technology by preventing third parties from doing the same without compensation (Meredith, 2011). Information disclosed in patent contributes to advancement in science and technology and development of new products and have helped bring economic prosperity of any society. Anderson (1998) stated that patents carry a huge amount of science and technological information. According to WIPO report (2004) patent information reflects the hundreds of thousands of the world's latest development and innovations in nearly all fields of technology.

According to Thurow (2007), as world economies continue moving towards knowledge-based industrial revolution, skills and knowledge have moved to the core of the economy, so crucially that it is considered the only source of sustainable long-term competitive advantage. As a result, IP now lies at the core of the modern company's economic success or failure. Sadler (n.d.) notes that the payments industry has witnessed tremendous evolution, with new electronic solutions replacing the old-fashioned paper-based payments, such as cheques and money orders. As a result, the evolution has led to innovativeness by various service providers who have had to create new platforms that allow businesses to accept mobile based payments.

### **2.2 Data Requirements and Characteristics of Mobile Payment Systems**

#### **2.2.1 Payment Methods**

Transactions have existed since time immemorial, as people have been engaging in trade since the days of barter trade. The transaction environment that pegs its existence on monetary value has undergone logical evolution as a result of the progress of technology. According to Ondrus and Pigneur (2004), payment methods have evolved from the old face-to-face based methods that included cash, paper, or card-based to technology based payments. The evolution

in technology led to the popularity of remote transactions as a result of the development of data wired networks, which would in turn lead to the birth of credit cards and e-payments.

Due to technological advancements, the current technological trend is geared towards implementation of wireless systems with the ability to handle both remote and face-to-face mechanisms using a single device. Further, Ondrus and Pigneur (2004) observed that several payment transaction methods can be classified based on multiple dimensions. It was against this backdrop that Buhan, Cheong and Tan (2002) proposed a hitherto new scheme of classifying the payment market's dimensions as shown in Table 2.1:

Table 2.1: Payment Dimensions (Buhan, et al., 2002).

<b>Payment classification</b>	<b>Description</b>
By means	This comprise of payments in form of Cash, Paper (Cheques, Bankers draft), Card (Credit, Debit, Smart), Electronic (e/m-commerce, virtual money, e-wallet, stored value account), Tokens/money surrogates
By size	This comprise of payments in form of Micro-payments (generally below \$10), Macro-payments
By place of purchase	This comprise of payments in form of Real-world or remote such as internet, Mail and telephone orders.
By Seller/Buyer	Origin B2B (rare for m-payment), B2C, P2P
By type of purchase	Physical goods, Digital/electronic goods, Rights (rich media)
By clearing and settlement method	This comprise of payments in form of Bilateral, Multilateral (joint clearing house), Using intermediaries
By type of transaction	This comprise of payments in form of Pay Per View (PPV), Pay Per Unit (PPU)
By type of payment	This comprise of payments in form of Pay now (debit), Pay later (credit), Pre-pay (against stored value)
By geography	This comprise of payments in form of Domestic, Cross-border, Single currency, Multiple currency
By location of payer's account details	This comprise of payments in form of Network-/server-based, Device (client-based), Chip (client-based)

### **2.2.2 Mobile Payments**

Cheney (2008) defines mobile payments as a range of financial activities that are carried out by the use of mobile devices. The exponential growth of mobile and cellular telephony in recent years has meant that mobile devices have become a must have for many individuals from all walks of life. According to the BBC (2014), mobile phones are highly in use in developing countries that have limited or deficient landline infrastructures. Thus, mobile telecommunications companies have much more subscribers than do fixed land lines.

In Kenya several mobile operators have developed mobile payment systems. Among the popular ones is Mpesa service provided by Safaricom Ltd that allows merchants to receive payments for goods and services from their customers by means of mobile money. Mbogo (2016) observes that since its launch in March 2007, the service has grown rapidly to become the largest mobile money service not only in Kenya, but also worldwide. Other mobile payment services in Kenya include Orange Money, Airtel Money, JamboPay, among others.

### **2.2.3 Ubiquity of Mobile Payments**

Ubiquity is the aspect of being able to move seamlessly between different devices while also using several devices simultaneously. “Understanding the Primary Mobile Payment Models,” (n.d.) states that the future of consumer IT is in mobile technology since this technology gives companies the opportunity to become more accessible to consumers, as mobile devices have become ubiquitous leading to consumers to always carry their mobile devices everywhere.

Use of mobile payments systems in transactions is popular and more widely used in third world countries due to the huge adoption of mobile phones by the populace. Due to the fact that most third world countries lack affordable financial services from traditional banks, provides fertile ground for the growth in mobile financial services, making the sector far much more attractive as they are cheap and more accessible (“Understanding the Primary Mobile Payment Models,” n.d.).

The proliferation of mobile payments industry in third world countries is largely driven by telecommunication companies using the WAP model (“Understanding the Primary Mobile Payment Models,” n.d.), whereas first world countries such as Japan and the North America are renowned leaders in deployment of NFC-based mobile payments. This, owing to the fact that first world countries lack the incentives to motivate customers to embrace mobile

payments, as such countries already have well established credit card payment systems in place (“Understanding the Primary Mobile Payment Models,” n.d.).

Lora (2013) notes that unlike laptops and cell phones, which gradually are replacing landlines, “mobile devices expand the opportunities for computer usage and media consumption”. In addition, Lora (2013) further notes that the mobile shift is more than moving from fixed personal computers (PCs) to mobile devices, as it entails a larger spectrum that shifts from fixed, restricted access to computing services to ubiquitous access.

According to Coonen (2012), smartphones ubiquity juxtaposed with their multi-functionality, has seen them acquire a critical position in the transactional chain, and are well on course to replace the physical wallet. This has led to a paradigm shift that has seen micropayments take centre stage even as the demand for online content, services and virtual goods have all been expanding. This, coupled with the continued growth in social media makes mobile payment ubiquity such an attractive aspect for development of payment systems. The present day consumer is increasingly connected, always able to access internet on the go, putting pressure on the need to have high services that are highly available, with a large pool from which they can make choices as well as flexibility to buy anywhere anytime.

#### **2.2.4 Requirements for Mobile Payment Systems**

Karnouskos and Fokus (2004), outlined a number of conditions that a system must satisfy in order to be considered in the market as a true mode of payment. These conditions include universality, platform compatibility, simplicity and security, among others. De Clercq (2002) also observed that a set of commercial, juridical and technological requirements must be met for a service to be determined a successful form of payment system. These requirements are as shown in Table 2.2:

Table 2.2: Requirements for the Success of M-Payment (De Clercq, 2002)

<b>Commercial</b>	<b>Juridical</b>	<b>Technical</b>
Universality	Digital signature	Network technologies
Instant connectivity	Current legislation on payment systems	Service technologies
Personalization		Service technologies
Convenience		M-commerce terminals
Expenses		M-commerce security mechanisms
Protection of privacy		
Security		

## 2.3 Challenges in Filing of and Payment for IP Fees

### 2.3.1 IP Filing Systems

IP offices have implemented different systems that are used in filing of IP rights. The following section looks at some of the systems.

#### a) Intellectual Property Administration System

Intellectual Property Administration System (IPAS) was developed by WIPO. The system is meant to automate the processing and examination of Industrial Property rights. The system is used in more than 64 countries including Kenya where it has been used to expedite IP filing and processing, significantly reducing timelines. The system has a component for online IP filing called WIPO File. If used without use of digital signatures, IP filing is susceptible to data interception which could lead to loss of sensitive IP data.

#### b) POLite+ System

This is the system in use at the African Regional Intellectual Property Organization (ARIPO). It is a web-based system used for the administration of IP, developed by Korea International Cooperation Agency (KOICA). The system has been interlinked with those of ARIPO member states hence ensuring security. However, it does not have a mobile component.

As can be seen from these systems, filing for IP rights using less secure systems presents a security challenge to the IP rights holders, as their IP data can be intercepted while in transit or be exposed to third parties thus compromising their inventions.

### 2.3.2 Challenges in Payment Methods

Different IP offices use different payment methods. Several challenges exist in making payment of IP fees using these methods: Using the bank deposit method has led to cases of applicants colluding with bank clerks to issue fake deposit slips and presenting them to the IP office. This leads to loss of revenue to the IP office, as they go ahead to render services based on these fake slips. Applicants on the other hand, face inconveniences, as the IP office has to track their payments made by bank deposits, before processing their applications, a somewhat slow process that delays conferment of their IP rights.

Furthermore, settlement of IP fees using mobile payment systems faces several challenges, such as the lack of adequate security in mobile payment systems used. As the World Bank working paper No. 146 “Integrity in Mobile Financial Services” observes, major security concerns centre on identification of customer, data protection, and the speed with which illicit transactions can be carried out, as well as level of regulation as handled by the service providers.

Jones (2001) noted that despite the growth in mobile telephony, mobile payments face technological and business issues leading to delay in its development. Among the major challenge facing mobile payments is how to make consumers and merchants realise the need for using the new payment systems (Jones, 2001). There also is the challenge of operation given the different platforms available, as different devices run on different operating systems. Thus, it becomes a problem to have a solution that can work across the numerous platforms. In addition, there are thousands of networks in existence each perhaps disparate or even linked to multiple other networks, posing a challenge that one payment system may not be able to function across all of them.

Odoyo, Liyala, Odongo and Abeka (2016) found that even though mobile banking has proven to be a valuable alternative, its delivery depends upon overcoming several bottlenecks across the varied societies. They point out that, the most pressing of these is meeting the prerequisite of mobile network coverage. Also, physical security concerns were more acute in rural areas, especially with the use of agents. Despite having cashless transactions, there is the hard cash challenge, as hard cash still need to be available for customers (Odoyo, et al, 2016).

## 2. 4 Mobile Payment Frameworks, Models and Architectures

### 2.4.1 Mobile Payment Frameworks

Frameworks play an important role in system design as they provide the basis for better understanding of technologies. In mobile payment, frameworks are crucial to the several players in the payments who constitute the payment ecosystem that includes banking and financial institutions, payment solution providers, merchants, mobile network operators as well as consumers (Carton et al., 2012). Some of the frameworks in existence include:

#### 2.4.1.1 Three Dimension Mobile Payment Framework

Ondrus and Pigneur (2004) proposed a three-dimension framework as a basis for understanding the functioning of mobile payments. The framework, as shown in Figure 2.1 comprises of three dimensions: network, device and mobile application. The network is responsible for gathering the technologies used in a wireless network infrastructure while the device represents the user wireless infrastructure. The mobile application offers a description of the popular technologies as used mostly by mobile application developers, mobile application service providers and content providers.

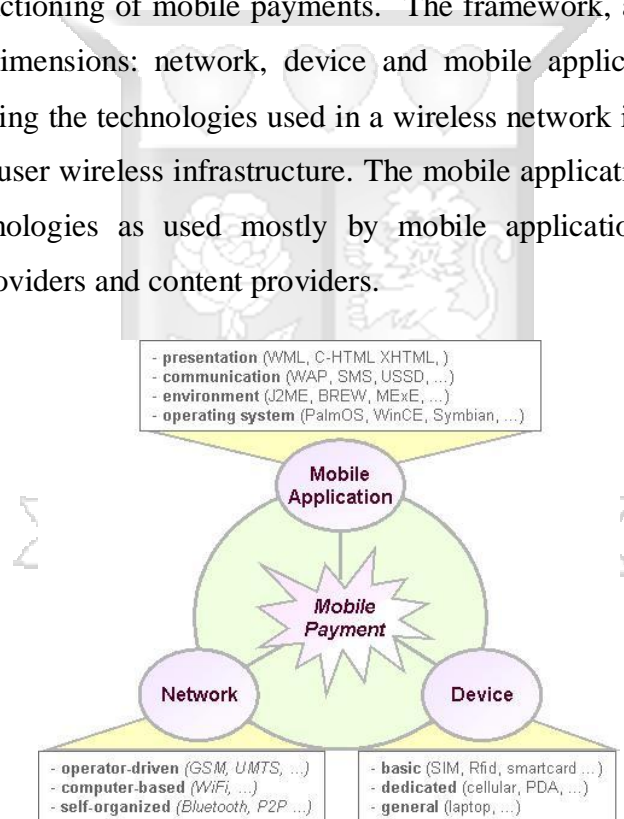


Figure 2.1: Three Dimension Mobile Payment Framework (Adapted from Ondrus, & Pigneur, 2004)

#### 2.4.1.2 Integration Framework for Mobile Payments

Carton et al. (2012) developed a framework for integration of mobile payments. Juxtaposing customer value with payment integration, the framework relates how payments are being made, and conceptualises payment integration as a continuous process that is

responsible for reconciliation of demand with supply. As shown in Figure 2.2, it consists of quadrants, with each representing a different phase of value proposition to consumers in electronic payments (Carton et al., 2012).

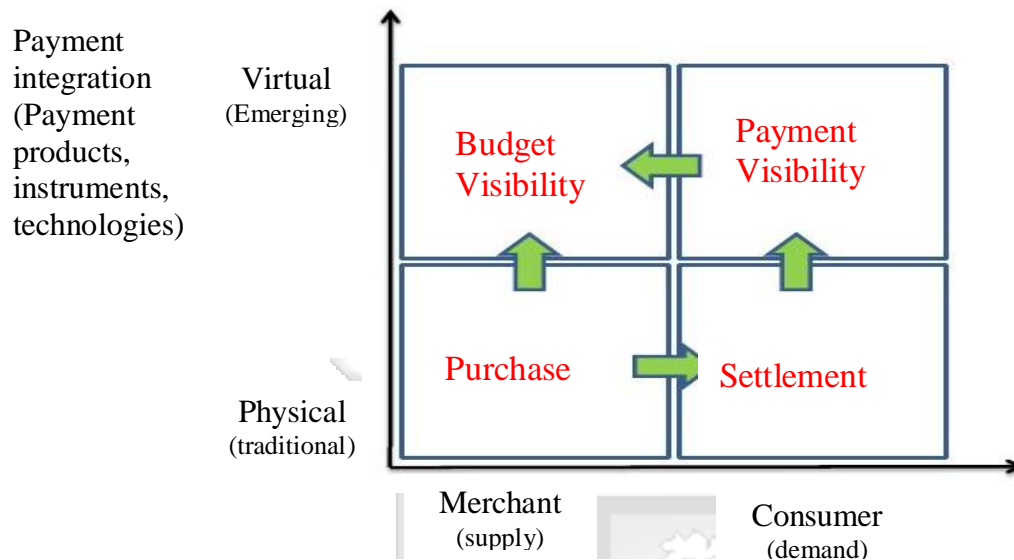


Figure 2.2: Integration framework for mobile payments (Adapted from Carton et al., 2012)

Firstly, purchase quadrant represents the buyer's commitment to purchase, and since at this stage it is the traditional physical payments instruments that are used, there is a limitation on the budget information visibility. Data related to product supply (for example, price, discount or loyalty credits) is the type of information that would be available to the available consumer budget. How this information is provided is a question of integration. The budget visibility quadrant shows the level to which visibility of available funds can be provided, information which may also entail electronic may decision support tools to help customers in making purchase decisions. The settlement quadrant represents real value transfer from the consumer to the merchant. This may be either automated process or may occur in stages, hence payment can be done by instant settlement using cash, or deferred payment that entails use of cards. Lastly, the payment visibility quadrant is used to show the degree to which settlement information is available, hence responsible for payment confirmation to the merchants, and also providing the customer with their budget position in real time (Carton et al, 2012).

## 2.4.2 Mobile Payment Models

Models play a fundamental role as they provide the basis on which concepts are understood, hence enabling the business and technology stakeholders to better comprehend and be in position to conduct thorough analysis of the situations and make strategic decisions in relation to each other. Realising the potential value of mobile payments, banks are now heavily investing in the technology.

Ondrus and Pigneur (2004) noted that mobile payment infrastructures were based on four-parties models. The parties comprised of the consumer, the merchant, the trusted third party and the payment service provider. On their part, Buhan et al. (2002) went on and proposed a four-party model of mobile payment comprising of the main phases as described in Figure 2.3.

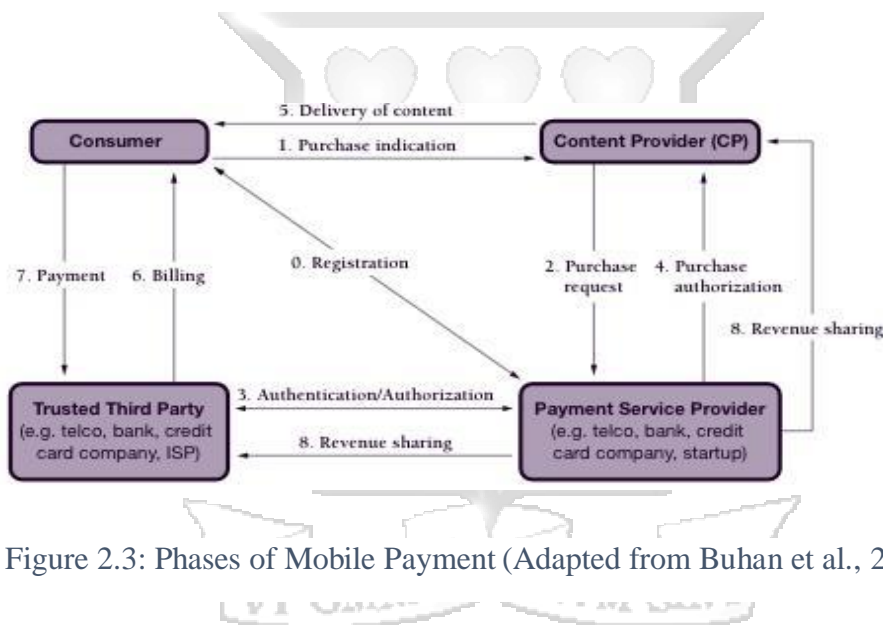


Figure 2.3: Phases of Mobile Payment (Adapted from Buhan et al., 2002)

Several mobile payment models are currently in use. The following section reviews some of them:

### 2.4.2.1 Mobile Web Payments Model

Billed as one of the most common model of mobile web payments in use today, this model uses Wireless Application Protocol (WAP) as its underlying technology (“Understanding the Primary Mobile Payment Models,” n.d.). Thus, the consumer of the service will normally make payments using the web pages or additional applications installed on the mobile phone. Sadler (n.d.) states that in this model, customers would make payments by means of web pages displayed on their phones or through web applications that can be downloaded and be installed on their mobile devices.

This approach presents users with two different mechanisms in which they can make payment. Firstly, users of the WAP mechanism use credit cards to pay, whereby the customers will be required to key in their card details into the Web page or app on their mobile phone and the business via an online credit card transaction. Alternatively, users can make use of online wallet- a web service that allows consumers to store and control their online shopping information as well as logins and credit card one central place. Various online sites including PayPal, Amazon Payments, and Google Checkout allow for creation of online wallets (Sadler, n.d.).

#### **2.4.2.2 Premium SMS/MMS Model**

One of the earliest forms of mobile payments, this model requires that a consumer sends payment request by means of SMS text message to a short code. Normally, the mobile service provider places a premium charge on the phone bill or their online wallet of the customer (“Understanding the Primary Mobile Payment Models,” n.d.). According to Sadler (n.d.), this model is most commonly used in low-purchases such as purchase of digital goods such as music, games and e-tickets.

#### **2.4.2.3 Direct Mobile Billing Model**

In this model, users are presented with different billing options hence they choose the options as they checkout at an e-commerce site. The model uses a two-factor authentication that comprises of a PIN and one-time-password, after which the consumer's mobile account is charged for the purchase. This model provides a true alternative payment method that does not require the use of a credit card, debit card or pre-registration at an online payment solution such as PayPal, thus bypassing banks and credit card companies altogether. This type of mobile payment method, is widely used and popular in Asia (“Understanding the Primary Mobile Payment Models,” n.d.).

Owing to the limitations of each of the models, mobile payment companies hardly use any one model on its own to service its customers, but instead combine different models. For instance, PayPal and Google Pay combine NFC technology and WAP model in their payments. Use of a hybrid model allows mobile payment companies to service more customers across more financial transaction situations (“Understanding the Primary Mobile Payment Models,” n.d.).

### 2.4.3 Mobile Payment Architectures

In a bid to aid explain the working of mobile payment systems, different architectures have been developed by different players. This sections reviews some of the popular architectures:

#### 2.4.3.1 M-Payments Generic Architecture

This is a generic payment architecture as presented by Carr (2008) that features the buyer of the goods (customer) and a merchant, parties who wish to participate in a transaction using m-payment service. The architecture comprises of several components including M-Payment Application Service Provider (MASP), telecommunications operator, and merchant bank and certifying authority. Carr (2008) further notes that the MASP handles the technical infrastructure hence facilitating m-payments and acting as an intermediary between the financial institutions and mobile network operators (MNOs). This component is therefore charged with registering details of the various players in the transactions, such as user and merchant details, bank account details as in addition to their valid digital certificates. Consequently, a mapping process takes place in which customers' and merchants' phone numbers are mapped to their respective bank accounts and maintained by the MASP. Thus, users are issued with mobile wallets which will reside on the phone or the sim cards and will normally interact with the MASP server. This architecture enables customers to carry out e-commerce transactions and make payments to the merchants based on their mobile phone numbers. Figure 2.4 is a diagrammatic representation of the architecture.

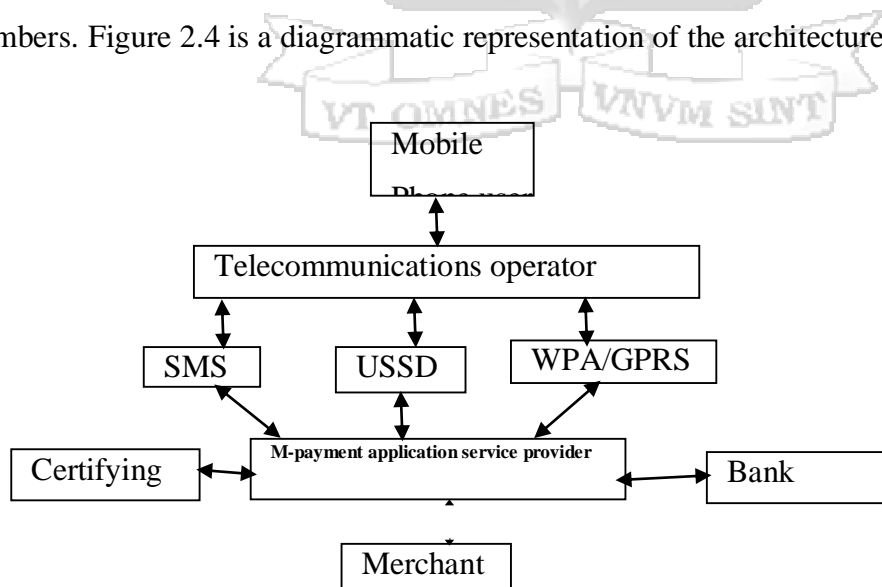


Figure 2.4: A Generic Model for M-Payments Application Service Provider (Adapted from Carr, 2008).

### 2.4.3.2 Mobile Payment System Architecture

According to Olanrewaju, Zavarsky, Ruhl, and Lindskog (2011), this architecture comprises of several entities including customer's mobile device, the issuer, acquirer as well as the merchant's POS. Proposed by EMV standard, the architecture encompasses an authorization process through that entails the issuer making approval or rejections of mobile payment transaction. In addition, the architecture comprises an authorization process which helps in monitoring transactions so as to enable detection of fraudulent use of mobile phone and POS terminal (Saxena, Manik & Gupta, 2005). Decision on whether to approve or decline the transaction is made following validation of the dynamic cryptogram. In the end, the mobile device provides the functionality of a payment token, consisting of EMV compliant-payment application and cryptographic keys that are stored on tamper-resistant component of the mobile device called Secure Element (SE). The architecture is shown in Figure 2.5.

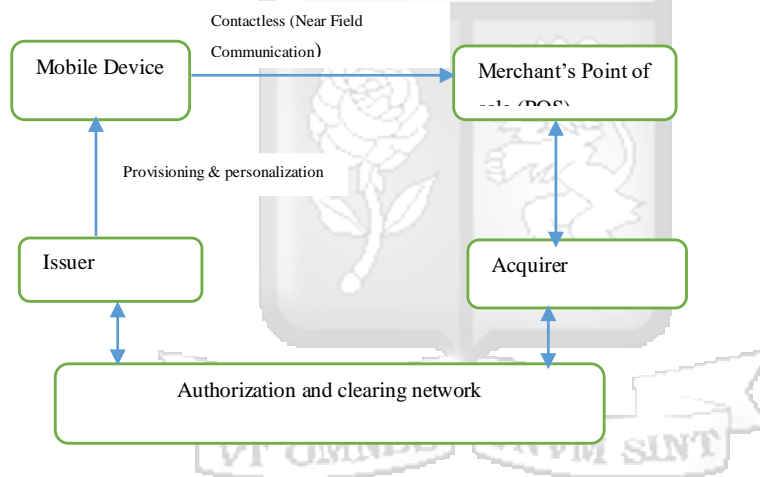


Figure 2.5: Mobile payment system architecture (Adapted from Olanrewaju, Zavarsky, Ruhl, & Lindskog, 2011)

### 2.4.3.3 End-to-end Mobile Payment Transaction Architecture

Kumar, Gonsalves and Jhunjhunwala, (2010) proposed architecture for use in making payments using mobile devices, that is suited for economic markets with heavy regulations hence the need for the payments to be carried out by means of bank accounts. This model supports interoperability, universality and simplicity so as to make mobile payments successful. The model defines a logical entity called the Mobile Payment Provider (MPP) that

is responsible for performing financial transactions involving different mobile phone customers. The end-to-end architecture is as shown in the Figure 2.6.

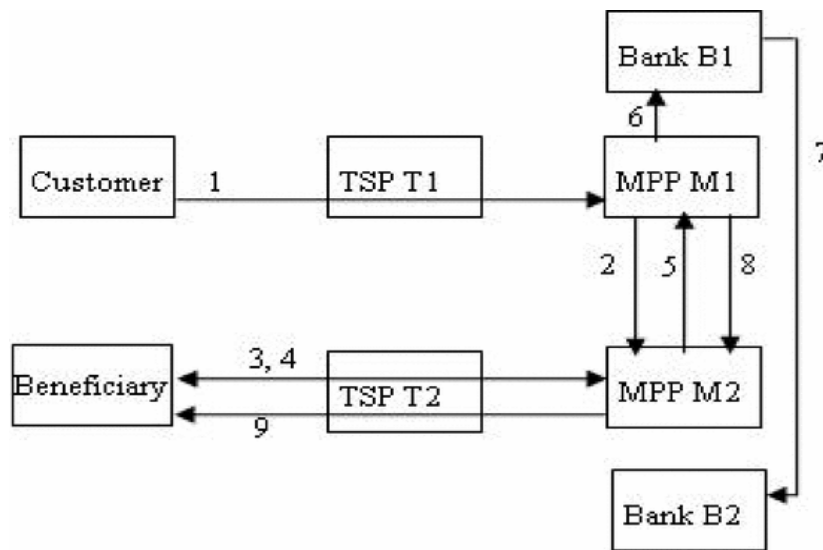


Figure 2.6: End-to-end mobile payment transaction logical flow (Adapted from Kumar, Gonsalves & Jhunjunwala, 2010).

## 2.5 Mobile Data Transmission and Payment Technologies

According to Cheney (2008), mobile payments can be grouped into two general categories, i.e., payments undertaken at the point of sale, known as “proximity payments” and “remote payments”. Proximity payments typically are those initiated using NFC technology whereas mobile remote payments, are normally associated with a certain payment network hence are initiated and settled through the mobile cellular phone network. Such payments run on a wide variety of technologies such as SMS text messaging, wireless Internet technology, or mobile applications that are downloadable and run to allow payment execution. The following sections reviews some of the existing mobile payment technologies:

### 2.5.1 Near Field Communication

NFC is a contactless model used mostly in paying for purchases made in physical stores or transportation services (“Understanding the Primary Mobile Payment Models,” n.d.). Using this approach, a consumer using a special mobile phone equipped with a smartcard waves his phone near a reader device at the point of sale and a payment is made. According to Cheney (2008), most transactions do not require authentication, but some require authentication using PIN, before transaction is completed. The payment amount is then deducted from a prepaid account at the merchant (similar to store-branded debit cards but without the plastic) or charged to the customer’s mobile phone bill, bank account, or credit or debit card (Sadler, n.d.).

As Cheney (2008) notes, by virtue of NFC chips being pre-built into handsets has presented users an opportunity to embrace contactless proximity payments hence the ability to use their mobile handsets in payments. A Smart Card Alliance (2007) research found that, NFC uses short-range, standards-based wireless connectivity technology, a feature that enables it to provide multitude of use including providing a mechanism for a safe and quick contactless transactions, access digital content, and connect electronic devices simply. As Rohde & Schwarz (2011) observe, NFC technology being versatile offers a wide range of uses, such as purchase of tickets, smart posters data translation and other tasks from a single device. Figure 2.7 is a graphical representation of the working of NFC technology:

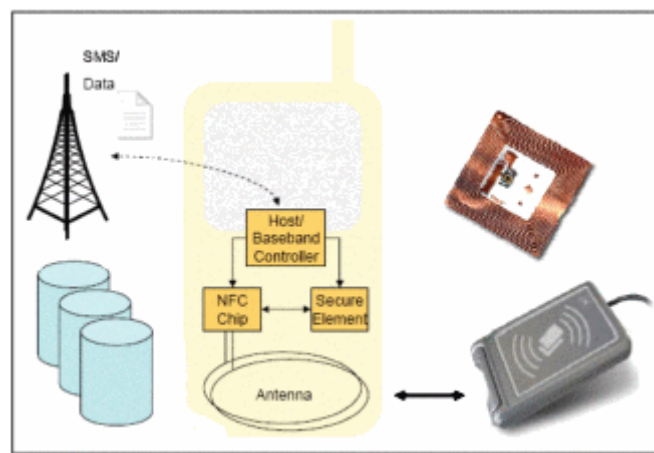


Figure 2.7: How NFC works (Adapted from Gu & Yao, 2010).

### 2.5.1.1 Strengths and Weaknesses of NFC

Due to its operation in close proximity, NFC technology is considered safe (Cheney, 2008). In addition, NFC supports passive communication – a model crucial for battery power-dependent devices that includes mobile phone. Furthermore, as Gu and Yao (2010) noted, NFC has high compatibility with other widely used contactless smart card protocols. On the other hand, as the transmission of data happens within the close proximity of two communicating devices, there are security concerns that data could be conceivably stolen from an NFC system even from a greater distance. In addition, this technology is quite expensive, as to take up NFC technology requires acquisition of extra equipment.

### 2.5.2 Radio Frequency Identification

Briseno et al. (2012) found that Radio Frequency Identification (RFID) communication is a technology that uses radio waves to both store and retrieve data from identification chips. According to Weis (2010), RFID traces its origin to the 19th century during time which a lot

of scientific strides were made in the field of electromagnetism. Weis (2010) further observes that RFID owes its roots to such profound scientific luminaries as Michael Faraday who discovered the electronic inductance, James Clerk Maxwell's who formulated various equations that were key in describing electromagnetism, and Heinrich Rudolf Hertz who performed experiments that were used to validate Faraday and Maxwell's predictions. It was these discoveries that would form the foundation for modern radio communications (Weis, 2010). Figure 2.8 shows a sample diagram of an RFID tag.

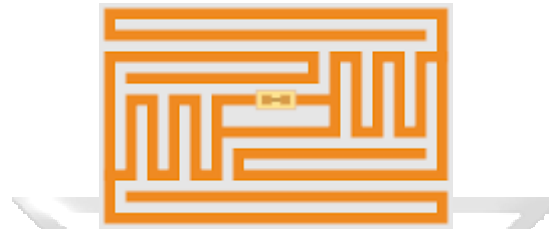


Figure 2.8: Sample RFID Tag (Adapted from Rafiq, 2005)

#### **2.5.2.1 RFID Strengths and Limitations**

RFIDs are known to have a number of advantages that have seen them being used in several applications. Some of these advantages include: the ability of tags to be read at a faster rate as compared to other technologies such as barcodes (Wireless Technology Advisor, 2014), processes can be run with minimal human intervention, as well as the capability of frequencies to be read from greater distances. Piasecki (2012) noted that when using RFID, there is no need to position the scanner and tag in a straight line of sight. Furthermore, tags have read/write capabilities, that can be customized and have high capacities of storing data.

Conversely, RFID is known to suffer from a number of limitations. Weis (2010) notes that RFID suffers from several vulnerabilities including a lack of a strong data security in place, hence predisposing people who use devices that carry personal financial information, such as credit cards or other ID numbers, to exposure of their accounts. Other limitations of RFID are that such systems are expensive compared to QR-Codes and barcodes. In addition, since tags are programmed to operate on specific applications, they cannot be used universally across many applications (Wireless Technology Advisor, 2014).

### 2.5.2.2 How RFID Works

According to Rafiq (2005), RFID tag's basic working mechanism is as outlined below:

- i. Upon antenna creating an RF field, the tag enters;
- ii. Antenna's RF signal activates the tag
- iii. The reader will then send a modulated signal
- iv. The tag will demodulate the signal and send it back to the reader
- v. On receiving the demodulated signal, the reader send the data to the database in a server

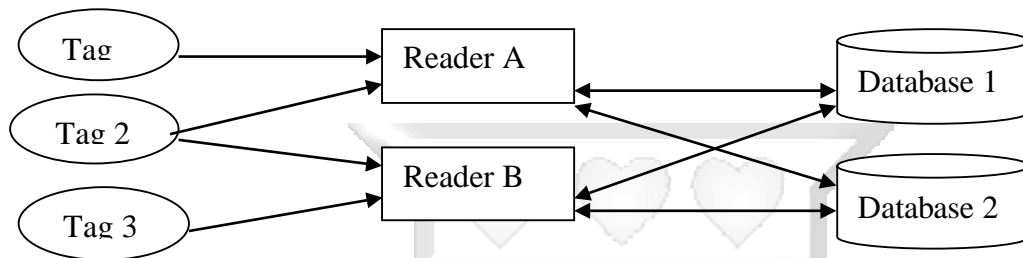


Figure 2.9: Illustration of RFID System Interaction

Figure 2.9 illustrates three tags readable by one or both of two readers, A and B because of imposed access control restrictions. Thus, for the readers to connect and communicate with databases, specific records associated with particular tag identifiers must be determined.

### 2.5.2.3 Applications of RFID in Payment Systems

RFID has been used in mobile payment systems in areas including embedding of RFID in consumer applications such as wireless transactions to ease payments and provide alternatives to cash. Such applications have been proven to enhance transaction speed as well as create convenience for users in places such as fast food restaurants, petrol stations and dry cleaners. Biever (2003) noted that several companies including Advanced Digital Solutions in Florida were using RFID in verichips to perform payments. Moreover, these tags were being deployed in wireless credit card for making payments. Companies such as ExxonMobil have used RFID in their operations whereby they have attached tags to key-rings, so as to make the process of gas station transactions faster for its customers. On his part, Booth-Thomas (2003) observed that several cities across China have widely used RFID payment system in their public transportation system. Booth-Thomas (2003) as cited in (Rafiq, 2005) further notes that millions of pets worldwide are tagged with RFID chips for identification and tracking.

### 2.5.3 Europay, MasterCard and Visa (EMV)

Ahmad, Zeki and Olowolayemo (2016) define EMV as a commonly used protocol used in payment systems using smart. This ensures that payments are more secure as compared to magnetic cards. EMV can be deployed in different across various forms of payments including contact payments, contactless payments and mobile payments.

Puhe, Edelman and Reichenbach (2014) noted that EMV being an integrated circuit card specifications for payments operates by way of having a microprocessor embedded in the card itself. The rationale behind EMV specification was to promote interoperability for chip-based payment (Puhe et al., 2014). EMV is founded on strong symmetric and asymmetric cryptography approach and an intricate key management technique that makes it considerably more secure compared to magnetic cards. Transaction integrity is guaranteed by digitally signing payment data and use of dynamic data where transaction carries a unique stamp to prevent reuse of data in cases where data is stolen from the database. Figure 2.10 shows a representation of EMV

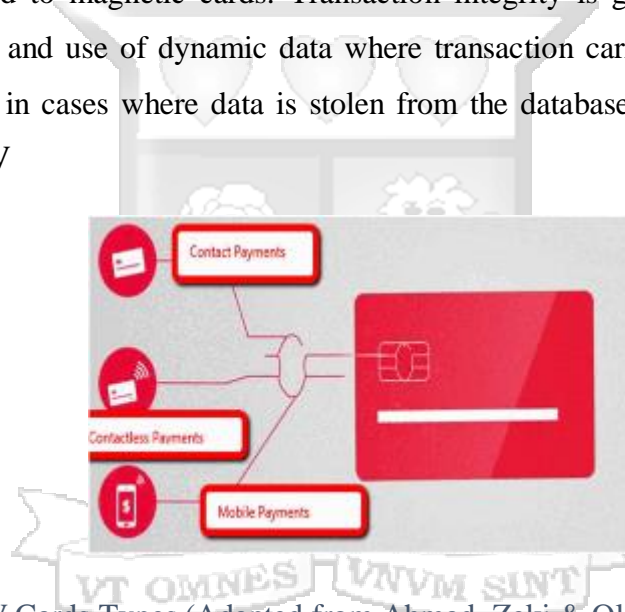


Figure 2.10: EMV Cards Types (Adapted from Ahmad, Zeki & Olowolayemo, 2016)

According to Murdoch and Anderson (2014), EMV transactions comprise of 3 stages; the first stage involves authentication of the card a process in which the chip in the card confirms to the terminal that the validity of the card. Stage two entails verification of the cardholder whereby the customer enters a PIN or signs for the transaction. The third stage entails transaction authorization whereby one or more message authentication codes will be generated by the card that will use a shared symmetric key between the card and the issuing bank. The confirmation will only occur if the terminal is online. Ahmad et al. (2016) further noted that EMV being a technology that does not rely on swiping, works by means of users simply inserting the card into the terminal and waiting for transaction completion.

Konsko (2014) notes that compared to technologies that use magnetic strip, EMV is more secure since its design ensures that data is protected and minimizes chances of skimming. Also, since it works based on the principles of secret cryptographic keys to generate a unique code for each transaction, EMV terminal will not accept stolen cards without the chip to generate the unique one time code (Ahmad, Zeki & Olowolayemo, 2016). On the flipside, EMV suffers from a number shortcomings such as its being expensive technology as it requires issuers and merchants to purchase new, expensive terminal and POS systems (Konsko, 2014). In addition, its wireless capability predisposes it to privacy challenges as data can be intercepted even when encrypted. Furthermore, since EMV transmits more data than a magnetic strip, it requires that issuers update their transmission and data processing (Konsko, 2014).

#### 2.5.4 Quick Response (QR) Code Technology

According to QR Code Essentials (2011), QR stands for Quick Response. It is a two-dimensional matrix code that belongs to a group of machine readable codes known as barcodes. Tarantola (2012) notes that QR Code was originally developed in 1994 by Denso Wave- a subsidiary of Toyota with the initial purpose of tracking vehicles as they were assembled and facilitate high speed scanning components. QR Code has overtime gained acceptance in varied industries among them transportation, healthcare and manufacturing, and is now available for use freely. Gura et al. (2011) observe that, smartphones have been seen as a catalyst in accelerating use of QR Code which has been instituted as an ISO standard and defined under ISO/IEC 18004 specification. Figure 2.11 shows a sample QR code image.



Figure 2.11: QR code image (Adapted from Denso Wave, 2014)

##### 2.5.4.1 How QR works

According to ("Createqr.codes.Org - How Do QR Codes Work?"), the functioning of QR codes is a long that of the UPC barcodes commonly used on items being sold in stores.

However, these codes differ from the UPC barcodes in the way they store information, in that, while information in UPC barcodes is one-directional hence only held in the horizontal direction, QR codes hold information in bi-directional way, thus allowing QR codes to hold much more information than UPC counterparts. QR codes are designed to hold information in the modules of the code in the form of the black and white dots, with 40 versions available ("Createqr.codes.Org - How Do QR Codes Work?").

### 2.5.4.2 Error Correction in QR

To ensure accuracy of the data, QR code employs an error correction process that uses 8-bits long code-words. Using the Reed-Solomon error correction algorithm (-a mathematical error correction code commonly used in music CDs-), the process entails four error correction levels whereby a higher error correction level translates to a low storage capacity (Plank, 1997).

### 2.7.4.3 QR Code Structure

Soon (2008) notes that the QR Code structure comprises a matrix type symbol with a cell structure arranged in a square consisting of the functionality patterns for making reading easy. It also contains a data area that stores different patterns as shown in Figure 2.12:

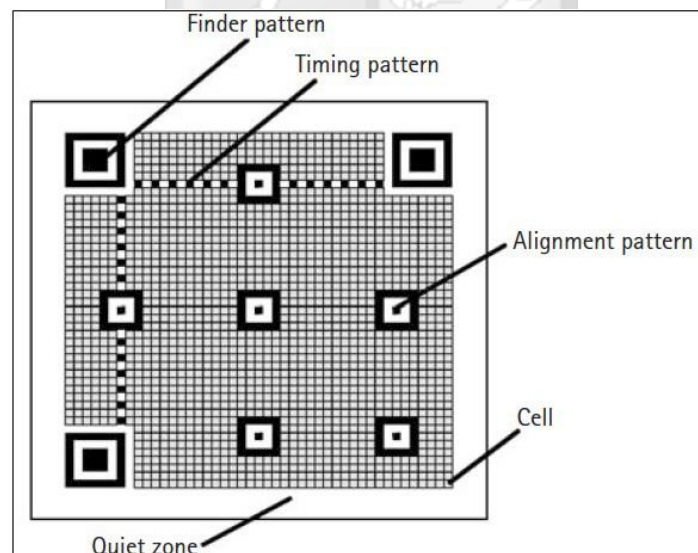


Figure 2.12: QR Code Structure (Adapted from Soon, 2008)

The components are as explained in the following sections:

- a) Finder Pattern -Soon (2008) observes that this components is responsible for detection of the QR Code position. By arranging this pattern at the three corners of a symbol, the

position, the size, and the angle of the symbol can be detected. This finder pattern consists of a structure which can be detected in all directions.

- b) Alignment Pattern -According to Soon (2008), this pattern is for correcting nonlinear distortions of the QR Code. The code identifies the central coordinate of the alignment pattern so as to provide symbol distortion correction, a task achieved by placing a black isolated cell in the alignment pattern.
- c) Timing Pattern -Soon (2008) states that this pattern provides central coordinate identification of each cell in the QR Code with black and white patterns arranged alternately. It is used for correcting the central coordinate of the data cell when the symbol is distorted or when there is an error for the cell pitch as it is bi-directional.
- d) Quiet Zone -according to Soon (2008), this margin space is necessary for reading the QR Code, making it for symbol detection from among the image read by the CCD sensor. At least four cells are required for the quiet zone (Soon, 2008).
- e) Data area -Soon (2008) notes that this is an area used for encoding into the QR Code data. These data is encoded into the binary numbers based on the encoding rule and then converted into black and white cells and arranged appropriately.

#### 2.5.4.4 Strengths and Limitations of QR Code

In comparison with the other technologies, QR offers the following advantages:

- a) Ability to read from all directions at high speed - the QR Code is organized such that it's readable from any angle within 360 degrees, a functionality made possible by detection pattern that is located at the three corners of the symbol. This functionality ensures that background interference will be cancelled out by these position detection patterns, thus ensuring stable high speed reading (Soon, 2008).
- b) Small printout size -since a QR Code stores data bi-directionally, it is able to hold as much data compared to bar code ("QR Code® Essentials", 2011). This is illustrated in Figure 2.13:



Figure 2.13: QR compression of storage of large data in small space (Adapted from "QR Code® Essentials", 2011)

- c) QR code is resistant to distortion –as “QR Code® Essentials” (2011) notes, to avoid symbol distortion when attached to curves, alignment patterns are used whereby they are arranged with a regular interval within the range of the symbol.
- d) Ability to restore data -QR Code’s error correction mechanism ensures codes can be read correctly even when they are smudged or damaged up until the error correction level (Soon, 2008).
- e) Code confidentiality-QR code creates a unique relationship between the character type and the stored data for a special usage. This ensures that easy encryption of the codes.

#### 2.5.4.5 Applications of QR

QR code has been implemented around the world in a variety of applications. Below are examples of such applications:

##### i) Issuance of Bus Commuters Passes

QR code has been used in this application where the user of the system is required to fill a form, upon which the QR Code on the commuter pass then carries the application information. This ensures a faster and efficient pass renewal for users of the commuter service. A sample QR based commuter pass is shown in Figure 2.14.



Figure 2.14: Bus Commuters Pass Issuing System (Adapted from Soon, 2008)

##### ii) Management of Betting Tickets

In this application used in Japan, betting tickets are QR-encoded with betting data. At the ticket office, winning ticket is matched with database by reading QR Code for confirmation. Other than being a speedy approach, it has greatly reduces impact on the environment as it replaces magnetic card with recyclable plain paper. This is as illustrated in Figure 2.15.

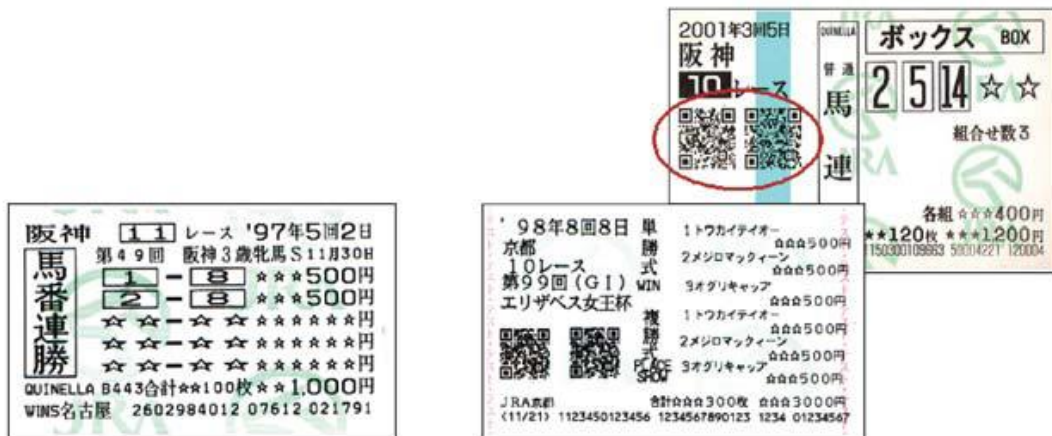


Figure 2.15: Betting Ticket Management (Adapted from Soon, 2008)

### iii) Management of Payment Slips in Taiwan

Soon (2008) observed that QR Code has been used in Taiwan for management of payment slips. A company will normally encode bill payment and then sent the URL link containing the encoded to customer. Upon receiving the URL link, they would, using a phone camera snap the QR Code printed on the bill to make payment by mobile phone through Internet, as shown in Figure 2.16.

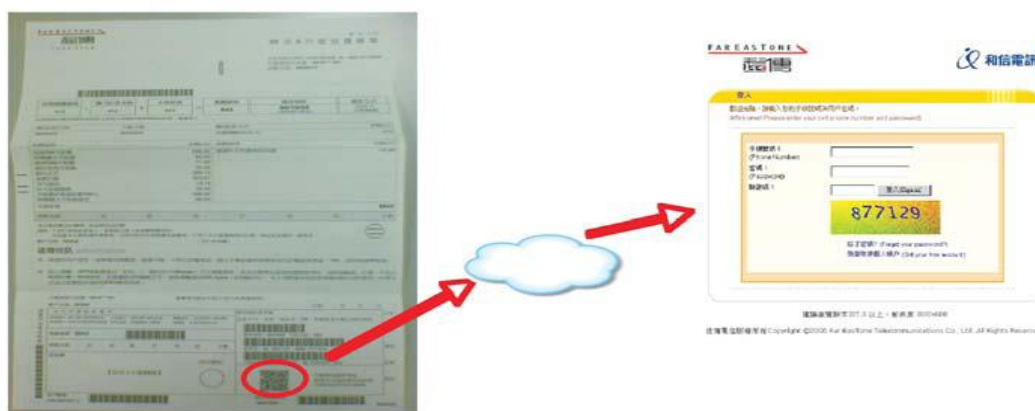


Figure 2.16: QR Code application in Payment Slips Management (Adapted from Soon, 2008)

## 2.5.5 Mobile Wallet

According to Carr (2008), this comprises of an application software that is installed on the on the mobile phone, and contains customer details such as bank and credit card information. This information enables customers to make payments using the mobile phone. This technology, allows its users to connect to several debit or credit payment instruments using one wallet.

Venkataramani and Gopalan (2007) noted that, the M-Wallet concept, as introduced by Motorola entailed user's credit card information being stored in their mobile phone which would then be accessed by users using their PIN number when they carry out purchases. They further noted that a major limitation of this approach is that loss of the phone would result in loss of entire set of credit cards. In addition, it is possible for one to hack data in the mobile phone, hence allowing strangers to access and view credit card information as well as previous receipts, leading to loss of privacy (Venkataramani & Gopalan, 2007).

## **2.6 Literature Review Summary and Way Forward**

Review of literature has revealed that though mobile payment systems exists, inventors and IP offices still face challenges in making settlement of IP fees. Hence, the need for an intervention that can successfully overcome the challenges by infusing the right technology with the existing mobile payments.

It has further shown that several proximity/contactless technologies exist that can be incorporated into mobile money services to make them secure and efficient. RFID offers a good option due to its strong security. However, it is best suited for large operations and would be expensive hence mobile money operators would be somewhat reluctant to use it in their systems. In addition, this technology is dependent on RF strength hence weak signals would interrupt service. EMV technology being a standard for integrated circuit card for payment system, offers interoperability for chip-based cards and is more secure in magnetic strips. This technology is however, expensive as it requires purchase of new terminal and POS systems. In addition, it is vulnerable to fraud. Whereas NFC technology is secure, as the transmission of data happens within the close proximity of two communicating devices, security concerns nonetheless exist with regards to the possibility to conceivably steal data from an NFC system even from a greater distance. In addition, this technology would prove costly for the IP office and individuals to take up NFC technology either through acquisition or maintenance of related machines and extra equipment. Mobile wallets allow users to multi-home with several debit or credit payment instruments in a single wallet. However, a major limitation of this approach is loss of the phone would result in a loss of entire set of credit cards. In addition, they are susceptible to privacy violations, as one can hack the mobile device.

It is evident that, while several mobile payment technologies exist, using any of these technologies is bound to pose implementation challenges as a means of filing for IP rights and

integrating with mobile money systems for settlement of IP fees. QR technology thus stands out as the most plausible technology due to the numerous advantages it has over others, including high capacity to encode data, support for several data types, ability to use small printout size hence holding much data, and the flexibility to be read from any direction. Thus, incorporating this technology in systems used for filing of and payment of IP fees would address the challenges identified. This technology is also cost effective, as there will be no requirement to purchase additional hardware to implement the solution. Furthermore, QR has been used in various applications and has proved effective hence it can be regarded as a tried and tested technology.

### 2.6.1 Conceptual Design

In light of the foregoing, QR stands out as the most plausible technology, seeing that it has the most benefits, is secure and has been proven working elsewhere. This research proposed a QR-based mobile application to address the challenges identified. The incorporation of QR-Code into mobile application would ensure accountability, accuracy and enhance productivity in settlement of IP fees by inventors. The conceptual system design is as shown in Figure 2.17.

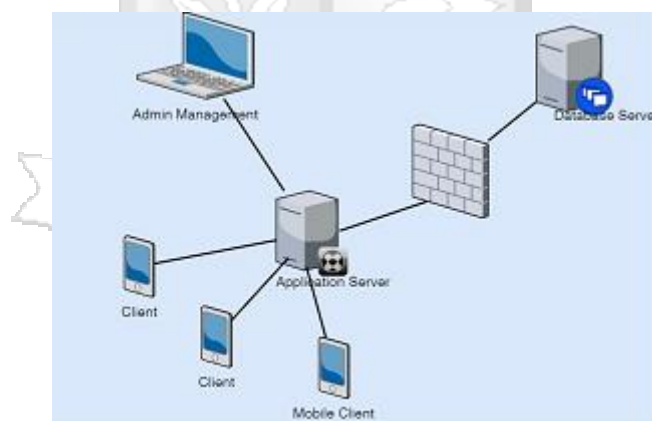


Figure 2.17: Conceptual system Design

### 2.6.2 Conceptual Architecture Design

The proposed system was implemented using the n-tier application architecture. In this architecture, the system is composed of independent components that work in multiple 'tiers' or layers as shown in Figure 2.18. According to Bradley and Millspaugh (2009), writing of multi-tier applications is a common practice in writing independent components that may be

stored and run in different machines. They further state that three-tier application model has, as shown in Figure 2.18 has become the most popular multi-tier approach.

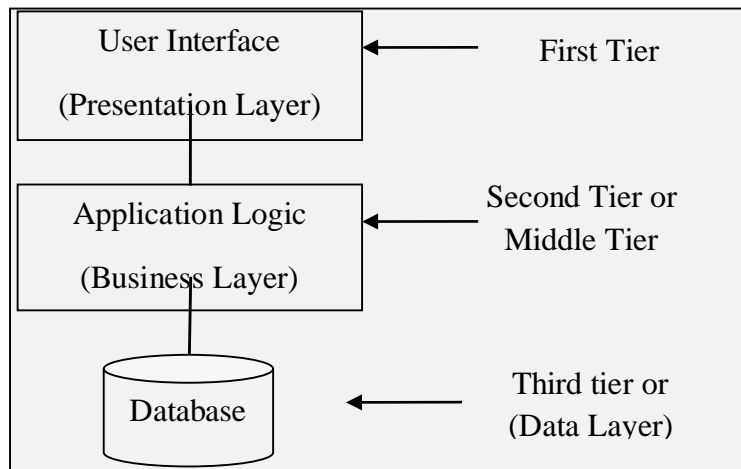


Figure 2.18: The n-tier Architecture for System Development (Adapted from Bradley & Millspaugh, 2009)

As shown in Figure 2.18, the architecture comprises of three tiers, namely: presentation, business, and the data tier. The presentation tier, also called the client layer, comprises of components dedicated to providing the user interface. The business tier on the other hand, encapsulates the business rules or the business logic of the application as well as being responsible for data manipulation and transformation into information. The data layer is responsible for handling of the database components like database files, tables, and views (Bradley & Millspaugh, 2009).

## **Chapter 3: Research Methodology**

### **3.1 Introduction**

As noted by Johnson and Onwuegbuie (2004), research methodology concerns the activities undertaken by a researcher to guide how research proceeds and how progress in research activities can be measured. Adopting specific methodology ensures that the author can achieve their research objectives (Johnson & Onwuegbuie, 2004). This section describes the steps, procedures and methodologies that were employed in carrying out the study and developing the solution.

### **3.2 Research Design**

Kombo and Tromp (2006) averred that if a study requires collection of information by interviews or questionnaires with the aim of ascertaining the state of affairs of a phenomenon, then survey design would be ideal. Thus, in establishing the current state of affairs in the existing IP filing and mobile payment systems as well as proximity/contactless payments, the research used exploratory research design to address the identified issues, since the research area has not had much research in Kenya. Collection and analysis of data was done by following a survey research design while development of the system was achieved by means of appropriate software engineering techniques.

### **3.3 Target Population**

This research targeted a study population encompassing various IP stakeholders including IP office staff at KIPI, members of the general public who have applied for patents/trademarks as well as selected patent agents in Nairobi. The respondents were selected using purposive sampling technique. Since an average of 3000 applications are received and processed by the IP office each month (KIPI, 2017), 3000 was the target population.

### **3.4 Sampling Design and Sample Size**

According to Saunders, Lewis and Thornhill (2009), several sampling techniques exist that provide a researcher with a range of methods that can be used to reduce the amount of data a researcher needs to collect. These techniques enable a researcher to limit data under

consideration to small, specific sub groups as opposed to having to consider all possible cases or elements. The sampling design and frame used are described in the following sections.

### **3.4.1 Sampling Design**

Luck and Rubin (1999) define population sample as a representation subset of the population under study thus enabling the researcher to make inference about a parameter that is known from the sample statistic that can be measured, as well as allowing him to test a hypothesis about a population. Luck and Rubin (1999) further note that sampling design is the procedure used by a researcher to obtain information about a given population by examining only a part of it.

Since the sample would be draw from different organizations such as IP office, IP agents as well as the applicants, the study used purposive sampling to choose the organizations and people from which the sample was drawn, because IP is a specialised area with only specific institutions and categories of people dealing with IP in Kenya. The main goal of purposive sampling was to focus on particular characteristics of the population of interest, which would enable the researcher answer the research questions.

### **3.4.2 Sample Frame**

In choosing the respondents, stratified random sampling was used, given that the population studied was heterogeneous, as there were differences among the participants in terms of gender, experience and level of use of IP filing and mobile payments systems. On the other hand, purposive sampling was used to target the specific IP applicants, patent agents as well as staff and personnel working at KIPI and IP offices. This sampling procedure was preferred because only those who are charged with the said responsibilities relating to IP filing and fee payments were required. The selection of respondents as per the classification was based on the fact that they played a crucial role in their organizations, thus giving meaningful contribution to the data collected.

### **3.4.3 Sample Size Calculation**

Kothari (2004) notes that in addition to the purpose of the study and population size, a researcher needs to specify three other criteria viz: level of precision, the level of confidence or risk, and the degree of variability in the attributes being measured, to be able to determine the appropriate sample size.

A confidence level of 90% and a sample error of 10% was used in calculating the size of the respondents needed for the study. In determining the sample population, Slovin's formula was used as shown in the equation:

$$n = N / (1 + N (e^2))$$

Where:

$n$ =sample size

$N$ = Population

$e$ =error tolerance

In this research therefore;

$N$ = 3000; and  $e$ =10%

Hence replacing the values in the equation gives, 96.7, which, when rounded off to the nearest tenth, gives a sample size of 100.

### **3.5 Data Collection**

This research used questionnaires to gather primary data. The questionnaires were administered to the selected participants for filling and then collected for analysis. Observation was also used to better understand the existing system functionality and inherent challenges. Secondary data was collected by reading and reviewing existing data such as journals, books, and online sources. The data collected formed the basis for determining the solution adopted. Using the data gathered, a prototype was developed and presented to the users to better understand user needs and fulfill their requirements and hence serve as a requirements elicitation tool.

### **3.6 Data Analysis**

A combination of quantitative and qualitative data was used in order to achieve research objectives. Statistical Package for Social Scientists (SPSS) was used for checking, coding and analysing the collected data. Since coding of variables in quantitative research is very critical for better interpretation of results, the questions and responses from the schedules were coded and entered into Microsoft Excel 2016 software. This data was later imported into SPSS, upon

which appropriate statistical methods were applied on the data to get the results, which was analyzed.

### 3.7 Research Validity and Reliability

In measuring a research's instrument, a critical factor to consider is its validity. Thus, validity gauges whether the findings indeed represent the real scenario of what they appear to be (Saunders et al., 2009). The research put in place measures to ensure the validity and reliability of the research results. Research questionnaires were formulated on the basis of the research questions and theory, ensuring that the questions were as simple as possible to enable respondents answer easily. This ensured that the results obtained can be replicated in other similar tests. In addition, the solution was methodically developed so as to closely mirror real world operations and meet the user requirements.

### 3.8 System Development Methodology

To ensure the objectives of the research are met, a prototype was built to demonstrate system functionality and proof of concept. The system has a back-end database that stores data and a front-end application (the user interface). The backend was built using MySQL database management system, whilst the front-end mobile application was built using Java for Android. PHP was used to build the server side web service scripts and the web application. Actual development of the system followed standard software system development lifecycle (SDLC) that encompasses the phases of requirements analysis, design, implementation and testing stages, as outlined below.

- i. **Requirements Analysis:** This phase entailed defining the system requirements. Thereafter, appropriate tools and techniques were used to collect and specify both functional and non-functional requirements of the system.
- ii. **Design:** During this phase, a detailed system design was produced, guided by the functional and non-functional requirements of the system. Appropriate software modelling techniques were used for design. During this phase, system inputs, processes and outputs were identified hence culminating into logical and physical design for the system.

- iii. **Implementation:** Based on the design developed above, the actual writing of the code based on the designs from the previous phase was undertaken.
- iv. **Testing:** the system underwent testing to check whether the functionality and usability of the system are met as per the user requirements. This stage would also help in identifying any possible errors in the system. The methodology is represented by the diagram in Figure 3.1:

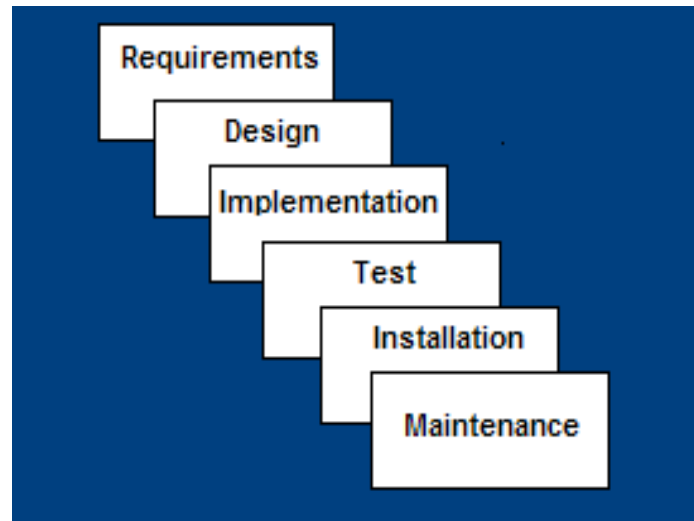


Figure 3.1: System Development Life Cycle (Adapted from Stair & Reynolds, 2008).

### 3.8.1 Pros of SDLC

Stair and Reynolds (2008) noted that, among the strengths of the SDLC approach is that, system development follows a structured approach resulting in the creation of a formal review upon completion of every stage hence ensuring control of the process. Using SDLC also allows the designer to have a fair amount of system documentation. In addition, this approach produces many intermediate products that can be reviewed to determine whether they meet the user's needs and conform to standards. As a result, it is possible to further rework on the system to ensure that it meets the business (Stair & Reynolds, 2008).

### 3.8.2 Limitations of SDLC

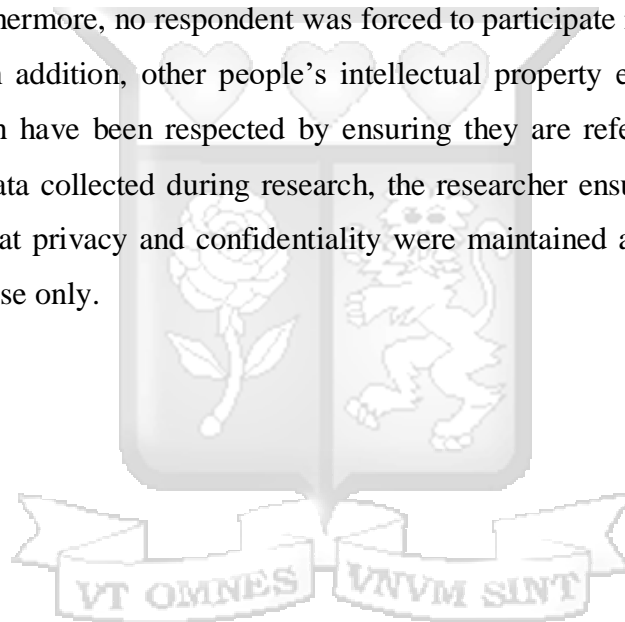
As observed by Stair and Reynolds (2008), SDLC suffers from a number of inherent weaknesses. Firstly, since it is a linearly approach, end users do not have the benefit of having a feel of the solution until the system is almost complete. This leads to the potential of developing a system that only meets the needs as understood by the developers and not as required by users; In addition, because of its linearly nature, it denies the users opportunity of

reviewing intermediate products as well as chance to evaluate the accuracy of a particular product in relation to requirements.

To overcome these shortcomings, the development was done using SDLC, which was infused with minor prototyping to allow users to review system as it was being developed.

### **3.9 Ethical Considerations**

As noted by Kizza (2007), ethics defines the standard of interaction between people, professionals, corporate or users. Thus, in carrying out the research, utmost care was taken to ensure privacy of participants. In line with this, consent of the potential respondents was sought prior to administering the questionnaires and no personal data was collected so as to protect the respondents. Furthermore, no respondent was forced to participate in the study, as it was a voluntary exercise. In addition, other people's intellectual property encountered during the course of the research have been respected by ensuring they are referenced and attributed. While handling the data collected during research, the researcher ensured data was securely stored to guarantee that privacy and confidentiality were maintained and protected and used for the intended purpose only.



## Chapter 4: Data Analysis and System Design

### 4.1 Data Analysis and Findings

#### 4.1.1 Introduction

Part of the major components of this study was establishing the current industry status regarding IP filing and payment systems. To achieve the research objectives, a survey was administered in order to collect primary data from selected IP stakeholders. The findings of this section are based on the data that was collected from the respondents who filled research questionnaires. The administered questionnaires had several questions ranging from demographics, characteristics and challenges of the existing payment systems, as well as factors that determined their preference for certain technologies. Data was collected from a sample population of 100 comprising of various stakeholders in the IP sector, including IP office staff, IP rights holders and IP agents. The results of the survey were analysed in order to determine the existence of the research gap and the willingness of the stakeholders to embrace the proposed solution so as to develop the QR based payment system.

#### 4.1.2 Survey Information

##### 4.1.2.1 Response Rate

A total of 67 responses were obtained out of the total 100 initially targeted, representing a 67% response rate as shown in Figure 4.1. As a result, only the responses from the 67 questionnaires that were filled and returned were used in analysing the data.

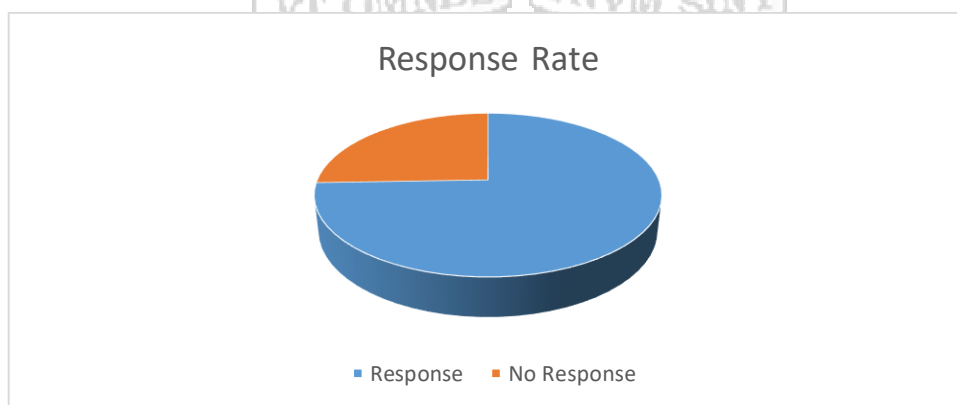


Figure 4.1: Response rate

#### 4.1.2.2 Respondents' Ownership of Smart Phones

As shown in Figure 4.2, 86.5% of the respondents said they owned smartphones, whereas 13.5% owned basic phones. The level of ownership of smartphones would go a long way in determining the readiness of respondents to use the proposed solution.

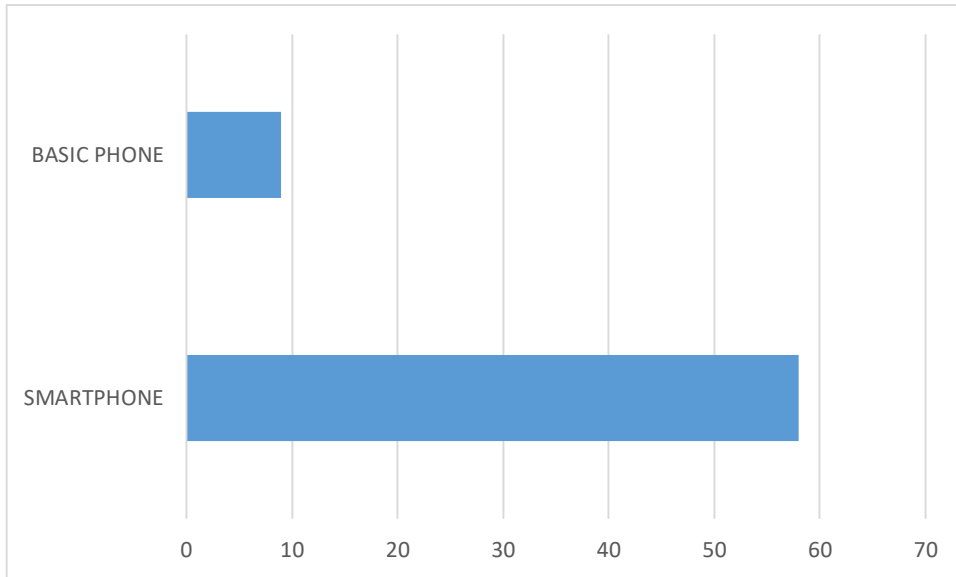


Figure 4.2: Respondents' ownership of smart phones

#### 4.1.2.3 Use of Mobile Payments Systems to Settle IP Fees Payments

As shown in Figure 4.3, 88% of the respondents revealed that they had used mobile payment systems to settle fees at IP offices, whereas 12% indicated they had not. This shows a majority of the respondents have previously used mobile payment systems to make payments, hence proof that many would embrace the proposed solution if it meets their requirements.

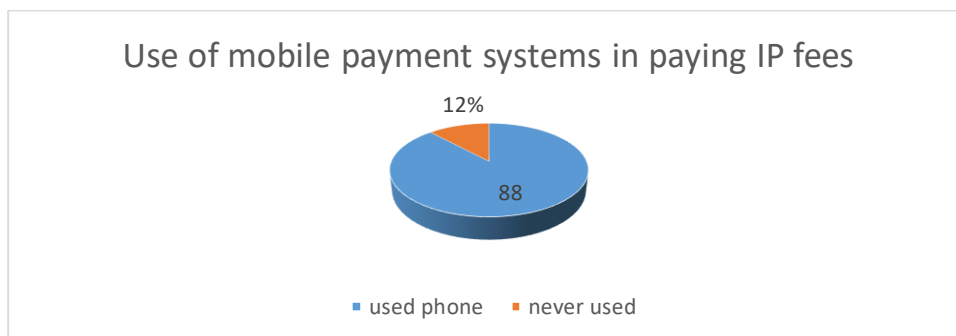


Figure 4.3: Use of mobile payment systems in paying IP fees

#### 4.1.2.4 Challenges in Filing for and Making Payments for IP Rights

On whether the respondents had experienced any challenges when filing for IP rights and making payments for Intellectual property fees, an overwhelming majority of 96% answered yes, while a paltry 4% said they hadn't experienced challenges, as shown in Figure 4.4.

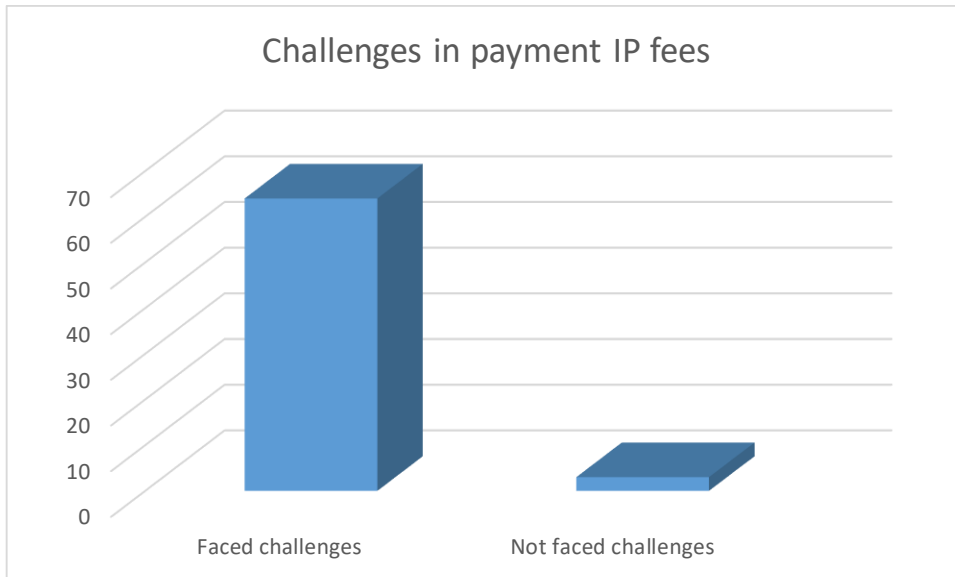


Figure 4.4 Challenges in paying IP fees

Data collected from the questionnaires showed that most of the respondents gave their main challenges as loss of IP data during transmission and handling, payment for one IP application being wrongly credited to another application, the system not being secure and prone to hacking as well as inability of the system to leverage smartphone technology and the internet.

#### 4.1.2.5 Important Factors in Selecting Mobile Systems

Respondents were asked to rate factors they considered to be of great importance when selecting a mobile payment system to use. Security of the payment system and ease of use were considered to be the most important. Whereas respondents from the IP office also considered cost of installation/use as a major consideration in determining what system to implement in their office, as shown in Figure 4.5.

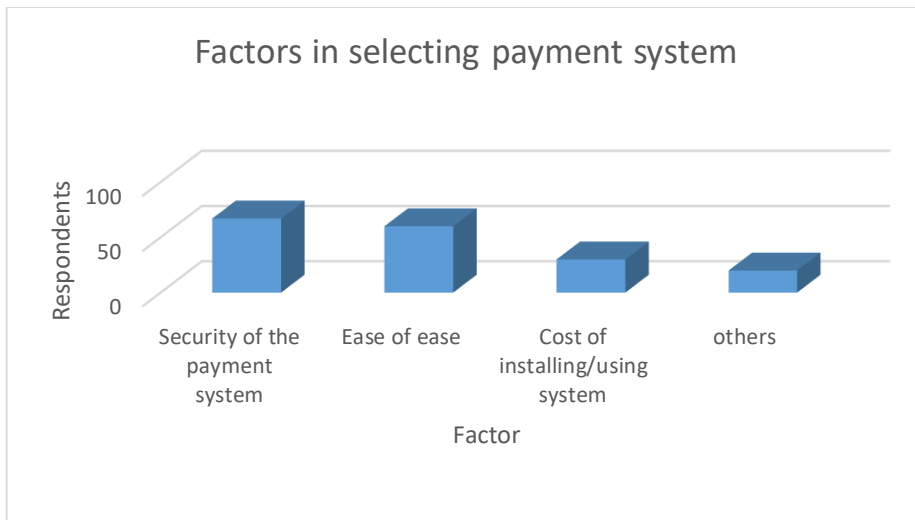


Figure 4.5: Important factors in selecting a mobile payment system

Respondents also indicated that they would consider other factors such as system robustness, popularity in the market, as well as the cost of transaction, as some of the additional factors they consider in determining what system to use.

#### 4.1.2.6 Familiarity with Mobile Proximity/Contactless Technologies

A large portion of the surveyed respondents pointed out that they were familiar with proximity/contactless technologies. NFC, EMV and RFID were the most popular methods, as shown in Figure 4.6.

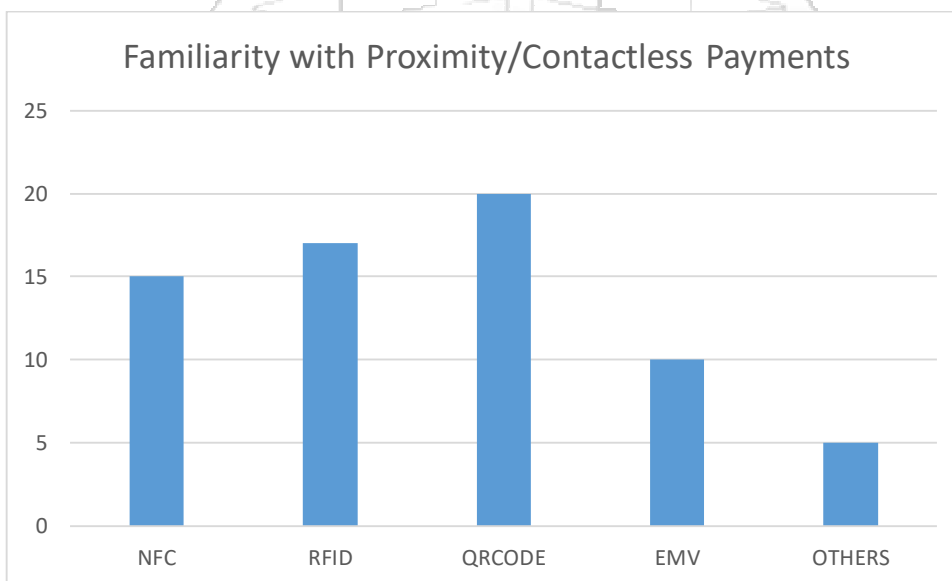


Figure 4.6: Familiarity with mobile proximity/contactless payment technologies

#### 4.1.2.7 Use of Proximity/Contactless Technologies in Solving Challenges

A majority of the respondents strongly agreed that these technologies would solve the challenges experienced when making payments as shown in Figure 4.7.

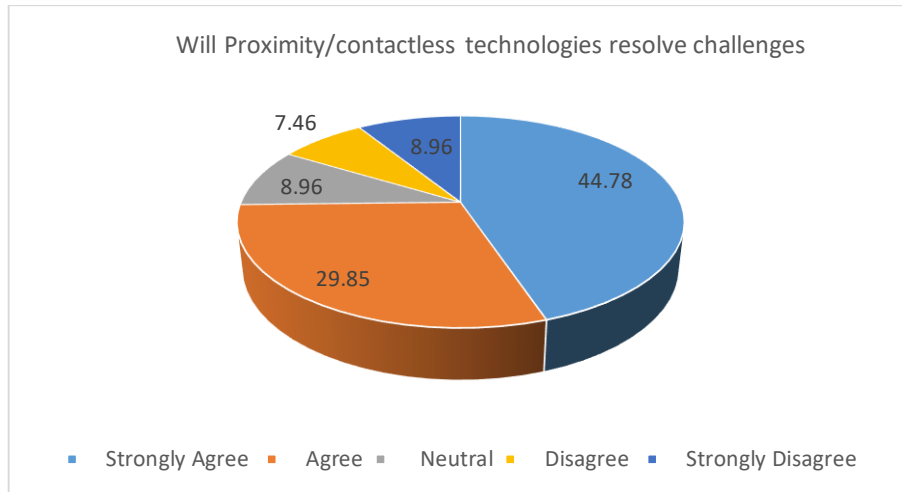


Figure 4.7: Use of proximity/contactless payment technologies in solving challenges

As shown in Figure 4.7, it is evident that a majority of the respondents surveyed appear to believe that indeed using these technologies in filing of and payment would eliminate the challenges they face when making payments. 44.78 percent of the respondents strongly agreed while 29.85% also agreed. 8.96% and 7.46% respectively, strongly disagreed and agreed. A further 6.96% of the respondents selected neutral when asked if the technologies would address the challenges –a response that could be interpreted they were not sure.

#### 4.1.2.8 Technology Preference in Making Mobile Payments for IP Fees

As can be seen from figure 4.8, regarding the choice of technologies, a majority felt that QR code would be their most preferred in making mobile payments for IP fees. 55.22 percent of the respondents selected QR code as their most preferred technology, 13.43 percent chose NFC while 16.42% preferred EMV. 11.94 percent of the respondents preferred RFID while 2.99 % preferred other technologies.

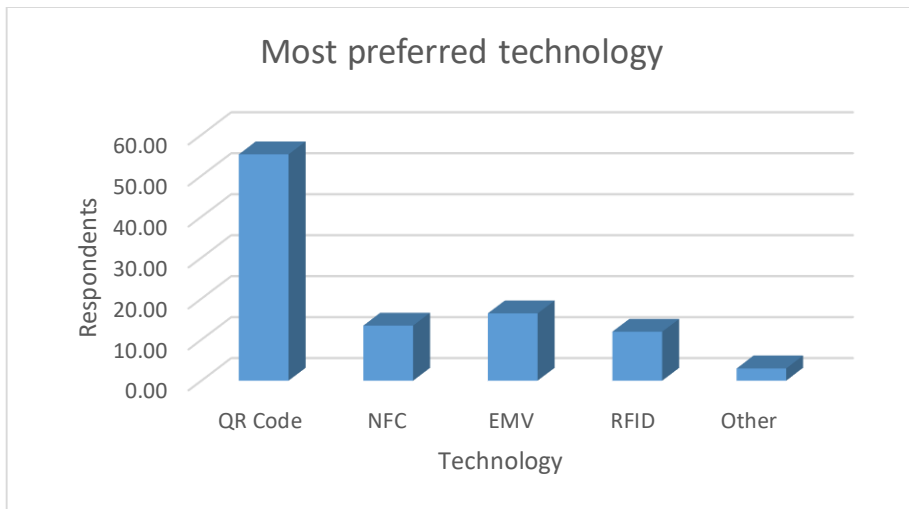


Figure 4.8: Preferred technology in making mobile payments for IP fees

Among the reasons cited for this preference was that QR code is more secure, was unique in operation and can store more data in a small area. Furthermore, IP office respondents felt that it was cheaper compared to other technologies, as no additional equipment would be required.

#### 4.1.3 Interpretation of Results

From the results presented, it is apparent that despite the existence of IP filing and payment systems, users of these systems faced challenges in ensuring that their IP data remained secure as it is transmitted to the IP office. In addition, most of the respondents had in one way or another experienced difficulties while settling IP rights fees to the IP office. As such, the systems presented gaps that required to be addressed to fully meet user requirements.

It is against this backdrop that a mobile solution would offer a perfect environment to suitably provide an electronic means of filing for IP rights as well as cashless means to electronically settle payment of the IP fees with the IP office. The solution is projected to provide many benefits, as it would firstly, help applicants of IP rights to submit their applications online in a secure manner and avoid the risk of data being stolen before their innovations/inventions have been patented; Secondly, it would also help the applicants make payments for their IP rights quickly and securely. Lastly, the IP office would be able to track revenue collection and reduce the overheads incurred while handling hard currency.

#### **4.1.4 Summary of Data Analysis and Findings**

From the foregoing, the survey findings reveal that there was a felt need for a mobile solution that would help the IP rights applicants in making applications for their IP rights as well as making settlement of IP fees, in addition to helping the IP office to streamline their payment operations. This would substantially help reduce the procedural bureaucracies involved and avoid loss of money. The results give a discernible picture that a majority of the respondents would welcome the development of the proposed mobile application. Furthermore, upon analysing the collected data, we are presented with a solid basis that would be critical in determination of important design requirements in that:

- i. A majority of the surveyed stakeholders owned internet-enabled smart phones. These smart phones would offer support for visual information such as charts, electronic invoices, vouchers and scanning that are key elements of QR codes. These enhanced capabilities would fit in well in dissemination of purchased electronic vouchers, presentation of graphical reports, and collection of fees by scanning the electronic invoices by means of a phone camera.
- ii. Most of the respondents had previous knowledge and interaction with mobile application systems, hence were conversant with proximity/contactless platforms and would therefore embrace a QR-based solution due to its added benefits.

From the survey findings, suffice it to say that a majority supported the need to carry on with the development of the mobile application. In light of these findings, it was clear that there was a need for mobile solution that would allow applicants for IP rights to apply and make payments for the same using QR-based mobile solution.

#### **4.2 Requirements Analysis**

System design entails schematic representation of the proposed architectures and models for the system as well as graphical representation of the various system aspects. It is in this light that the current state of art in regards to filing of applications and payment of IP fees was critically looked at. Data collected from the survey was incorporated in a bid to determine the requirements needed to design the new system. The mobile solution is expected to enable IP rights holders to easily and securely file applications and make payments via a smartphone; provide a platform for the IP office staff to validate and collect the fees paid by scanning an electronic vouchers and ticket presented on the user's mobile phone; and hence enable management of the IP office to view the revenue collection breakdowns as required.

This section offers a description of the system requirements—(both functional and non-functional), based on user needs. The functional and the non-functional requirements for the system are as shown in the following sections.

#### 4.2.1 Functional Requirements

These set of requirements help define the critical capabilities and functions that an implemented system or its set of components ought to perform successfully. Thus, they consist of the mandatory functionalities that a system must satisfy in terms of input, behaviour and outputs, in line with the research’s objectives. The system’s functional requirements are shown in Table 4.1.

Table 4.1: Functional requirements of the system

ID	Requirement
FR-1	User able to load app on their mobile device and access IP application page;
FR-2	Allow user to securely file IP applications on their mobile phone;
FR-3	Allow IP rights owners to make payments for their IP rights;
FR-4	Store the transaction details in a database.
FR-5	Allow authorised users to view IP application and payment details;

#### 4.2.2 Non-Functional Requirements

These requirements specify the criteria used for evaluating system operation, as opposed to functional requirements, that are concerned with specific system behaviour or function. The systems Non-functional requirements of the system (NFR) are as shown in Table 4.2.

Table 4.2: Non-functional requirements of the system

ID	Requirement
NFR-1	The system should be reliable when being used by users;
NFR-2	The system should be user friendly to allow users with basic skills to be able to use it;
NFR-3	The system should be customizable i.e. should easily be modified to suit the users changing needs;
NFR-4	The system should be scalable to cope with changing requirements.

### 4.3 Process Modelling

Feiler and Humphrey (1993) posit that software process modelling provides an abstract representation of the architecture, design or definition of the software process. This therefore provides description of the organisation of the elements of a finished, ongoing or proposed process at different detail levels. This section shows the logical modelling of the mobile application solution.

#### 4.3.1 Use Case Modelling

Use cases aid in describing the proposed functionality of a new system, as they represent discrete units of interaction between users and the system. Figure 4.9 shows the interaction between users and the various processes in the system, with the main actors being IP office staff, management and IP applicants.

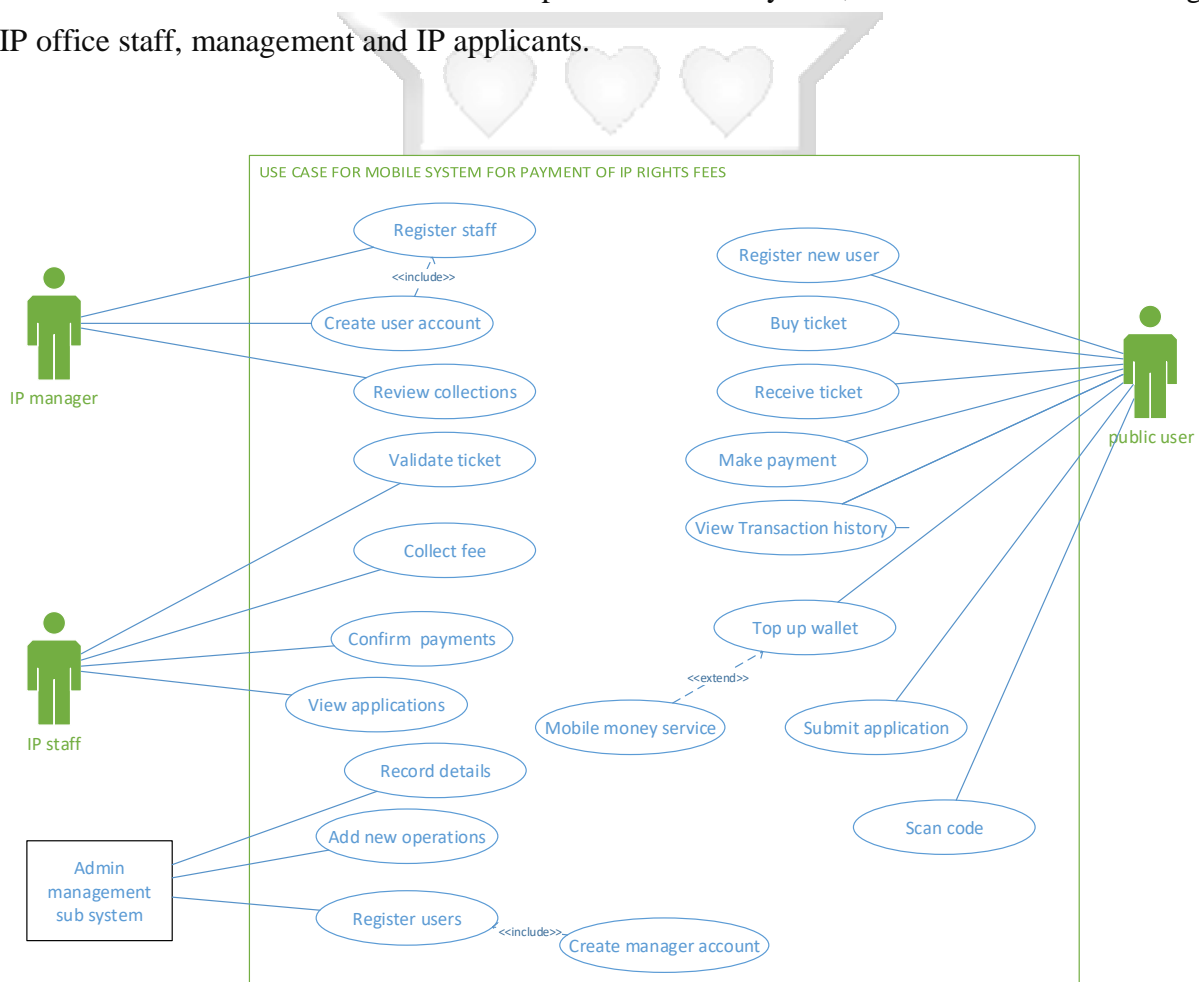


Figure 4.9: Use case diagram for the mobile application for payment of IP rights fees

To better understand the use case model, each of the main use cases were described in detail. Table 4.3 shows the use case description for the process of filing an IP invention. The rest of the use case descriptions are presented in Appendix C.

Table 4.3: The File IP Application Use Case Description

Use case ID	UC1
Title	File IP Application
Description	User access 'File Request' menu from the main mobile app screen
Actor(s)	IP Applicant
Pre-conditions	User must have launched the mobile app and accessed the main mobile app screen
Post-conditions	IP data entered and submitted to database
Main success scenario	<ol style="list-style-type: none"> <li>1. User selects the 'File Request';</li> <li>2. User then keys in all the bibliographic IP data regarding their invention as well all user details</li> <li>3. User then clicks on the "Submit" button;</li> <li>4. IP data is captured and stored in database.</li> </ol>
Alternative flow of events	System declines data entered and returns error message

#### 4.3.2 Sequence Diagrams

Sequence diagrams are used in system design to show graphical representation of object interactions over a period of time, focusing on identification of behaviour within the system (Larman, 2006). They show object interaction arranged in time sequence, depicting the actors and objects during use case execution. The following diagrams show sequence diagrams for some of the main system processes and actors. Figure 4.10 and 4.11 respectively show the sequence diagrams for the process of filing and application and encoding data into QR respectively. Figure 4.12 is a sequence diagram depicting the process of payment of IP rights fees

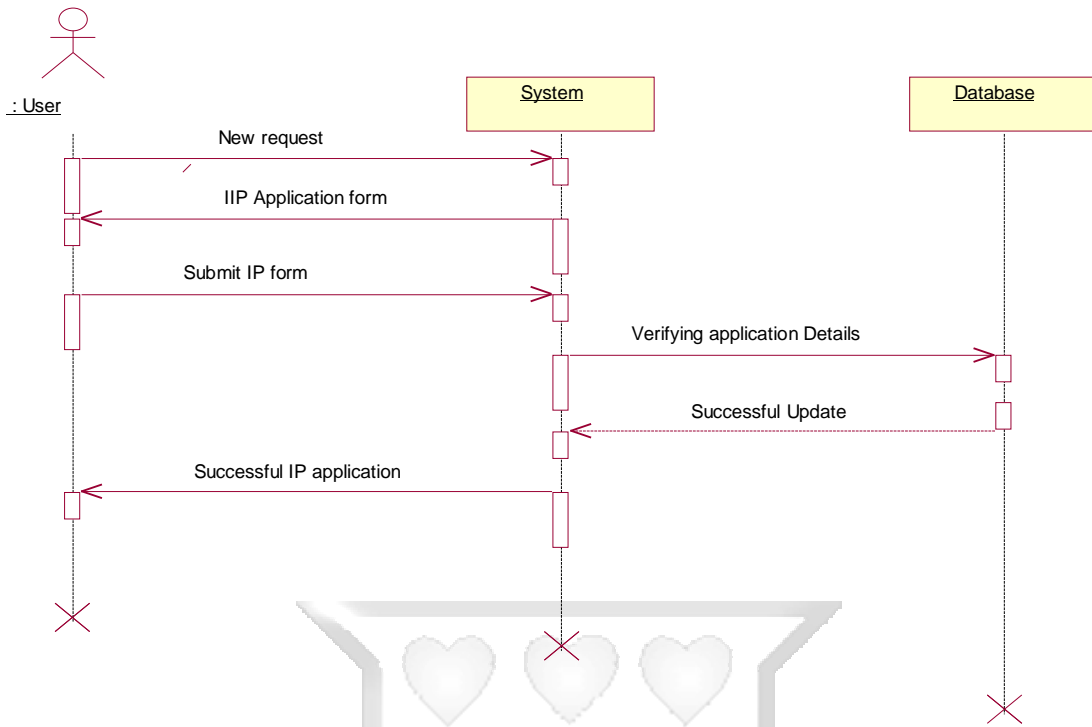


Figure 4.10: IP Application filing Sequence Diagram

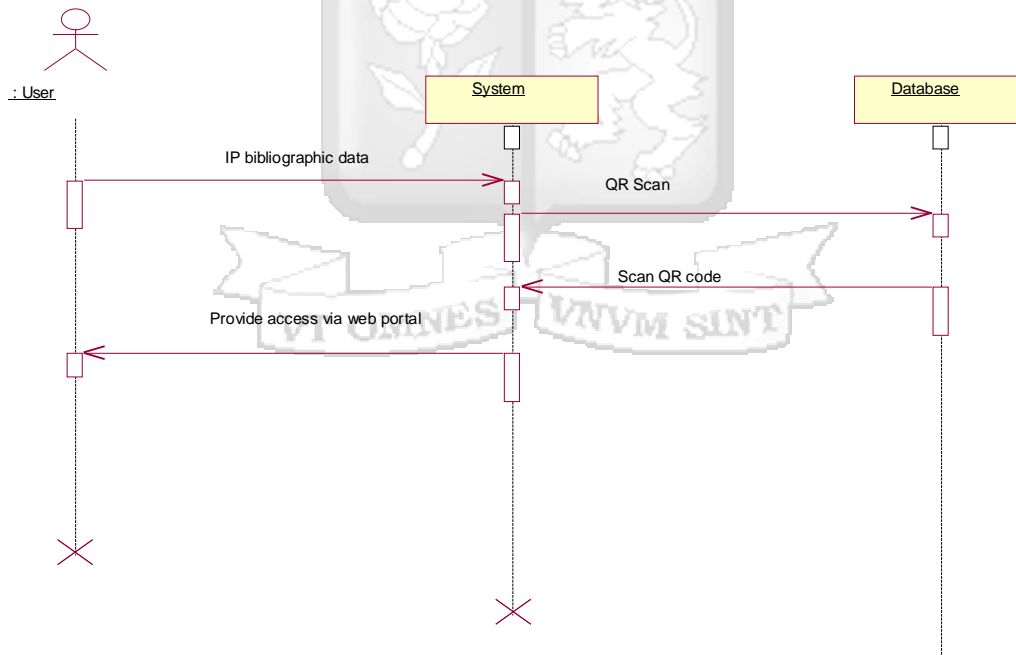


Figure 4.11: IP data QR coding Sequence Diagram

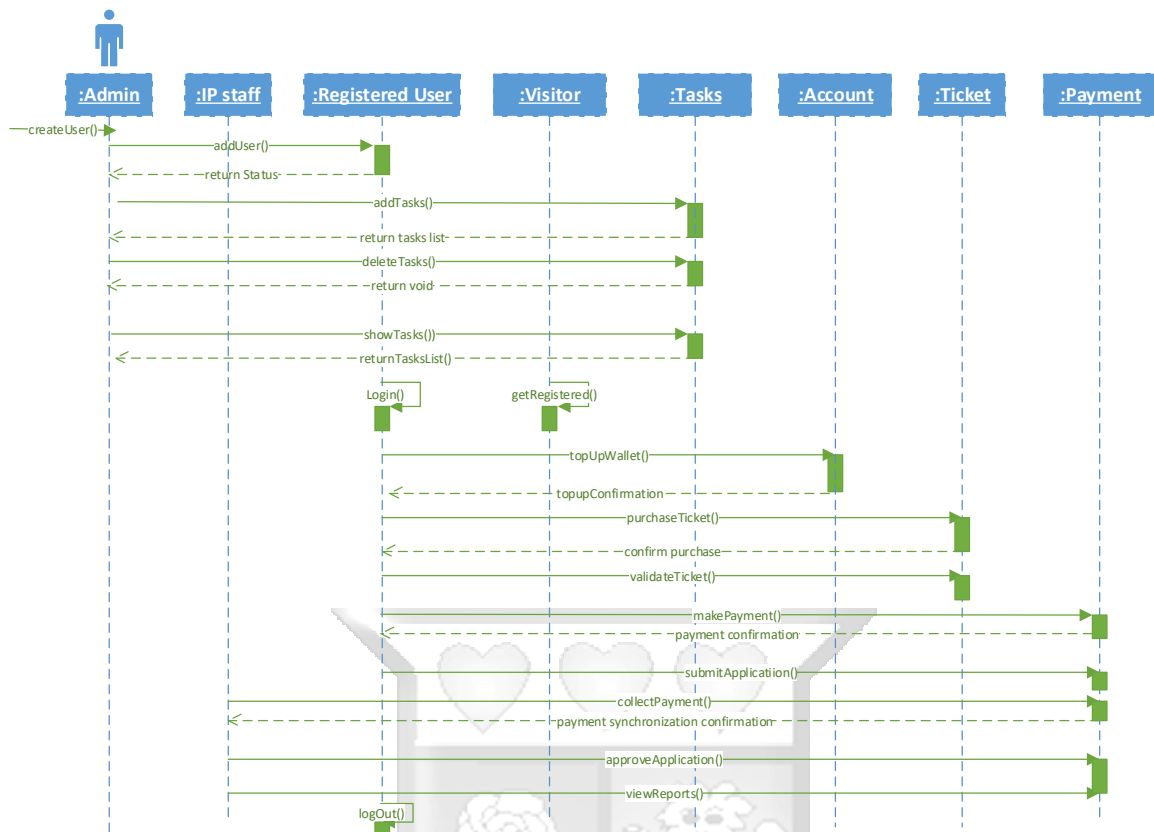


Figure 4.12: Main Sequence Diagram for payment of IP rights fees

### 4.3.3 Data Flow Diagrams

As Burge (2011) notes, data flow diagrams (DFD) are used to show the flow of data as it moves throughout the system, in terms of inputs and outputs and the data stores. DFDs for the system are presented in the following sections.

#### 4.3.3.1 Context Diagram

The system requires that, as a general rule, a user should be registered in order to access and utilize the system functionalities. As such, user profiles must be validated before they are allowed to use the system. Once validated, the system should allow IP applicant to file IP application and make payments appropriately. The IP office staff should be able to receive the payments and view record as illustrated in Figure 4.13.

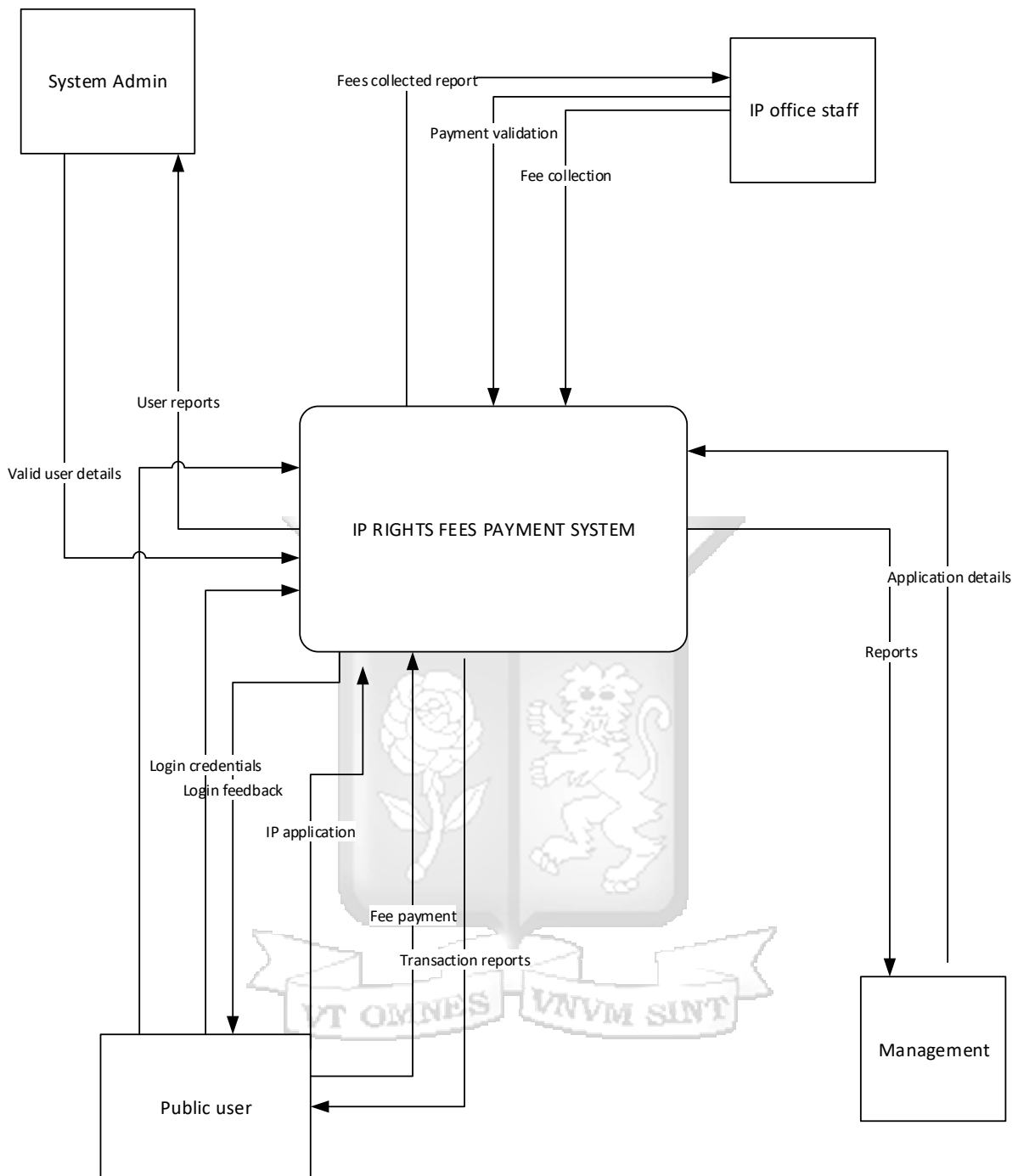


Figure 4.13: Context diagram for QR-based mobile application for payment of IP fees

#### 4.3.3.2 Level 0 Data Flow Diagram

Figure 4.14 shows level 0 DFD, depicting the major processes involved in the mobile application. These processes include user registration, log in, submission of IP application, making payments, collection of fees, and viewing of reports via QR code.

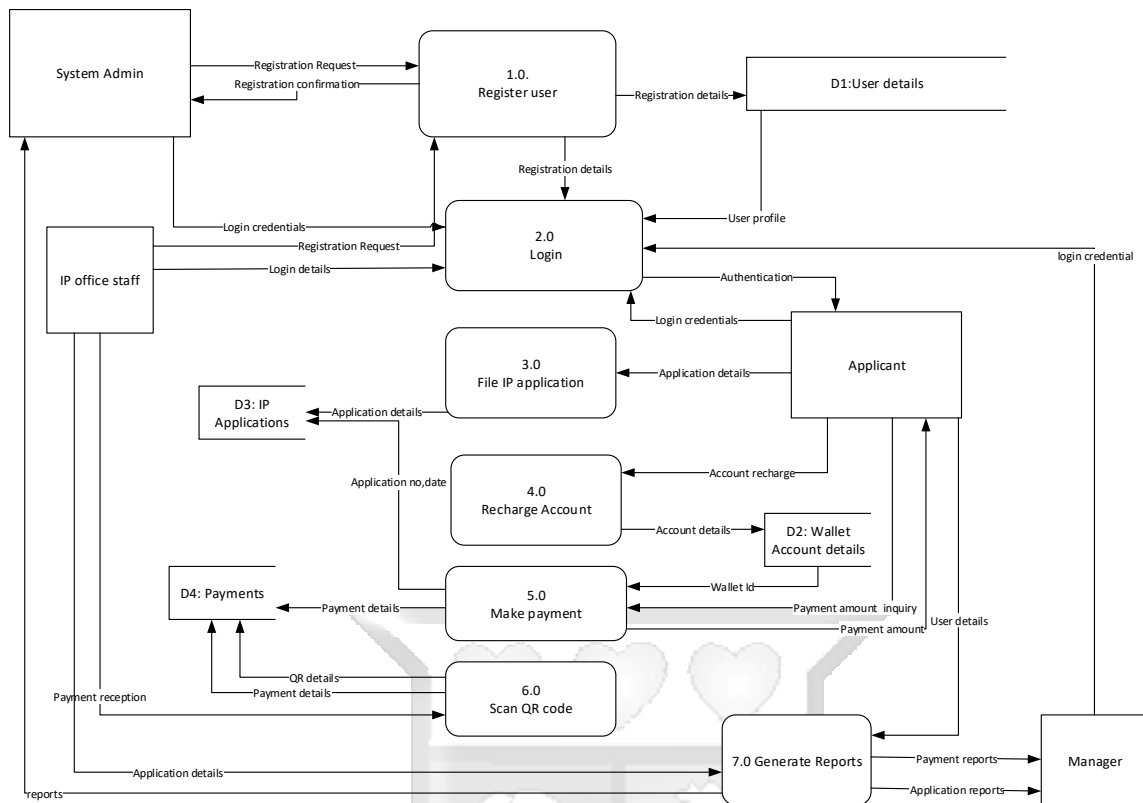


Figure 4.14: Level 0 DFD for QR-based mobile application for payment of IP fees

### 4.3.3.3 Level 1 Data Flow Diagrams

Figures 4.15 and 4.16 respectively, show level 1 DFDs for two of the main processes in the system.

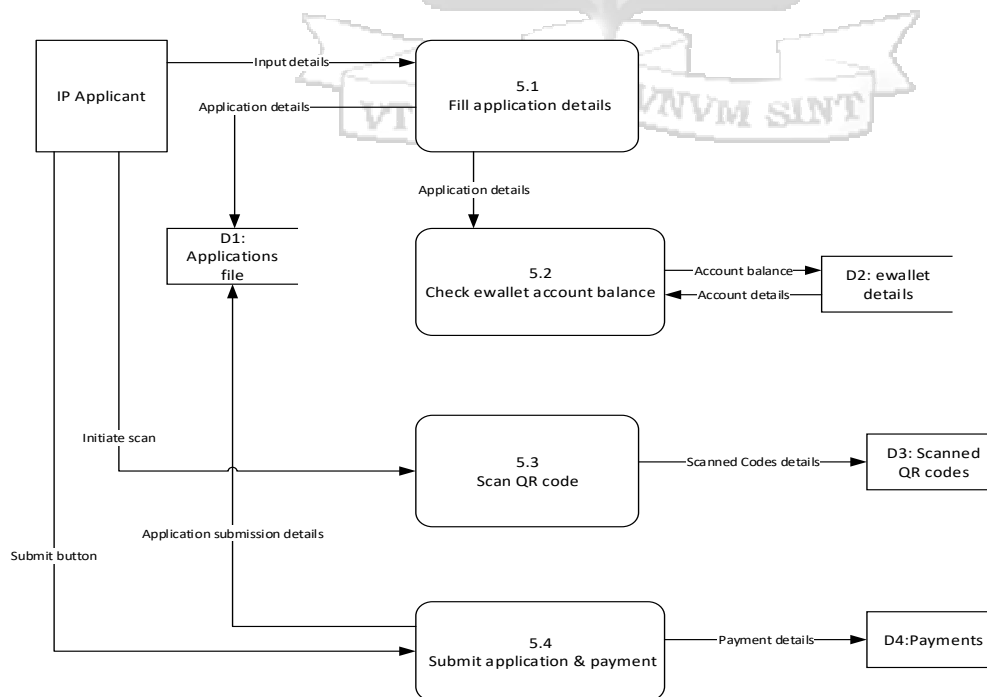


Figure 4.15: Level 1 DFD for Make Payment process

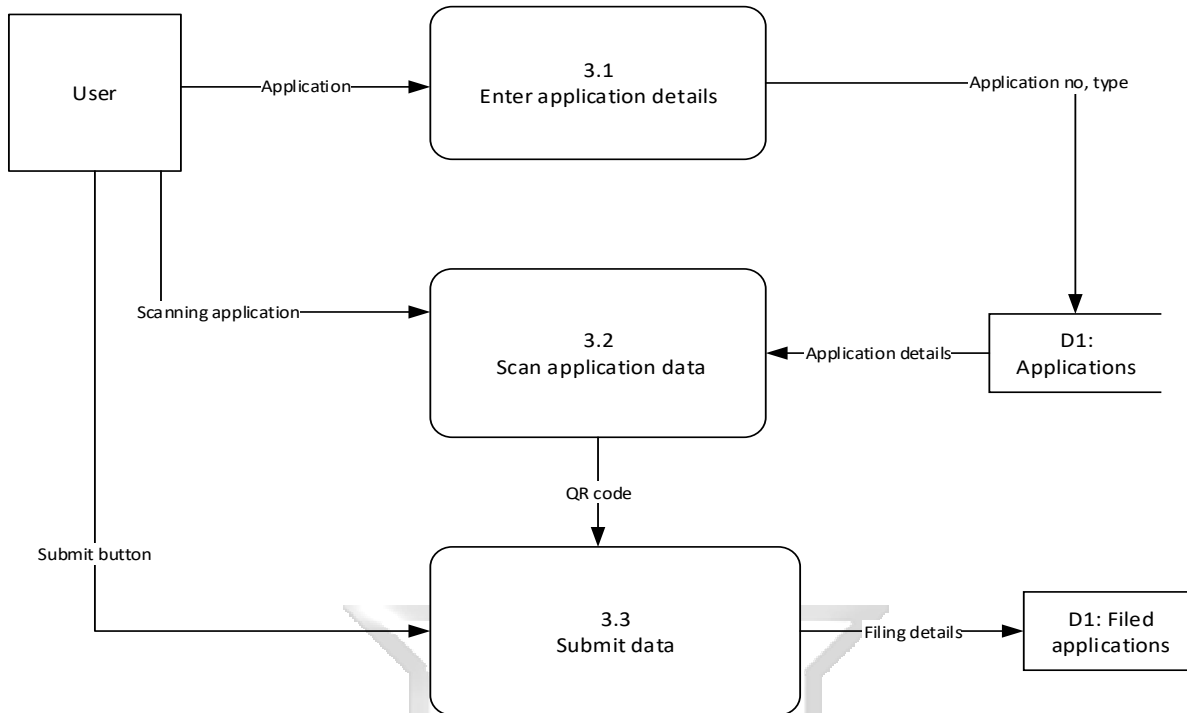


Figure 4.16: Level 1 DFD for File application process

## 4.4 Control Modelling

### 4.4.1 Conceptual Model and Entity Relationship Diagram

As Larman (2006) observes, conceptual modelling helps in illustrating the main concepts in a given problem domain, as they provide a bearing on the direction of the final system. Use of such models and Entity Relationship Diagram (ERDs) help show domain objects or conceptual classes and associations. Figure 4.17 shows the ERD comprising of various entities and their attendant attributes and relationships.

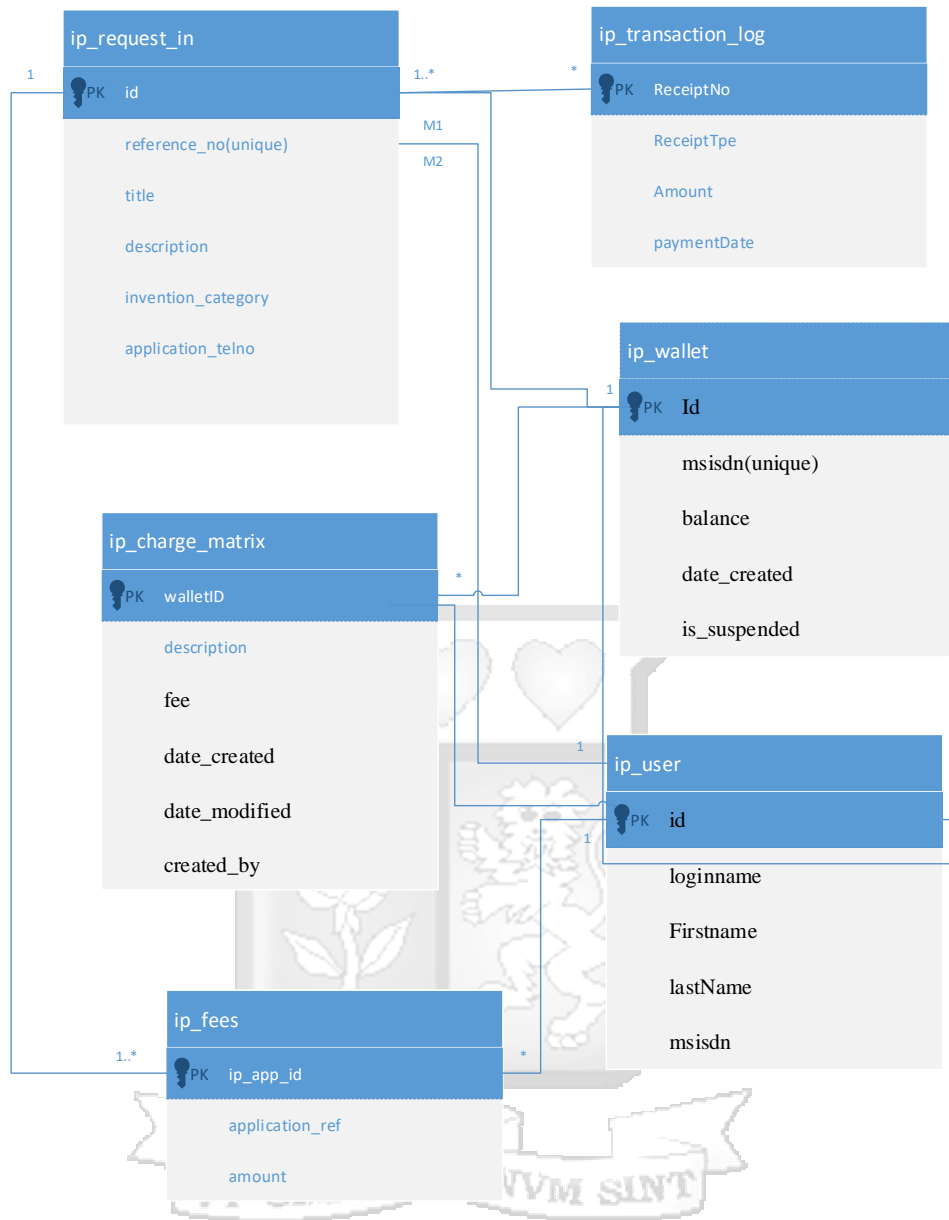


Figure 4.17: ERD for proposed system

#### 4.4.2 Database Schema

In implementing the system, a database was built for storing of user accounts as well as all transaction details. This was done using MySQL –an open source relational database management system. As can be seen from Figure 4.18, the main entities for the mobile application are the ip\_charge\_matrix table which handles data related to amount of fees charged and paid by applicants, the ip\_request\_in table that holds data regarding the application being filed as well as applicant’s bibliographic data. On the other hand, ip\_transaction\_log stores data regarding transactions taking place, while the ip\_wallet stores data on account balances, account status etc. Each entity comprises of several attributes as shown

### ip\_charge\_matrix

Field	Type	Null	Key	Default	Extra
id	int(5)	6 b...	NO	PRI (NULL)	0 Kb... auto_increment
description	char(50)	8 b...	NO	(NULL)	0 Kb...
fee	double(15,2)	12 b...	YES	0.00	4 b...
date_created	datetime	8 b...	YES	(NULL)	0 Kb...
date_modified	timestamp	9 b...	NO	CURRENT_TIMESTAMP	17 b...
created_by	char(100)	9 b...	YES	(NULL)	0 Kb...

### ip\_request\_in

Field	Type	Null	Key	Default	Extra
_id	int(5)	6 b...	NO	PRI (NULL)	0 Kb... auto_increment
reference_no	char(50)	8 b...	NO	UNI (NULL)	0 Kb...
title	varchar(1000)	13 b...	NO	MUL (NULL)	0 Kb...
description	varchar(5000)	13 b...	NO	(NULL)	0 Kb...
invention_category	char(100)	9 b...	NO	(NULL)	0 Kb...
specific_field	char(100)	9 b...	YES	(NULL)	0 Kb...
f_name	char(50)	8 b...	NO	(NULL)	0 Kb...
l_name	char(50)	8 b...	NO	(NULL)	0 Kb...
applicant_telno	char(20)	8 b...	YES	MUL (NULL)	0 Kb...
applicant_address	char(25)	8 b...	YES	(NULL)	0 Kb...
applicant_email	char(25)	8 b...	YES	(NULL)	0 Kb...
qr_data	text	4 b...	NO	(NULL)	0 Kb...
date_created	datetime	8 b...	YES	(NULL)	0 Kb...
is_paid	int(1)	6 b...	YES	MUL 0	1 b...
is_deleted	int(1)	6 b...	YES	MUL 0	1 b...

### ip\_transaction\_log

Field	Type	Null	Key	Default	Extra
_id	int(5)	6 b...	NO	PRI (NULL)	0 Kb... auto_increment
application_ref_no	char(50)	8 b...	NO	UNI (NULL)	0 Kb...
cr	double(15,2)	12 b...	YES	0.00	4 b...
dr	double(15,2)	12 b...	YES	0.00	4 b...
running_bal	double(15,2)	12 b...	YES	0.00	4 b...
msisdn	char(15)	8 b...	YES	(NULL)	0 Kb...
transaction_date	timestamp	9 b...	YES	CURRENT_TIMESTAMP	17 b...

### ip\_wallet

Field	Type	Null	Key	Default	Extra
_id	int(5)	6 b...	NO	PRI (NULL)	0 Kb... auto_increment
msisdn	char(50)	8 b...	NO	UNI (NULL)	0 Kb...
balance	double(15,2)	12 b...	YES	0.00	4 b...
date_created	timestamp	9 b...	YES	CURRENT_TIMESTAMP	17 b...
is_suspended	int(1)	6 b...	YES	0	1 b...
is_deleted	int(1)	6 b...	YES	0	1 b...

Figure 4.18: Mobile IP system Database Schema

## 4.5 Proposed System Architecture

The architectural design provides a high level view of the proposed system, giving a snapshot of the major system components with the services they provide and the mode of interaction among the system components. Below is a description of the proposed system architecture:

### 4.5.1 High Level System Architecture

As such, architecture for the mobile solution has been designed to accommodate the different and varying stakeholders including the IP office accounts staff, management and the

public who will use the system to make payments. Figure 4.19 depicts the high level architecture for the system, comprising of the user interface which is in the form of mobile client for users and web browser for the system administrator, the internet running on TCP/IP protocol, the application server and database server.

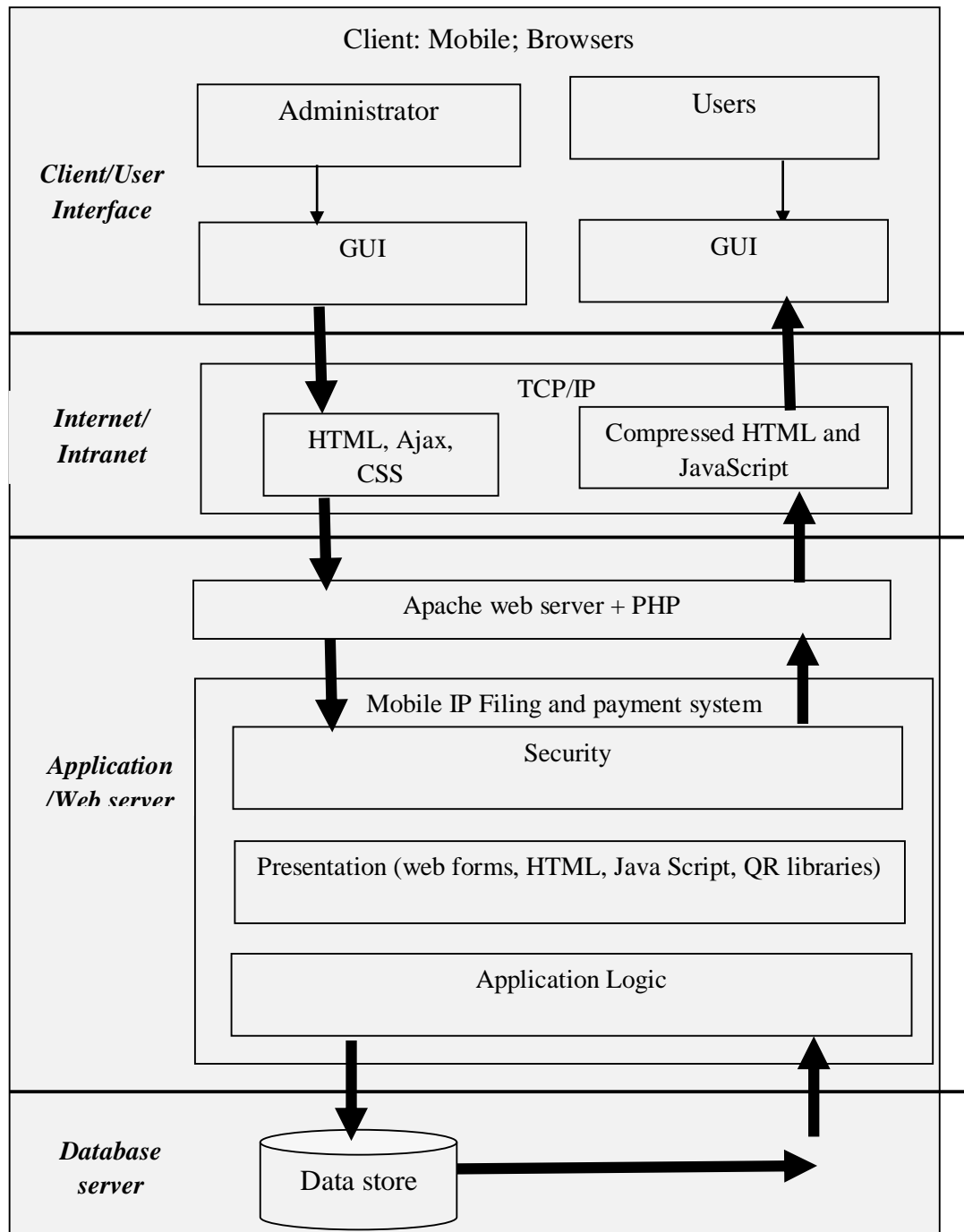


Figure 4.19: High level Architecture for the system

As shown in Figure 4.19, the high level architecture shows four layers of system interaction as explained in the following section:

- **Client/user interface**- this shows the component of the system where the users will be able to interact with the system. Interaction will be by means of mobile application interface (for users) or by means of web browser for the system administrator.
- **Internet/Intranet** – this will be the mechanism by which the mobile device connects to the database and application servers. Users will require internet-enabled devices to be able to use the system. Users at the IP office will have the option of accessing the system via intranet
- **Application server/web server layer** –shows how the application server and web server will be connected. This layer will provide security and application logic.
- **Database layer**- this is where the database will be installed and will be interacting with application server and web server to store and retrieve data as required.

#### 4.5.2 IP Filing and Payment System Architecture

The architecture follows a client-server approach, breaking up workload between the service providers (host server) on one hand, and requesters of the service (the client) on the other. Both the members of the public and IP office staff who will use the system will be required to utilize a mobile device installed with the mobile application which will communicate with the core system via the telecommunication network. Similarly, the IP office management will access the resources on the same server either by means of a browser on a mobile device or a personal computer. Figure 4.20 shows the architecture for the system.

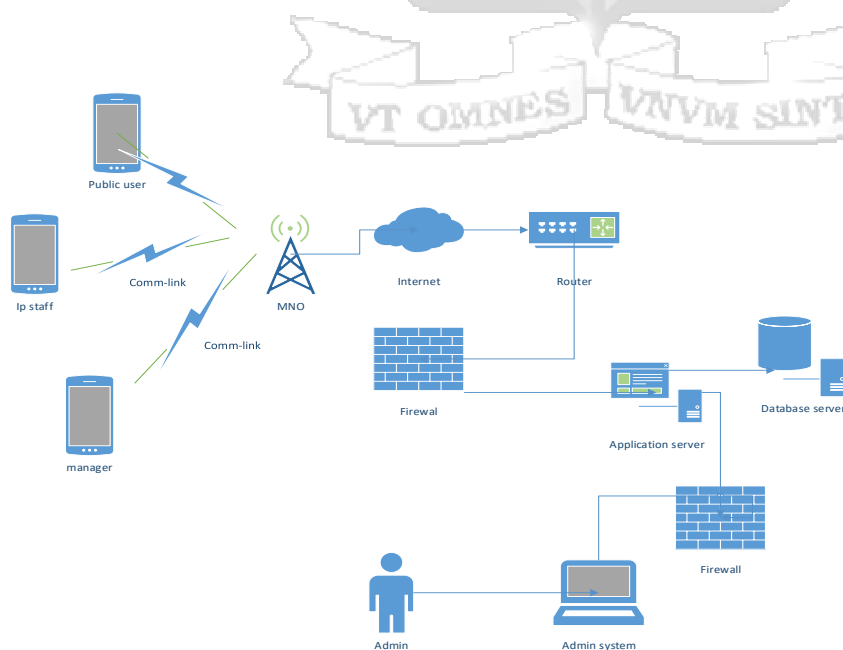


Figure 4.20: System architecture

The proposed solution is a mobile application and hence intended for use from any location. Thus, communication between the system users and the application server will be by means of the internet. The application server will handle processing and storage of information into the database server, as well as retrieval of information from the database server. Communication routing between the mobile phone and the application server will be handled by Mobile Network Operators (MNOs) through use of data services such as 3G and 4G, whereas HTTP protocol will be used for communication. The architectural components of the system are as discussed in the following sections:

#### **4.5.2.1 Web Application**

The system design provides for a simple web page to present the submitted information which has been encoded in QR format. In addition, they will be able to set agreed collection targets and view summarized fees collections reports.

#### **4.5.2.2 Mobile Application**

Applicants of IP rights will use this application to enter and submit bibliographic data of their inventions and submit it securely by QR Code. After which they will be required to access the simple web page and scan the QR code to make payments for their applications.

#### **4.5.2.3 Application Server**

This server uses HTTP protocol to provide the necessary services and resources to client applications. Qpay system then takes scanned data and posts it to the server to make transactions. The web services will handle the communication between the client applications and the server. This system will run on Apache web server.

#### **4.5.2.4 Database Server**

This server hosts the system's database where all details and transactions are stored. Upon completion of the transactions, the server posts back to the application sever as confirmation code.

### **4.6 Mobile Application Wireframes**

System design incorporated mobile application wireframes to give a visual skeletal framework representation of the final application. This was informed by the fact that wireframes provide sketchy blueprints for the mobile application that acts as basic draft design

devoid of application details, colours or shapes ("How to design a mobile app? The importance of wireframes and mockups - Blog Ready4s.com", 2017). These tools are critical as they guided on how to arrange design elements on the mobile application to achieve the goal of this research. Figure 4.21 shows the wireframe for main application screen. The rest of the wireframe designs are available in Appendix D.

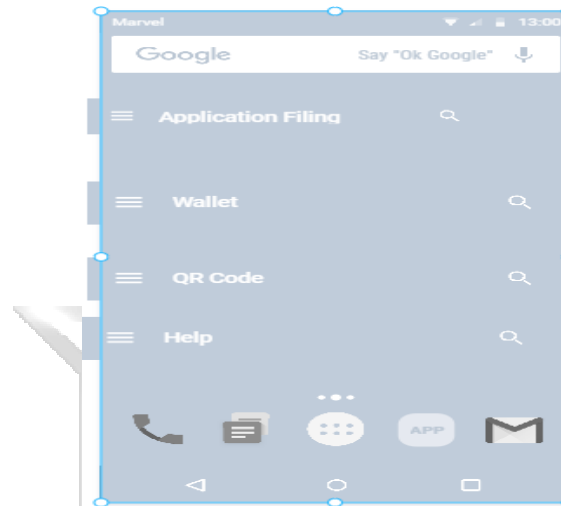


Figure 4.21: Mobile application main menu wireframe

## **Chapter 5: System Implementation and Testing**

### **5.1 Introduction**

Subsequent to the system and architecture design, the system was implemented, whereby coding and actual construction of the system components was carried out. The system also underwent different tests to ensure it met functionality as well as user requirements.

### **5.2 System Implementation Environment**

During system implementation, different programming technologies, mobile programming and web technologies were employed as outlined below.

#### **5.2.1 Mobile Application Prototype**

The mobile application part of the system was developed using Java for Android platform which was used to write the source code while utilizing Android classes. The system was then compiled and tested using the android Software Development Kit (SDK) Emulator and an Android device. Android was selected as the language of implementation due to the fact that it has a flexible SDK, Android Development Tools (ADT) is easily available, as well as its being a mature technology hence has a lot of support readily available from online developer forums. In addition, Blikoon QRcode scanner library that is implemented in Java for Android was incorporated in the mobile application for the purpose of decoding QR Codes, while PHP-QRcode library was used on the server side to aid in generation of QR Code images.

#### **5.2.2 Web Application**

The thin web based application part of the system was developed using Hypertext Preprocessor (PHP), HTML, CSS and jQuery. These languages were used to create the web page as well as to create the scripting of the server-side web service/web application. The website was hosted on an online Apache HTTP server. PHP was selected mainly due to the fact that it is an open source platform hence provides platform-independence. In addition, PHP supports all major webservers and databases due to its multiple layers of security that is key in preventing threats and malicious attacks.

#### **5.2.3 Database**

The database component of the mobile app was built using MySQL Database Management System (DBMS). The choice of MySQL was influenced by various factors, among them, its open source platform nature, compatibility with PHP and other platforms as

well as being relatively secure, due to its ability to encrypt passwords before storage hence restricting unauthorized access to the database.

### 5.3 System Functionality Summary

The developed application allows one to file IP application and submit payment securely by use of QR code. The application is able to generate a QR code, post the same to a remote server and allow one to make payment by scanning a QR code from a simple web page provided, hence presenting the submitted information which has been encoded in QR format. As a validation mechanism, the application will not process QR code not generated by the system, but will give error message. Each payment QR ticket generated is tied to a mobile number. Payment will only be initiated when there is enough wallet balance, as partial payment is not supported. The system also captures wallet balance and fee payable.

### 5.4 Major System User Interfaces

To demonstrate system functionality and how the system can be used to file for IP and make payments, requisite information was entered into the system and the resultant screens are as follows:

#### 5.4.1 Mobile App dashboard screen

Upon running the mobile app from an Android device, the user is presented with the main screen as shown in Figure 5.1. Here, the user is presented with options of the tasks that they can undertake using the application

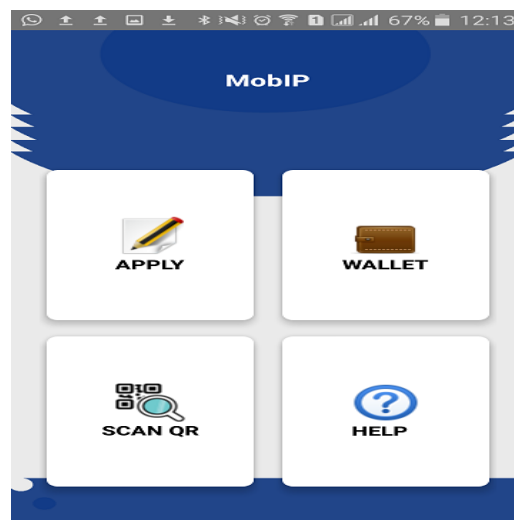
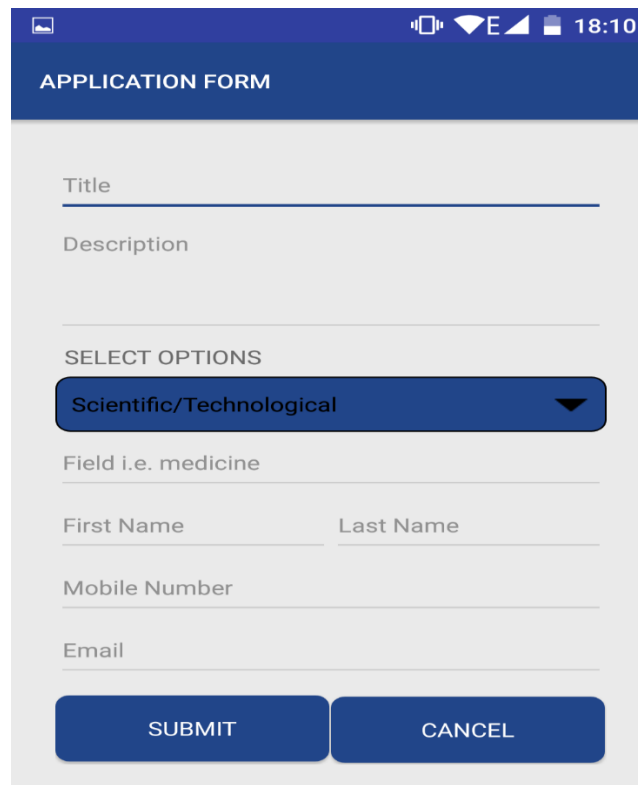


Figure 5.1: Main Mobile App Dashboard screen

### 5.4.2 IP Rights Application Form

To file IP rights and submit the same to the IP office, the user selects the Request IP screen from the main screen, upon which they are presented with the application form as shown in Figure 5.2 where they enter the details of the invention and submit to database.



The screenshot shows a mobile application interface titled "APPLICATION FORM". The form contains the following fields and options:

- Title
- Description
- SELECT OPTIONS: A dropdown menu with "Scientific/Technological" selected.
- Field i.e. medicine
- First Name and Last Name (split input fields)
- Mobile Number
- Email
- SUBMIT and CANCEL buttons at the bottom.

Figure 5.2: Mobile IP application screen

### 5.4.3 Scan QR Screen

As shown in Figure 5.3, once a user submission IP application via mobile device, they then access the web portal url whereupon they will access their filed application. Once they choose the Scan QR option, they are able to scan the QR code using the camera on their mobile phone.

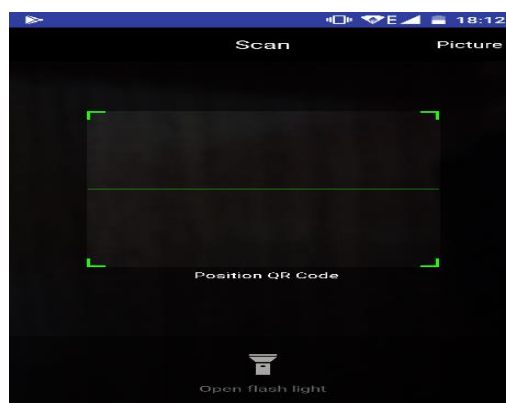


Figure 5.3: Scanning QR code

### 5.4.4 Mobile Wallet

The mobile wallet as shown in Figure 5.4 enables the user to load money in their wallets and use the same to settle payments. Users are also able to recharge their wallets.

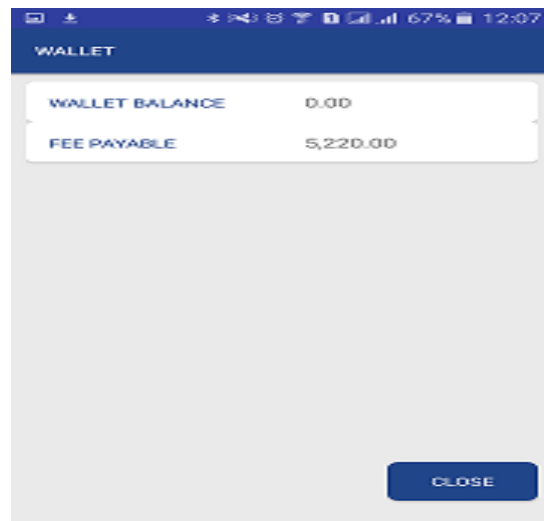


Figure 5.4: Mobile Wallet Screen

### 5.4.5 Web Portal

As shown in Figure 5.5, the web portal is a simple web page used to present the submitted information that has been encoded in QR format. Users are able to scan the QR code presented and then submit payments.

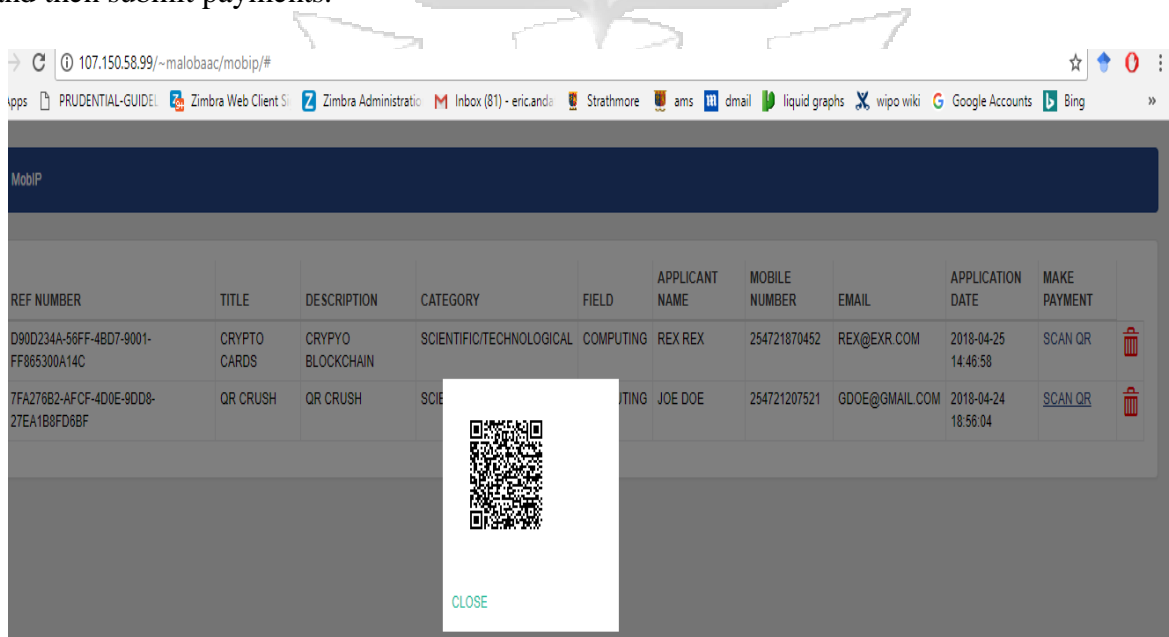


Figure 5.5: IP system Web Portal

## 5.5 System Testing

System testing was carried out to test the behaviour of the software solution based on the software requirements specifications. Thus, the mobile solution was subjected to various kinds of tests including functional test, compatibility test and usability tests. The tests were undertaken to determine its suitability to business and end-user requirements. Some of the tests included the following:

### 5.5.1 Functionality Test

This test was carried out to establish whether the developed solution fulfilled the system functionalities as per expectations and that user requirements are met. Each of the projected mobile application functions were put to test repetitively with the results being registered in the table. This test was instrumental in ensuring that the system was devoid of software bugs and hence confirm that key objectives of study were met. Table 5.3 shows test conditions and results for system testing:

Table 5.1: System Test Conditions and Test Results

S/No	Test	Expected Results	Achieved Results
1	Mobile app loading	The system to correctly launch on mobile Android device and display main screen;	The system correctly loaded on Android device and displayed main menu.
2	Accepting and storing IP application details	System able to store IP application details in a database.	The captured IP application details were successfully stored in a database.
3.	Submission of IP application in QR Code	The system should allow user to file IP rights securely by use of QR Code	The system securely transmits IP rights data by use of QR code
4.	Payment for IP rights using QR Code	The system should allow user to make payment for IP rights by scanning of QR Code	Users able to make payments using QR Code
5.	Display of data in web portal	The system should, using simple web page, present the submitted information which has been encoded in QR format.	Submitted information that was encoded in QR format was presented on web portal.

### 5.5.2 Compatibility Test

During this test, the application was tested against devices using Android platform and as well as different web browsers to confirm that it was compatible with them. Some of the Android platforms that were tested included Infinix, Samsung j5 and Techno BL-4E.

### 5.5.3 Usability Test

This testing was conducted by potential system users and their feedback analysed to determine whether it met the user needs and requirements. The users were provided with the system and asked to test. Thereafter, they were presented with a short questionnaire which required them to respond to questions regarding how they rated the system in terms of usability.

#### a) Mobile Application's Ease of Use?

When users were asked to rate on ease of use of the developed mobile solution, 70% of the respondents indicated that the solution was very easy to use, 20% said it was easy to use while a paltry 10% felt that the application was somewhat hard to use. The results are as shown in Figure 5.6. This therefore confirms that the solution is user-friendly.

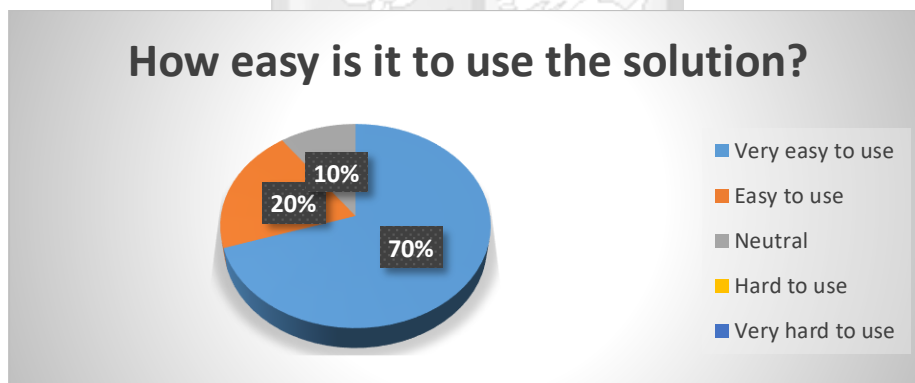


Figure 5.6: Ease of use of the Mobile Application

#### b) Solution's Fitness for Purpose

As shown in Figure 5.7, 90% of the respondents said they felt the solution was fit for purpose, while 10% felt it was not. This goes to show that the developed mobile application would meet the user requirements.

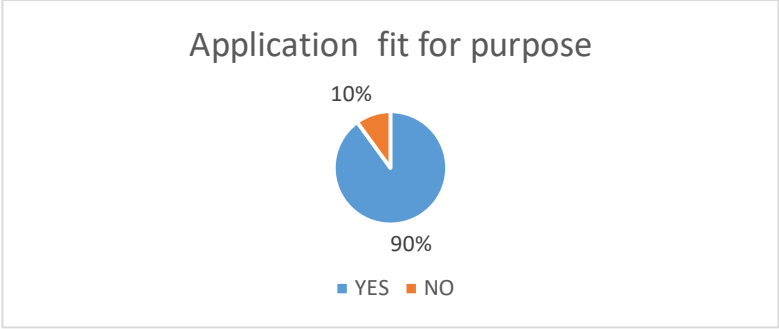


Figure 5.7: Solution's Fitness for Purpose

**c) Willingness to Recommend Application to Others?**

When asked whether they would recommend the mobile application to other people, 90% of the respondents said would recommend, whereas 10% felt they wouldn't, as shown in Figure 5.8. This willingness of a vast majority to recommend the application to others shows the confidence that the respondents have hence a proof that it is a value-adding solution and hence a contribution to the IP field.

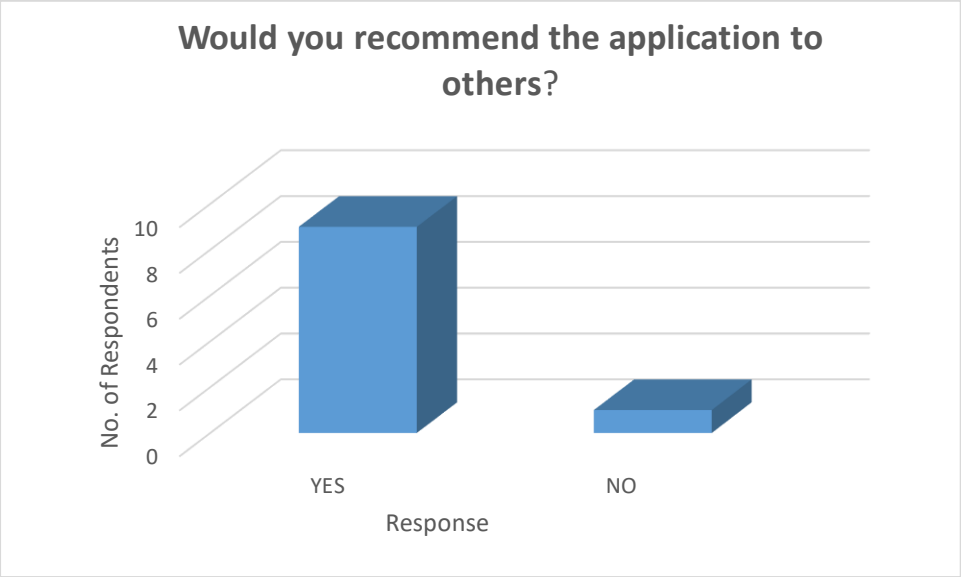


Figure 5.8: User willingness to recommend solution

## **Chapter 6: Discussion**

### **6.1 Introduction**

At the onset, the research set out to meet five research objectives. Following the implementation and testing of the system, this section discusses the summary of the findings of the research that sought to establish the possibility of integrating QR code into mobile system for filing of and payment for IP rights fees. This section outlines the achievements attained in relation to the objectives of the study.

### **6.2 Review of Research Objectives: Findings and Achievements**

The research's first objective was to identify the data requirements and characteristics of mobile payment systems. Through a research survey, a number of characteristics and types of data required for such applications were identified. Among the types of data identified included IP application type, payment data, IP right types, inventors, and IP agents. The identified data was handy as it informed the design and development of the system and the database of IP filing and payments. The research found out that potential users of the system required a system that was easy to use, was secure and easily accessible to them.

The second objective centred on determining the challenges that were faced when filing for and making payments for IP rights at the IP office. This objective was achieved by comparing methods that exist in industry with what literature describes as ideal systems for the IP office. It was established that various challenges exist while filing for and making payments for IP rights. Even though these challenges existed in various dimensions, ranging from social, cultural and also technological challenges, the study was mainly concerned with technological challenges which the developed system intended to eliminate. Among others, challenges that users faced when filing for IP and making payments included: potential theft of sensitive IP data as it was being transmitted to the IP office hence loss of IP rights; the problem of one making a payment being credited to wrong application/file number; slow transaction process arising from long and rather laborious processes; as well as some systems not being user friendly.

The third objective aimed at reviewing the existing IP filing systems, mobile payment models, frameworks and technologies. The study achieved this objective through analysis of literature and the insights gained through a survey. Literature analysis was used to identify

major frameworks, models and architecture related to the mobile payments that formed part of the mobile application. The study established that several models, frameworks and technologies existed, and that these systems incorporate different technologies ranging from mobile money service, card based payment systems, as well as systems incorporating NFC, RFID as well as QR Code. However, the research established that though these technologies and frameworks were in place, they had their limitations, including data insecurity, expensive hardware requirements as well as inability to store more data. Among the technologies studied, RFID was shown to offer a good option due to its strong security. However, the study revealed that it is best suited for large operations and would be expensive hence mobile money operators would be somewhat reluctant to use it in their systems. In addition, this technology is dependent on RF strength hence weak signals would interrupt service. EMV technology being a standard for integrated circuit card for payment system, offers interoperability for chip-based cards and is more secure in magnetic strips. This technology is however, expensive as it requires purchase of new terminal and POS) systems. In addition, it is vulnerable to fraud. Whereas NFC technology is secure due to its ability to transmit data within close proximity of two communicating devices, it is still susceptible to security concerns, as there is the possibility to conceivably steal data from an NFC system even from a greater distance. In addition, this technology would prove costly for the IP office and individuals to take up NFC technology as it would require acquisition and maintenance of related machines and extra equipment at extra cost. Hence QR code was determined to offer a more plausible solution that would address the user requirements.

The fourth objective was to develop a secure mobile payment prototype incorporating QR code that could be used for securely filing for IP rights and make payments in a secure manner. Different system models and architectures were reviewed in a bid to determine the most appropriate architecture to be used. Development of system design and architecture was done following a comprehensive review of literature and analysis of data collected from administered questionnaires, taking cognisance of the various stakeholders. Various design tools were used to model the mobile application so as to ensure system represented the real world scenario. Among the tools used included use cases, sequence diagrams, data flow diagrams, and entity relation diagrams. These tools provided a basis for a deeper understanding of the major processes, data flow, data stores, interaction between entities, identification of behaviour within the system and relationship between entities for the mobile solution.

The last objective was to test the developed prototype and show that it is indeed an improvement on the existing systems. This objective was achieved through testing of the prototype and experimentation whereby the system was used to make IP filing as well as make payments. Finally, a comparison between the new system and those existing in literature and in the industry was conducted for the purpose of validating the superiority of the new application.

### **6.3 Critical Appraisal**

In line with the research's aims and objectives, the mobile-based QR-code prototype was developed, which requires internet connection and a working camera. For the system to function, it requires interaction with a QR-Code reader and a thin web application. This brings about benefits and limitations as highlighted in the following sections.

#### **6.3.1 Benefits of the Developed Mobile Solution**

The developed mobile application presents the following benefits compared with other systems:

- i. The system offers a secure means of sending IP data from the inventor to the IP office, encoding the data in QR code format hence ensuring there is no theft of data during transmission. This provides the IP rights holders with security and prevents potential theft of their inventions;
- ii. The solution provides the IP office with a secure method of collecting payments for fees, thus preventing loss of revenue.
- iii. Compared to similar systems that use other technologies such as RFID, NFC, the mobile solution offers a cheaper option as no additional hardware and equipment is required as is the case with the other the technologies;

#### **6.3.2 Limitations of the Application**

Whereas the mobile solution was developed and tested after thorough research, it is worth noting that, in spite of a carefully prepared research process, the solution presents some limitations as highlighted below:

- i. The mobile application requires the use of only data enabled phones with an embedded camera. In addition, internet must be available on the phone for it to run. Consequently, potential users without access to internet connectivity and lacking an embedded camera would not be able to use the application. This would

disadvantage potential users from areas where mobile connectivity is still limited and internet is not stable.

- ii. The solution is biased towards users with mobile devices running on Android Operating system. This will impact its use and adoption, as a substantial number of users use mobile devices with other operating systems.



## **Chapter 7: Conclusions and Recommendations**

### **7.1 Conclusions**

The study sought to investigate and hence attempt to address challenges that exist in systems used for filing of IP rights as well as making payments for the filed applications. Thus, the overarching goal of the research was to identify the challenges applicants face when making applications for their IP rights as well as when making payments – and hence implement a mobile application encompassing QR code that would effectively address the challenges. To achieve this goal, empirical and theoretical literature analysis was conducted, as well as a survey that involved different stakeholders in the IP industry. A review of literature was undertaken so as to identify the challenges as well as the key requirements that users would consider - information which played a key role in identifying limitations of the existing systems, as well as in the development of a novel mobile application that has the identified characteristics. The survey on the other hand was conducted to provide a basis for a comprehensive understanding of the challenges and knowledge of proximity/contactless technologies, establish the state of affairs regarding the area, and to identify payment methods used in settlement of IP fees, and the shortcomings of these methods.

Indeed literature shows that IP is gaining in popularity, as countries move towards knowledge-based economies. However, IP practitioners still face challenges when filing for and making payments for their IP rights. A review of literature indicated that this was due to unreliable and insecure IP filing systems which leaves sensitive IP data exposed to unauthorized third parties. This study determined that incorporating proximity/contactless technologies in these systems would go a long way in making them secure and enhancing their reliability as well as efficiency.

In a nutshell, it is this study's conclusion that, use of QR based mobile application systems in filing for protection of IP rights as well as payment for the same can significantly improve the security of IP data in transit hence offering better protection of inventors' IP rights, as well as speeding up payment and reducing loss of revenue to the IP office.

### **7.2 Recommendations**

As seen from this study, use of proximity/contactless technology provides a secure and faster means for applicants to file their IP rights with IP offices as well as securely make payments

hence preventing others from stealing their inventions and misappropriating them. This section offers recommendations to different stakeholders, as well as recommendations for improving this study. Offering of protection for applicants IP rights data requires commitment from the IP office. To realize a secure IP rights filing and payment regime, it is incumbent upon IP offices to remain innovative and proactive. In light of this, it is recommended that:

- i. The IP offices should seek to integrate the mobile app with their existing IP administration systems so that the IP examination process and its results are communicated to the applicants immediately and securely by means of QR code.
- ii. Other players in the IP sector should adopt the developed mobile application that is presented in this study, as it will go a long way in improving the security of their IP rights during filing, and ensure that they are able to claim priority for the same. In addition, the process of paying for IP fees will be streamlined thus ensuring effectiveness.

### **7.3 Suggestions for Future Research**

This study has presented a novel mobile application that uses QR code to ensure secure filing of IP rights as well as making payments in a faster and secure manner. Notwithstanding that the prototype application is functional, a critical analysis reveals that there still is place for further research and improvement. Thus, the following are the recommendations given regarding future research in the study area:

- i. Researchers should consider undertaking further research with the aim of developing a common framework that can be used by various IP offices across the spectrum so as to have a standardized uniform approach in implementing such systems.
- ii. It is necessary that researchers should consider carrying out a study on the human/non-technical factors that would impede successful use of the solution and hence make recommendations on the best ways of overcome them.
- iii. Since the mobile application developed only works on data-enabled phones running on the Android Operating system and must have internet available, a study can be carried out to explore how the solution can be enhanced to cater for potential users from areas where mobile connectivity is still limited with less than stable internet connection.

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## **Appendix A: Questionnaires**

### **A-I: Letter of Introduction**

**Eric Andati**

**Faculty of Information Technology,**

**Strathmore University.**

Dear Respondent,

I am a student at Strathmore University pursuing a Master of Science degree in Information Technology. As a requirement for the degree program, I am conducting a research on filing of and payment for Intellectual Property (IP) rights at the IP offices and how proximity/contactless technology can be incorporated therein to make them secure and efficient.

The information collected will go a long way in establishing the challenges faced in filing and making payment for IP rights and determining what are the popular existing proximity/contactless technology. This will form the basis for developing a mobile application that will apply the proximity/contactless technology to eliminate the challenges identified. The research will culminate in developing of a mobile application incorporating the proximity/contactless technology into existing mobile payment systems.

The information in this questionnaire will be kept confidential: names of respondents and institutions they work for will be concealed when compiling the report.

I will be glad to offer any clarification. I can be reached via email [eric.andati@strathmore.edu](mailto:eric.andati@strathmore.edu).

Your participation will be highly appreciated.

Yours faithfully

**Eric Andati**

**A-II: Survey Questionnaire**

**PART A: GENERAL BACKGROUND**

1. Please select your appropriate category as a respondent
  - IP office staff
  - Inventor/IP rights holder
  - IP Agent
  
2. What type of phone do you have?
  - Simple phone
  - Smart phone
  - Don't own phone

**PART B: EXISTING PAYMENT SYSTEM AND CHALLENGES**

1. Have you ever used mobile payments systems to file for IP and settle IP fees?
  - Yes
  - No
  
2. Have you ever experienced any challenges when filing or making IP fees payments?
  - Yes
  - No

If the answer is yes, please select which challenges from the list below: (Select all that apply)

- IP rights application was intercepted while in transit;
- Payment being credited to wrong application/file numbers;
- Slow transaction process
- Payment not reflected in system
- System was not user friendly
- Payment system was not secure
- Others

(Please specify).....  
.....

**PART C: MOBILE PROXIMITY/CONTACTLESS TECHNOLOGIES**

1. On a scale of 1 to 5, how important are the following factors when selecting a mobile payment system?

	Least important				Very important
Security of the payment system	1	2	3	4	5
Ease of ease	1	2	3	4	5
Cost of installing/using system	1	2	3	4	5

2. Are you familiar with mobile proximity/contactless technologies?

Yes

No

If your answer is yes, which of the technologies are you aware of?

QR Code

NFC

EMV

RFID

Others

(Please specify).....

.....

.....

3. Do you agree that these technologies will solve the challenges in making payments?

Strongly Agree

Agree

Neutral

Disagree

Strongly Disagree

4. Which of the technologies listed below would you prefer to use in making mobile payments for IP fees?

- QR Code
- NFC
- EMV
- RFID

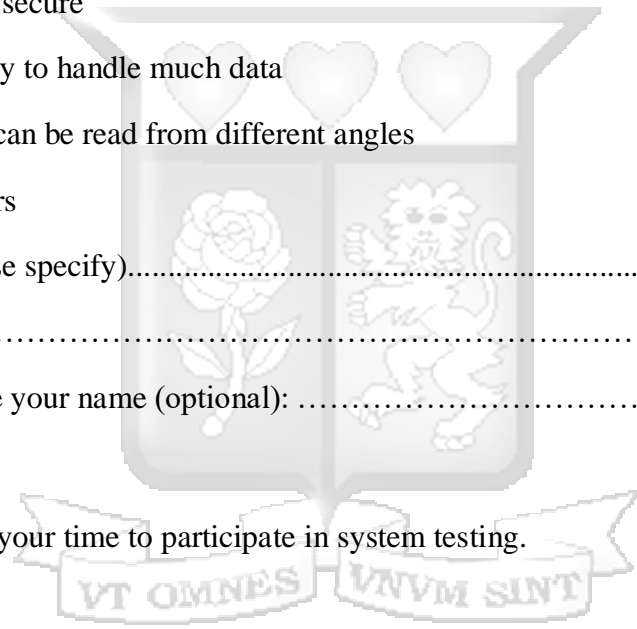
5. What are your reasons for preferring the technology you have selected in 4 above?

- It is cost effective in implementation
- It is simple to use
- More secure
- Ability to handle much data
- Data can be read from different angles
- Others

(Please specify).....  
.....

6. Please indicate your name (optional): .....

Thank you for taking your time to participate in system testing.



### A-III: System Test Questionnaire

1) Please select your gender:

Male

Female

2) In your view, does this application look fit for purpose?

Yes

No

If your answer is no, please specify reason(s) \_\_\_\_\_

3) How easy is it to use the mobile app?

Very easy to use

Easy to use

Neutral

Hard to use

Very hard to use

4) Would you comfortably use the application without guidance?

Yes

No

5) Would you recommend the app to others?

Yes

No

If no, please specify reason: \_\_\_\_\_

\_\_\_\_\_

Thank you for taking your time to take part in this survey

## Appendix B: Activity Schedule

Items of Work/Activities												
	1	2	3	4	5	6	7	8	9	10	11	12
Proposal concept writing and submission												
Writing of literature review and Methodology												
Proposal Defense												
Preparation for and data collection												
Data analysis and interpretation												
System Development and testing												
Thesis writing												
Submission of draft thesis for review												
Submission of final thesis to SGS												
Thesis defense												
Thesis corrections and final submission												

## Appendix C: Use Case Descriptions

Table C-1 shows some of the major use case descriptions of the proposed mobile application, such as View IP application details and Make Payment use cases.

Table C-1: Additional Use Case Descriptions

Use case ID	UC2
Title	Make payment
Description	A user (IP applicant) accesses the simple web portal;
Actor(s)	System user;
Pre-conditions	User must have submitted IP data using the mobile app and has money in the mobile wallet;
Post-conditions	A payment for the application is made;
Main success scenario	<ol style="list-style-type: none"> <li>1. The user accesses Mobile wallet from the mobile application menu;</li> <li>2. User then purchases payment tops up their mobile wallet;</li> <li>3. User opens the web portal url and scans the QR code containing details of their invention using phone camera;</li> <li>4. Payment is submitted.</li> <li>5. Payment confirmation is received.</li> </ol>
Alternative flow of events	Where user does not have enough funds in their mobile wallet, payment transaction fails.
	<b>UC3</b>
Title	View IP Details
Description	IP applicant accesses the web portal;
Actor(s)	IP applicant
Pre-conditions	IP data must have been successfully submitted using the mobile app;
Post-conditions	A payment for the application is made;
Main success scenario	<ol style="list-style-type: none"> <li>1. User opens the web portal url and scans details of their invention.</li> <li>2. User can view a list of all applications by scanning QR code on the web portal;</li> </ol>
Alternative flow of events	IP data was not correctly submitted to database in QR coding hence wrongly decoded when it is scanned.

## Appendix D: Mobile Application Wireframes

Figure E1 shows a wireframe for the QR scanning screen that was used to aid in designing the QR scanning interface.

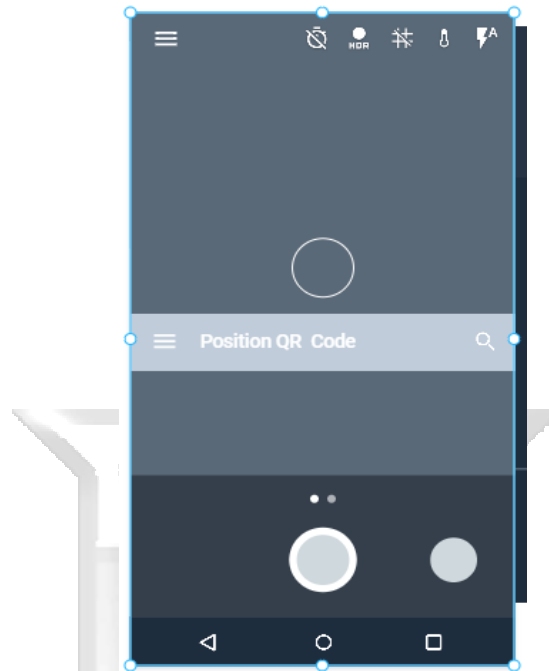
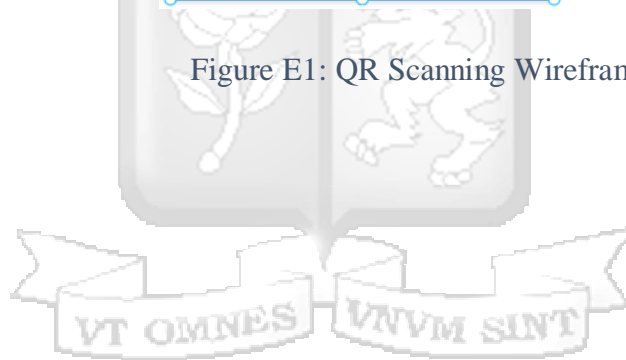


Figure E1: QR Scanning Wireframe

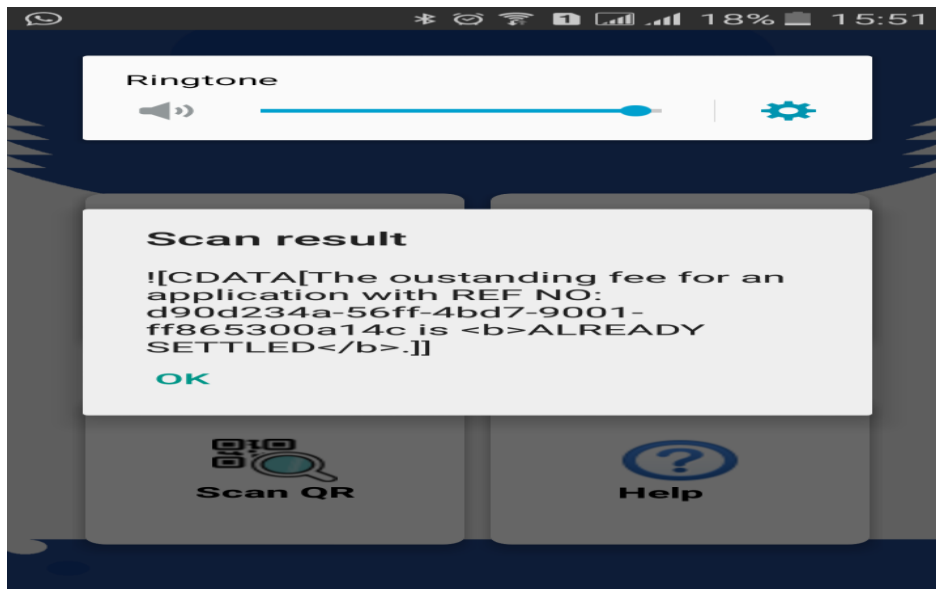


## Appendix E: Additional System Screens

Below are additional screens of the mobile application:

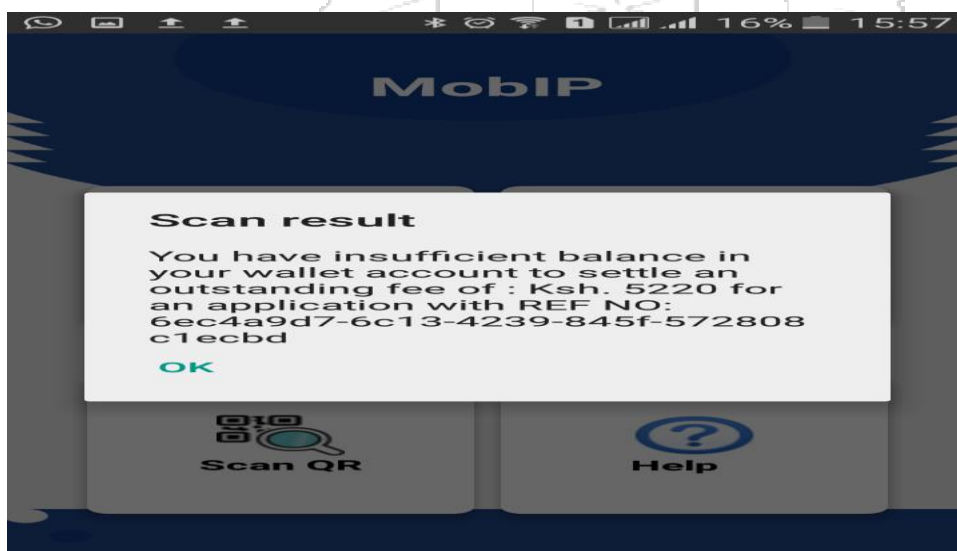
### a) QR Scan Payment Confirmation Screen

Upon a user scanning QR Code and making payment for an IP application, the following screen appears, confirming that fee has already been settled.



### b) Scan Result for Insufficient Wallet Balance

When a user attempts to make payment with their mobile wallet lacking enough funds, the following screen is displayed.



## Appendix F: Plagiarism Checker Report

### a) Originality Report

As can be seen from the following TurnItIn report, plagiarism checking returned a similarity report of 14%. This was well within the acceptable maximum similarity percentage allowed by the University's School of Graduate Studies (SGS).

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### b) Digital Receipt

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