AN INVESTIGATION OF THE FACTORS THAT INFLUENCE THE ADOPTION OF SECURE CRYPTOGRAPHIC QR IN COUNTERFEIT GOODS AUTHENTICATION: A CASE OF NAIROBI

BY

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UNITED STATES INTERNATIONAL UNIVERSITY –AFRICA
SUMMER 2017
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A Project Report Submitted to the School of Science and Technology in Partial Fulfillment of the Requirement for the Degree of Master of Science in Information Systems and Technology

UNITED STATES INTERNATIONAL UNIVERSITY-AFRICA
SUMMER 2017
STUDENT’S DECLARATION

I, the undersigned, declare that this is my original work and has not been submitted to any other college, institution or university other than the United States International University –Africa for academic credit.

Signed: _______________       Date: _______________

Emily Wanjiru Ruciini (ID No. 645302)

This project has been presented for examination with my approval as the appointed supervisor.

Signed: _______________       Date: _______________

Prof. Jimmy K.N. Macharia

Signed: _______________       Date: _______________

Dean, School of Science and Technology
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ABSTRACT

The purpose of this study was to investigate the factors influencing adoption of secure cryptographic QR application by focusing on alcohol vendors who engage in the business of selling alcoholic beverages in Nairobi and its environs. This research was based on four specific objectives which were: to study the influence of cryptographic embedded QR code characteristics on the adoption of secure QR technology; influence of merchant attitudes; government factors on adoption of secure QR; and developing a secure QR prototype that was used by participants.

The conceptual model adopted included the encrypted QR code characteristics, merchant attitudes and government factors which constituted the independent variables. The behavioural intention to use the secure QR application was the dependent variable. The research therefore sought to investigate the influence of the independent variables on the dependent variable. Additionally, the relationship between some variables and their indirect influence on the dependent variable was included in the model.

The research adopted two approaches that is a behavioral approach in which a quantitative research design using a survey questionnaire was issued to the selected sample of 120 alcohol vendors located in Nairobi County. Primary data was used and the questionnaires were distributed by hand. The experimental approach involved component design and development of the cryptographic QR system. The data was analyzed using the Statistical Package for Social Sciences (SPSS version 24). Reliability analysis was done to establish how items positively correlated to each other. The aim of correlation was to study the relationship between variables while regression studied the relationship between dependent and independent variables.

The first research objective aimed at establishing influence of encrypted QR characteristics on adoption of secure QR technology. The study concluded that encrypted QR characteristics influenced intention to use to a great magnitude. Also, notable secure QR characteristics in terms of security of records in the database is that the application makes it hard for the records to be interfered with. Trust of the application was explained in that alcohol vendors increased their level of embracing the secure QR by recognizing its trustworthiness.
The second research objective aimed at establishing the influence of merchants’ attitude in adoption of the secure QR. The study concluded that that perceived efficiency and effectiveness of the secure QR application is crucial in business operation when it comes to authenticating products. It was also noted that there is need for easy and navigable applications. Additionally, senior management support is crucial in influencing decision to use the cryptographic QR.

The third research objective sought to establish the influence of government factors in adoption of secure QR technology. The revelations from these showed the inadequacy of current policies formulated by government to combat counterfeit goods in the market. These also includes awareness campaigns that were inadequate in making the masses aware of the benefits of using secure QR applications and bar codes to combat counterfeit goods. The conclusion was that the participation of the government and awareness agencies is crucial in adoption of secure QR which to a large extent revolves around the policies formulated, creation of awareness and enforcement of the said policies and strategies for combating counterfeit goods.

The conclusions emanating from the study were: encrypted QR characteristics and merchant attitudes greatly influenced the alcohol vendors’ intention to use the secure QR application. Features of the application that stood out included reliability and perceived cost effectiveness of the secure QR application. The investigation of how merchant attitudes influence intention to use QR showed that perceived efficiency and effectiveness of the secure QR application is crucial in business operation in authenticating products. It was also noted that there is need for easy and navigable applications. This study can also help government and other relevant agencies to come up with strategies and policies as this would increase users’ intention to adopt use of the secure cryptographic QR. The policies could focus on the usefulness, cost effectiveness, reliability and security of the secure QR. The findings on how government factors influence adoption of secure QR technology indicate the need for government participation in formulating favourable policies, creating awareness and enforcing those policies to fight the war against counterfeit goods.

The study recommended that there is room for improving the infrastructure of the application to enhance its usability. It would also be ideal for future developers to incorporate features of ease of use while developing applications as these features are key
in coming up with positive intentions to use a technology. Based on the findings while investigating the influence of government factors on the adoption of secure QR technology, the recommendation is that other target populations should be included in future research such as government officials and enforcement agencies that formulate policies, create awareness and enforces these policies. The input from this population would contribute greatly in understanding the roles they perform in their fight against counterfeits.
ACKNOWLEDGEMENT

I want to take this opportunity to thank the Almighty God for the gift of life and the far He has brought me during the entire project period. I also extend my sincere gratitude to my project supervisor Prof. Jimmy Macharia for his guidance and supervision during the entire project. He guided my every effort and encouraged me to work hard and strive for the best.

I also thank my parents Mr. and Mrs. Ruciini for their endless support which I so much required during the project. My heartfelt gratitude also go to my friends for their contribution and suggestions which were useful during the project duration.
DEDICATION

I would like to dedicate this project to my parents Mr. and Mrs. Ruciini who instilled in me the desire to learn and also for their love and encouragement. To my siblings for their support and encouragement. To my project supervisor Prof. Jimmy Macharia for the dedication, guidance, advice and availability he accorded me during the entire project duration. God bless you all.
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<td>Anti-Counterfeit Agency of Kenya</td>
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<td>CSE</td>
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<td>ITU</td>
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<td>RFID</td>
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<td>SPSS</td>
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CHAPTER 1.0: INTRODUCTION

1.1. Background of the Problem

Several prior researchers have posited that rejection, non-adoption, and poor utilization of information technology artefacts and systems is common (Fichman, 2004). This phenomena has been a concern for over three decades now by researchers, business entities, organizations, policy makers and educators (Ejiaku, 2014). Buntin & Blumenthal (2011) in their study to review benefits of health records information technology, indicates that a major problem and barrier to fully utilizing the potential of this technology is the discontent of the electronic records by some providers. Kyratsis (2002) mentions that acceptance and implementation of new technologies in healthcare has resulted to being challenging and very slow in certain cases. Other barriers to adoption of technology from prior studies showed that reliability of the technology was cited as the most significant problem whereas lack of technology know how and difficulties in technology uses (Butler & Sellbom, 2002). Other barriers also include lack of institutional support for technology use in the present and future and also difficulties in learning the technology. A technology adoption failure as suggested by Charness and Boot (2009) has attributed attitudes and abilities as among the most dominant indicators of technology use. Some of the technology adoption failures in recent literature include: (a) failure of MPESA in South Africa; Mutong’wa & Khaemba (2014) attributed among other factors to the technological advancement, financial liquidity and accessibility of the banking system; which has been termed as the most advanced in the continent. In South Africa, the growth rate has continued to increase and most consumers in the rural and urban areas have access to banking system (Leanig & Averweg, 2016). This failure is also attributed to the high costs associated with technology penetration in relation to other countries (Mbele, 2016). Adoption issues have also been manifested globally in Africa, and also in Kenya. Other prior studies have reviewed the adoption of technology through use of corresponding inputs with new technologies to investigate barriers of technology adoption in low income countries (Foster & Mark, 2010).

Adoption of technology has also been studied in several European countries such as New Zealand, Canada, Australia and the US to address barriers associated with this adoption in health sector through use of electronic medical records (Anderson, 2007). The barriers of technology adoption as stated in their study indicate that complexity of systems, data privacy
concerns and lack of data standards to guide how data is exchanged inhibit its adoption. The issues emanating from RFID adoption in South Africa among retail organizations was attributed to technological aspects such as cost implications, organisation is not ready to embrace the technology and other external factors such as lack of standards on a global scale (Brown & Russell, 2007). Closer home here in Kenya, several studies have been done to establish the drivers of technology for a viable economy. However, some issues arise from this and impede on achievement of this goal. These include lack of creating awareness and capacity building among recipients delays the adoption or non-adoption of a technology (ABSF, 2009). Additionally, lack of an enabling environment is also largely blamed for slow adoption of technology in a developing economy.

Previous research has revealed that Quick Response (QR) code are experiencing adoption challenges as well as awareness and effectiveness (Probst, 2012). In barcodes, 2D (2010) argued that the adoption of QR codes is making the customers to take more time to understand which is contrary to vendors anticipation. This is the foundation and motivation for this study that aims to investigate the factors that influence the adoption of QR codes by small and medium enterprises (SMEs).

The history of QR codes dates back to 1994 after it was developed by Denso Wave, a Japanese automobile company to help track automobile parts that were being produced (Hara, 2010). Their popularity then grew and in recent years the QR codes have been adopted since they can store high information density and have improved readability compared to conventional one dimensional barcodes (Yu-Chen, 2010). Japan and Europe have been using QR codes in marketing, manufacturing and inventory control for the last decade. Growth of QR codes has also been attributed to the popularity and use of smart phones by many users as the application is easily downloaded or comes as an inbuilt feature. Denso company also released open source code for QR code to the public domain thus making their accessibility and use wide among users especially those with mobile phones as stated by (Soon, 2011). In light of its popularity, QR codes can be used in authentication of counterfeit products which have had an increased effect on many industries and markets. In Kenya, trade of product counterfeiting has continued to thrive due to its prevalence in industries that manufacture consumer goods (Okoth, 2016). Most reports and statistics have indicated an increase of the estimated annual losses arising from counterfeit products. Various agencies such as the Anti-
Counterfeit Agency of Kenya (ACA) listed products most prone to counterfeiting: beverages including alcoholic beverages & soft drinks and processed foods among others.

From the above, the study is clear on investigating the factors influencing adoption of secure cryptographic QR.

1.2 Problem Statement

The emergence of QR codes is aggressively trying to write a new punch line due to its increased growth and popularity. QR codes were first developed in Japan by Denso Wave as a means of tracking vehicles after they were manufactured. QR are two-dimensional barcodes that have, over recently been embraced by a variety of organizations and from small to large companies as a solution to a variety of business process including (a) consumer interaction, (b) product identification as stated by Soon (2008). Various products such as food items, stationery and equipment have been identified using QR codes; (c) inventory tracking as in the case of Denso Wave (2D, 2010) and (d) marketing purposes. Consumers have interacted with QR codes in several areas such as advertising and communication. In the context of inventory management, QR codes have been adopted in supply chains to enable suppliers and retailers respond to consumer needs in a more timely fashion. Lummus and Vokurka (1999) indicates that in managing supply chains, QR codes were able to maximize the profits. QR codes have also been adopted in mobile marketing to enable marketers interact with consumers to promote their brands (Cata, Patel, & Sakaguchi, 2013). The use of QR codes in marketing has been largely attributed to the popularity, growth widespread use of mobile phones. Unfortunately, prior studies have posited that QR code are facing adoption challenges (Probst, 2012). Earlier theoretical research and empirical studies to identify factors relating to adoption of QR have not been satisfactory (Ko & Brown, 2000).

Thus, the gap addressed investigated factors that influence adoption of QR technology in the context of counterfeit goods authentication. A model was used to predict the vendors’ intention to use the QR application by integrating several determining factors. Hence, the concern of QR code adoption was addressed by investigating the factors that influence intention to use this technology.
1.3. Objectives of the Research

1.3.1 General Objective

The main objective of this research was to propose a method of enhancing system security against counterfeit goods through the use of cryptographic QR code.

1.3.2 Specific Objectives

i. To investigate the influence of cryptographic QR code characteristics on the adoption of secure QR technology.

ii. To investigate the influence of merchant attitudes on the adoption of secure QR technology.

iii. To investigate the influence of government factors on the adoption of secure QR technology.

iv. To develop a prototype of secure QR technology for use by alcohol vendors to enhance system security.

1.4 Importance of the Study

The importance of this study was provision of vital information that consumers, merchants and the government can use to make critical decisions that impact each of them. Use of secure QR application is a simple yet effective method that will enable traders add value to their business. The consumers are protected against consumption of the counterfeit products that have devastating effects such as loss of life and life threatening illnesses. On the other hand, the merchants are empowered to verify products they sell to consumers by scanning the cryptographic QR. The QR application enables them to effectively authenticate products in a more efficient way than the traditional barcodes. The application also provides invaluable information to the vendors regarding the products that can inform decision making processes within the business. Additionally, this information can be used by the government and other enforcement agencies in their fight against counterfeits in the market and more so in tracking the sources of these goods and controlling their circulation in the market. The government is therefore empowered to make informed decisions that can be used to formulate appropriate policies, strategies and regulations regarding fight against counterfeits. It can also curb the loss of revenue that is realized from trade of the counterfeit goods.
1.5 Scope of the Study
The sample size in the study comprised of vendors within Nairobi and its environs that deal with sale of alcoholic beverages that include but not limited to beer, wines, liqueurs and spirits among others. These vendors were chosen through simple random sampling. The geographical location covered areas surrounding Nairobi Central Business District from where most of these vendors operated from. Some of the limitations of this study were that only merchants from Nairobi and its surroundings were considered and not the others form other towns or counties due to limitation of time to complete the study. Also, the questionnaires were submitted to 120 merchants to authenticate the products. The time frame for this research study was three academic semesters after which the deliverable was a working cryptographic QR code application.

1.6 Definition of Terms
Some of the terms in the context of study include the following.

i. Counterfeiting
According to (Eisend, 2006) counterfeiting can be defined as copying product attributes into another product which is indistinguishable from the original and is sold at a lower price as if it were the original. Bloch (1993) has also described counterfeiting as the unauthorized copying of trademarks and copyright products.

ii. Counterfeit Goods
According to the Anti-counterfeit Act of Kenya (cap.130a), Anti-Counterfeit Act, (2008) counterfeit products are defined as goods that are a result of counterfeiting and include any means used for counterfeiting purposes. On the other hand, the World Trade Organization (WTO) defines product counterfeiting as: “Unauthorized representation of a registered trademark carried on with a view to deceiving the purchaser into believing that they are buying original goods” (WTO, 2011).

iii. QR Codes
According to Rouillard (2008), QR codes are defined as two-dimensional barcodes invented by Denso Wave, an automobile company in Japan to track inventories of vehicles and auto parts. In recent times, functionalities of QR codes can now be transferred to other industries because they are efficient and easily adaptable on mobile platforms specifically smartphones. Currently, mobile smartphone is the biggest driver of QR code commercial popularity (Denso Wave, 2010).
1.7 Chapter Summary

This chapter described the purpose of the research which was to propose a method of enhancing system security against counterfeit goods through cryptographic QR here in Kenya. The scope of this research was to investigate the factors that influence adoption of secure cryptographic QR in counterfeit goods authentication. It focused mainly consumer goods and did not cover electrical or electronic products and had a bias on deceptive counterfeiting where consumers and companies are victims of deception and are not aware while making purchases.

The remaining chapters of the research focused on review of literature on recent studies that formed basis for the proposed area of study. The methodology section described in details the method used to realize the objectives of the research. The chapter on results and findings presented research findings based on the specific objectives as stated in chapter one. The last chapter was the discussion, conclusions and recommendations of the research.
CHAPTER 2.0: LITERATURE REVIEW

2.1 Introduction

This section examined the review of literature that related to the study. It specifically reviewed the factors influencing adoption of secure cryptographic QR. These includes encrypted QR code characteristics, merchant attitudes and government factors. It also discussed the solution for developing the secure QR based on block chain technology. This technology has widely been used in financial transactions that involve online transactions and thus its adoption comes in handy while authenticating genuine products from fake ones. The chapter concluded with a summary of the chapter’s discussion.

2.1.1 Introduction to QR Code

A QR Code is a 2D matrix of black and white pixels that was developed in 1994 by Denso Wave, a Japanese automobile company to help track automobile parts that were being produced (Hara, 2010). QR codes have gained popularity in recent years as they can store high information density and have improved readability compared to conventional one dimensional barcodes (Yu-Chen, 2010). Japan and Europe have been using QR codes in marketing, manufacturing and inventory control for the last 10 years. Growth of QR codes has also been attributed to the popularity and use of smart phones by many users as the application is easily downloaded or comes as an inbuilt feature. Denso company also released open source code for QR code to the public domain thus making their accessibility and use wide among users especially those with mobile phones as stated by (Soon, 2011). Another notable fact is the standardization of of QR Code as the JIS standard in 2000 as stated in (Japanese Industrial Standards, 2004). This was later revised in 2004. Soon (2011) also highlights that QR Code was also standardized internationally in 2001 by ISO/IEC18004 and later became widely used in Singapore, China and Korea. According to Adam (2013), businesses are now focusing on QR codes to provide an easy and simple way of directing smartphone users to their websites to convey product information to users.

2.1.2 Structure of QR Code

QR code can encode information such as URL, text or other data and has the following features as stated indicated by Law (2010): high capacity to encode data, small printout size, Chinese kanji capability that holds 1871 characters, it also has dirt resistance and can be read
from any 360 degrees angle. QR code can hold 7089 numeric characters. Figure 2.1 shows structure of a 2D QR code.

![QR Code]

Figure 2.1: Structure of QR Code (Narayanan, 2012)

Ian (2012) has defined the QR Code matrix as a square cell structure consisting of finder pattern, timing pattern, allignment pattern, cell and quiet zone.

![QR Code Structure]

Figure 2.2: QR Code Structure (Soon, 2008)

The structure is further described in Figure 2.2; the finder pattern detects QR code position in all directions that is 360 degrees and it’s arranged on the three corners so as to detect size and angle of the QR code. The allignment pattern is used to rectify QR Code incase it is distorted and identifies the central coordinate of allignment pattern so as to correct any distortions on the code. The quiet zone is the margin space needed for reading QR code thus making it easy to detect the symbol from the image read by the sensor. This zone requires four or more cells.
2.1.3 How QR Code Works

Kato (2009) also indicates that QR codes are scanned using desktop applications and mobile devices such as smartphones and this image is interpreted by a QR code reader which is downloaded and installed on the device. The QR code reader deciphers the message and carries out an operation such as redirecting users to the phone’s web browser and visiting a company website as stated by the QR code. QR code has continued thriving because it provides an simple and efficient method of installing the QR code readers thus users can authenticate products at will. In 2011, a study carried out on USA mobile users established that 14 million people scanned QR codes in June (Radwanick, 2011).

2.1.4 Limitations of QR Code

Popularity of QR codes has also come with several challenges that include attacks and malicious codes that make their use vulnerable to unsuspecting users. Narayanan (2012) found that in 2011, Kerspesky Lab was able to detect a malicious QR code that was generated when users attempted to scan products through a reader. It also stated that users were directed to bogus websites where malicious files were downloaded without them knowing. With this trend, manufacturers and vendors are seeking a more secure approach to distinguish genuine products from counterfeits to fully eradicate this menace. Sharma (2012) indicates that several websites containing malicious QR codes in mobile applications were detected and they included trojan horses from sites like Opera Mini and Jimm. According to Tamil (2011), there is a growing concern regarding how QR Codes are created and distributed which on one angle is advantageous for businesses but on the other hand attracts scammers whose intent is to direct users to phishing websites. Tamil (2011) further defines phishing as an attack that misleads users into revealing sensitive information while believing that they are accessing a legitimate website. In this light, most manufacturers and vendors concur that more secure QR codes need to be implemented to eradicate the issue of counterfeits without jeopardizing their business operations. Their growing concerns is that information on products can be revealed to unauthorized third parties especially their competitors who are trading in contrabands.

2.1.5 Motivation to Embed Cryptography into QR Code

QR codes are used to store messages due to their large storage capacity and fast response time as compared to conventional barcodes. However, if the data or message in the QR codes is not encrypted, this possess a security concern in the event that data is handled by
unauthorized parties. It is in this light that this study proposes to embed cryptography to QR code in identification of counterfeits. Diffie (2000) defines cryptography as the techniques used to protect integrity of electronic messages by converting them into unreadable format. Modern day methods used for encryptions are symmetric key and public key cryptography (Diffie, 2000). Symmetric key cryptography involves use of the same key to encrypt and decrypt data while in public key cryptography, one key is used for encryption while the other to decrypt data. The cryptograph embedded QR code for the proposed solution relies on public key technique using block chain technology.

A blockchain refers to a distributed database of records or a ledger of all transactions (accessed publicly) executed and shared among participating parties. Each transaction in the ledger is verified by agreement of a majority of the participants in the system. The data captured can never be erased thus providing an excellent method of authenticating products (Crosby, 2016). This technology keeps a record of every transaction that has ever been made.

2.1.6 How Blockchain Works

According to Gregoriou (2015), blockchain is based on use of cryptography instead of reliance of trusting third parties while executing an online transactions as in the case of bitcoin which is based on blockchain. The transaction is protected by a digital signature that is sent to the public key of the receiver and is digitally signed using the sender’s private key. It is secure in that ownership of the private key needs to be proven. After the entity receives the digital currency, the digital signature is verified that denotes ownership of the matching private key using the sender’s public key for a given transaction. The transaction is then announced to every node in the blockchain network and is then documented in a public ledger after it is verified (Gregoriou, 2015). The figure below shows how blockchain works.
Currently, the anti-counterfeiting solutions available can be broadly classified into two categories i.e. verifying the authenticity without any special equipment such unique labels. The second method is where specialized tools or skills are needed to verify the authenticity of the product in question such as watermarks or sensitive inks. With modern manufacturing techniques it is becoming easier to outsmart the above mentioned anti-counterfeit solutions. The solution therefore lies in the blockchain technology. The analogy of blockchain for the study will be adopted as follows:

2.1.7 How Cryptography Embedded QR Code Works with Blockchain

The manufacturers will represent the sender and will have a database of products. The manufacturer wants to send a product to the retailer who is the receiver. The manufacturer needs to perform a blockchain transaction and will require a private key to sign a message and the receiver’s digital address. The message to be signed contains information about the sender, the receiver’s digital address and any other relevant data such as product characteristics. Each product is labeled with a unique number displayed as a QR code. This unique number can be the manufacturer’s public key and as the product(s) move in the supply chain, this QR code is signed with the sending member’s private key. Once QR code is scanned, it provides information used to verify authenticity of products and also identify counterfeits in the chain.
2.1.8 Blockchain Authentication

Blockchain technology validates and safeguards entries and also preserves historic records of transactions (Kalyanaraman, 2016). He argues that this technology can greatly reduce levels of counterfeits where companies maintain their own production inventory and also keep copies of this product data. This is facilitated by storing it in a distributed blockchain database and tied to the corresponding products. All the product data will be in sync and not obsolete and thus always be verifiable as authentic (Kalyanaraman, 2016). Authenticity of products has also been established in various fields as described below:

Higgins (2016) indicates that blockchain can be used as a decentralized two-factor authentication process for confirming user’s identity when accessing websites and social media platforms. Once the users click the QR code for the first time, the server creates a new private key for authentication. According to Higgins (2016), blockchain has also been used to improve the efficiency of e-commerce processes since these sites require proof of identity at checkout. Once users scan the QR code with their authenticator device, it establishes both their identity and also authorizes their transactions. It is clear that most entities have leveraged blockchain to identify and authenticate transactions. Driscoll (2013) has stated that organizations have ensured integrity of their networks, prevention of loss of critical digital assets data and verification of enterprise behaviours courtesy of blockchain. All digital assets are registered in a global blockchain that generates a viable baseline image of the network. He also mentions another blockchain aspect that has been successful for anti-counterfeits measures in different industries such as luxury items and pharmaceuticals; blockverify. It tracks the products in the supply chain to ensure use of authentic products by consumers. Blockverify also enables authentication and enhancing trust in certificates and fraud prevention (Driscoll, 2013).

Counterfeit market has continued to thrive especially for high value goods. Thomson (2016) indicates that blockchain has been adopted to authenticate counterfeit products already in a company’s possession and track if the goods have diverted from their original destination. Companies create a product register that they use for monitoring supply chains. The products are also verified through mobile phones thus increasing viability to verify products on a large scale and at delivery points. According to Interpol, drugs are the most commonly counterfeited products that account for more that USD 200 billion dollars annually. Counterfeit products also account for many deaths due to consumption of these drugs. Just
like the high value goods, blockchain technology tracks these pharmaceuticals throughout the supply chain for authenticity and establish ownership of different companies.

Coppersmith (2011) mentions that any system that verifies authenticity of a product should comprise of an electronic tag attached to the product and it also contains memory storage authentication information; a reader for reading authentication information from the electronic tag to verify authenticity of the product and a label attached to the product with the authentication information to be verified against the authentication information stored in the electronic tag which is read by the reader.

Through cryptography, blockchain is able to achieve authenticity of products in that it encrypts the authentication information of the tag using a private key. The reader decrypts this information using a corresponding public key and authenticity is achieved by comparing authentication information read by the reader and the printed information on the label (Coppersmith, 2011).

2.2 Cryptographic QR Code Characteristics

2.2.1 Perceived Cost Effectiveness of Encrypted QR Codes

Perceived cost effectiveness can be defined as the perception of a person in using a system and achieving the required result at a lower cost compared to its alternative (Ahmad & Ahlan, 2015). Neumann (2017) in their study to establish the cost and benefits of diffusion of new technology in health care indicate that cost effectiveness is an important factor to guide the process of adopting new technologies. Their argument is that new technologies that give health outcomes at lower cost per unit than the current technologies should be implemented while those that don’t should not be considered. The study used cost effectiveness analyses through several examples to show a crucial lesson of conducting research in adoption of new technologies that are cost effective. Cost effectiveness of online instruction has been evaluated against that of face-to-face instruction through a cost matrix that had a set of costs relevant for both learning formats. The matrix enabled a person to consider training being developed, number of training times used with and without updates and also the number of participants expected to participate. Some organisations have argued that the tool has enabled online learning to be cost effective as the tool provides justification for likely costs associated with this learning program (Bartley, 2004).
Technologies such as integrated pest management have also been adopted in agricultural sector in developing countries through a study done to bridge the gap of cost effective dissemination strategies. Results show the farmers need to visualize the technology being implemented on basis of cost effectiveness and sustainability. The farmers perception of cost effectiveness is a technology that they are empowered to speedily observe the pest results on their own. The study also recommended a visible technology that is likely to be widely adopted and thus resulting to greater economic benefits to individuals and the economy at large (Harris, 2013).

On the other hand, Gitau and Nzuki (2014) have defined perceived cost as the extent to which a person believes that using a particular technology is costly. In a study to establish what determines adoption of m-commerce by consumers, it shows that cost is important in set up of various m-commerce services in how these are delivered and it can also slow down efforts towards expanding a new technology. They identified perceived cost as an key element which consumers used to decide whether or not to adopt m-commerce (Gitau & Nzuki, 2014). Other studies have also shown that cost can be a hindrance that slows down adopting m-commerce among Malaysian consumers (Wei et al., 2009).

The cost can be related to a perceived declining cost that is the extent to which declining cost to adopt the cryptographic QR influences behavioural intentions of QR (Mugeni, Wanyembi, & Wafula, 2012).

2.2.2 Trust Characteristic of Encrypted QR Codes

Trust is defined as the willingness of individuals to accept susceptibility on grounds of positive expectations about the behavior of another entity in situations of risk. In other words, it is the belief that the other party will behave in a socially responsible manner thereby fulfilling the expectations of the trusting party without taking advantage of their weaknesses. This concept has been explained in the study on impact of trust and perceived risk in adoption of internet banking where it reduces risks of transacting online. Consumers hold the beliefs that online retailers will not attempt to be opportunists and expect them to be competent and traders of integrity. From this trust has a negative impact on perceived risks to adopting the technology of internet banking (Kesharwani & Bisht, 2012). Other sources have also defined trust as the thoughts, feelings, behavior and emotions of people when they feel that another party can be relied upon to act in their best interests when they give up their control (Mugeni G. B., 2012).
QR code has been adopted as label mechanism in organic food produce in a bid to improve the trustworthiness among organic consumers and also increase the brand loyalty. The issue of trustworthiness needed to be hypothesized by the organic farmers to eliminate the skeptical issues among the consumers who had problems distinguishing authentic organic foods from the fake ones. From their study, consumer trust was related to the positive attitude they had on labelling of products, advertising means and the opinion of other leaders. It aimed at guaranteeing trust between the organic consumers and the organic growers by enabling verification of growers by consumers while buying the organic food and enabling growers to use an authentication mechanism to gain trust of the consumers (Huque, Hossain & Rana, n.d.).

Trust has also been indicated as a significant factor in adoption of business process outsourcing due to its benefits of reducing complexity in consideration of key decisions and new technologies, it builds business relationships by increasing performance and satisfaction in the decision making processes. The positive influence of trust on adoption of business process outsourcing concluded that trust is an important element of how technology is adopted and used. For the practices, the e-banking services provider must ensure that their online services equipped with trust element for the success of adoption. A cost should be invested to meet the responsibility of the managers and all the staff as required by CRM principles. The management must start thinking about developing brand loyalty, positive word of mouth (WOM) through technological trust among the customer to support the CRM performance and e-services adoption.

Trust has been described as an important factor that affects consumer behavior and affects successful adoption of various technologies (Holsapple & Sasidharan, 2005). Their study also mentioned an earlier study that adopted TAM framework to investigate effect of trust on users accepting use of e-commerce sites for online shopping. The conclusion on this was that trust played an important role in users accepting to use the portals. There are various definitions of trust in prevailing literatures. Kim, Ferrin, and Rao (2008) defined trust as the degree to which one is willing to attribute good intentions to, and have confidence in the words and activities of other persons or systems. Perceptions of trust among users have been recognized to have an impact on their intention to use e-government services as mentioned by Carter and Bélanger (2005) study on utilizing government services by citizens. The study expounds on the concerns of citizens in sharing their information over the internet due to issues of data privacy. Data privacy is a recurrent issue in use of any technology or system and this fact cannot be ignored.
In this study, various elements of trust were incorporated on the secure QR application in offering data privacy, primarily on how data is accessed and stored. Trust in this study is therefore defined as the extent to which a person believes that using the secure QR application is secure and does not pose any data privacy threats.

2.2.3 Reliability Characteristic of Encrypted QR Codes

Reliability is defined as a test of how consistently a measuring instrument measures whatever concept it is measuring. It indicates the stability and consistency with which an instrument measures the concept and accessing the goodness of a measure (Sekaran & Bougie, 2014). Reliability is a system characteristic that was studied in this research. System characteristics have been postulated to have a direct effect on beliefs of individuals since the proposal of TAM by (Davis, 1989). There have also been other studies including that by Davis (1993) which have confirmed the role of system characteristics to predict beliefs of individuals and acceptance of technology in varied contexts. In their study to investigate how system characteristics influence e-learning use, Pituch and Lee (2006) included system characteristics as external variables that were posited to have an influence on perceived usefulness, perceived ease of use and arguably the use of the e-learning system. The conclusion of their study was that the system characteristics acted as significant factors on the perceived ease of use, perceived usefulness and on use their e-learning system.

There have been studies conducted showing that reliability as a major concern in influencing the adoption technology for teaching and online programs for computer based distance education. In this study according to Butler and Sellbom (n.d.), the faculty in question articulated their doubts on unreliable systems that were mostly characterized by software incompatibility, system errors and omissions and outdated software. The suggestions mentioned included having uninterrupted access of the technology, frequent system checks and reliability of communication service such as email as an effective online program. In this study however, the secure cryptographic application that was studied was designed to execute transactions quickly and efficiently. In addition the design and navigation of the application makes the process of verifying a transaction comfortable for the users. It also presents the information clearly.

In addition to reliability feature, the secure QR application must be cost effective which is the second system characteristic that was examined in this study. Ahmad and Ahlan (2015) define perceived cost as the perception a person has in using a system and achieving the
required result at a lower cost compared to its alternative. The secure QR application being studied allows increased productivity for the users due to the quick verification of the product. It also saves them a lot of time since the application indicates the identified fake products including reducing the chances of purchasing and stocking of fake products. With the above review of system characteristics of the study, thus the above hypothesis:

Various studies conducted on factors affecting adoption of mobile banking services; M-banking have shown that customers trust in these services i.e. funds transfer, loans applications, bills payments among others have a positive effect on adoption of the M-banking (Ndumba & Muturi, 2014). In this case customers of the mobile bank services have the perception of the competency of the service provider to provide the expected the expected services effectively and efficiently.

Some characteristics of unreliable systems include: denial of service where the system fails and users cannot use it, unauthorized access where system losses confidentiality because the working system had been attacked by viruses or hackers. Another reason is loss of data integrity due to corrupt or incomplete information (Greenberg, Li & Wong-On-Wing, 2012). They mentioned in their study while investigating how trust affects system reliability to adopt online accounting systems. Consumers’ trust in reliability of the system and their trust in the internet greatly influenced their intention to adopt the system. Their suggestion was that if consumers trust or don’t trust reliability of the online system and internet, they are most likely or least likely to adopt the system. Consequently, the consumers’ trust in system reliability had a more substantial effect on their intent to adopt the system if their trust on the internet was low than when it was high. The conclusion was that system reliability is significant in adoption of online accounting system (Greenberg, Li & Wong-On-Wing, 2012).

Additionally, reliability has been studied to be a fundamental aspect that forms service quality in internet banking as it related to performance standards. Reliability has been linked to quality interactions of consumers and service providers that resulted in a positive effect of their satisfaction. Consumers in the banking sector anticipate to get services that are error free, correct, prompt, of high standards and also those that are timely otherwise their needs and trust on the company are not satisfied. If the bank services are not reliable, the customers will go to competitors (Saeed, Azim, Choudhary, & Humyon, 2015). A similar study conducted in Zimbabwe to identify factors affecting adoption of internet banking cited
reliability as a critical determinant. Reliability is one of the most important factors of quality in internet banking; others are durability and serviceability. Reliability in this context entails performance consistency and dependability i.e. banks perform the right services at the initial time, accurate information and maintenance of correct records. Reliability also relates to the functioning of the internet banking sites more specifically availability and thus from this study, it was noted that reliability has a positive relation to use of electronic banking (Muzividzi, Mbizi, & Mukwazhe, 2013).

Reliability has also been a major concern in influencing the adoption technology for teaching and online programs for computer based distance education. The faculty expressed doubts that unreliable systems were characterized by software incompatibility, system errors and omissions, outdated software among others. The suggestion was having uninterrupted access of the technology, frequent system checks and reliability of communication service such as email as an effective online program (Butler & Sellbom, n.d.). Reliability of systems has been found to have a positive effect on adoption of any given technology (Taylor, 2016).

The literature described above has reviewed effect of reliability on adoption of technology in mobile baking services, online accounting systems, online programs and computer-based distance education. It is clear that reliability is a major determinant of adoption of a given technology and also the effects it has on consumers. There exists a gap to further investigate the influence of reliability in adoption of secure QR.

2.3 Merchant Attitudes on Adoption of Secure QR Technology

2.3.1 Perceived Usefulness & Perceived Ease of Use

According to Ertekin and Pelton (2014), perceived usefulness is defined as the degree to which a person believes that using a particular system would enhance his or her job performance. When an individual uses a given technology, they believe that they will be more effective. Perceived usefulness is also consistent with extrinsic motivation which is a condition where a person will perform a certain activity since it’s alleged to be instrumental in achieving valued outcomes which are distinct from the activity itself (Thayer, 2012). When individuals perceive a given technology to be easier to use, they are more likely to find that technology useful that is if they do not use much effort or resources to use a given system, they will ultimately perceive greater benefits from using a particular technology. Perceived usefulness is also defined as the degree to which a person believes that using a particular
system would enhance his or her job performance (Davis, 1989). In this case the secure cryptographic QR to authenticate counterfeit goods is such a technology and there will be a close relation between perceived ease of use and perceived usefulness toward using the proposed model. Thayer (2012) also notes that perceived usefulness also relates to users attitude towards using QR code technology: when individuals perceive they will benefit from using a given technology, then their attitude towards that technology is likely to improve.

The Technology Acceptance Model herein referred to as TAM identified two major factors that influence adoption of information systems technology: perceived usefulness and perceived ease of use which then forms the attitude of individuals towards the information system product (Davis, 1989). These then result to behavioural intention to use. Cox and Shiffler (2014) states that in the context of QR codes, lack of interest by individuals to use a system may be a function of either perceived usefulness or ease of use.

Demira, Kaynak and Demir (2015) in their study on investigating the current and future possibililty of using QR codes among college students found that the recognition levels of QR codes among this group was high, well over 80%. They were mostly interested in using the QR codes due to what they were enabled to do courtesy of this technology: make purchases, access additional information and so on.

The use of QR codes have been investigated in several sectors that include mobile learning & marketing, healthcare and in security authentication as consumers are interested in knowing more about the products they are scanning. I.T. Asare (2015) and D. Asare (2015) also established that when consumers are satisfied with the content of QR codes, re-scanning in the future will be highly likely.

They continued to state that consumers are not deriving most from QR codes campaigns since they want something of value when they scan the codes and recommends that pages are optimized to deliver high-value experience for consumers of QR codes. In their study on effective use of QR codes as a marketing tool, also stated that consumers are being driven away from using barcodes due to poorly aligned expectations of consumer brand thus the need for perceived usefulness in a given technology.

Santos (2015) in his view based to understand motives of consumers on acceptance intention towards QR code states that many consumers in the study perceived the QR codes located in
various media that could be used to access websites, social media networks and attain more information about products and services. However, they noted consumers’ perceived usefulness of the codes was inhibited by the lack of a mobile devices, applications and mobile internet access for this to be successfully adopted.

Both perceived usefulness (PU) and perceived ease of use (PEOU) are based on the TAM and were included in the theoretical model used for this study. While PEOU is the degree to which a person believes that using a particular system would be free of efforts (Venkatesh & Bala, 2008). It has been observed that when individuals perceive a given technology to be easier to use, they are more likely to find that technology useful that is if they do not use much effort or resources to use a given system, they will ultimately perceive greater benefits from using a particular technology. TAM also strongly suggests that actual usage of a system is determined by the behavioral intention to use (ITU) of users which is determined again by the users’ attitude towards using (ATU), PU and PEOU. Thus both PU and PEOU have a significant influence on the ATU which consequently affects ITU. PEOU has been studied to have a casual effect on PU that is it has a substantial direct effect on PU. Users should always find a system that is easier to use to be more useful. In this study, PU has not been hypothesized to have an impact on PEOU as its focus is on the impact of intention to use on how users perform their job with the secure QR.

The positive effects of PU and PEOU on BIU information systems have been showed in several studies that adapted TAM. For instance Makhal (2015), suggests that the value perceived by consumers is determined by the quality of information from the system output which can be measured through its relevance and applicability. Additionally, other previous studies on mobile applications and services have showed positive effects of PU to positively influence intention to use mobile service that was being studied.

According to Thayer (2012), a person’s intention to use a technology may be low if the person doesn’t understand how to use a given technology or they hold the belief that it’s not easy to use. Consumers therefore avoid using technology that involves complex instructions or which at first appears difficult to use. He further explains that in context of QR code, consumers may view QR codes as not being easy to use if there existed no need before for them to scan products. For instance when information is available from other sources such as on emails, product packages among others. Thus a consumer’s perceptions of how easy a technology is to use may affect their attitude toward a technology (Thayer, 2012). The secure
cryptographic QR should be easy to use in the process of authenticating counterfeit goods for successful adoption. Chen, Chang, Kao, and Huang (2014) in their study to recommend a new technology information model maintains that the service quality of a system has a positive effect on perceived ease of use which is affected by functions such as complete and ample information, real-time interaction and proficient system efficacy.

According to Hwang and Chung (2015), mobile marketers were asked to offer the sport consumers simple QR codes, participants PEOU was based on the fact that the QR codes were accessible and visible in scanning them. This in turn influenced their intention to scan QR codes at sport facilities. According to Thayer (2012), a person’s intention to use a technology may be inhibited if they doesn’t understand how to use a given technology or they hold the belief that it’s not easy to use.

According to Ozkaya, Ozkaya, Roxas, Bryant, and Whitson (2015) on her report on factors that affect consumer usage of QR codes, it was established that educated collage students found QR codes easy to use. The experiment conducted showed that many subjects identified using QR codes in a class management system was very easy thus a high perceived ease of use of the QR codes. Suggestions were made for provision of instructions to participants who were not familiar with the technology.

Therefore, in this study PU is defined as the degree to which a person believes that using the secure cryptographic QR will enhance his or her job performance. This construct shows how the cryptographic QR can help users achieve task goals such as efficiency while performing their tasks e.g. authenticating consumer goods.

Also, based on the definition by Davis (1989) on PEOU, this study defines it as the degree to which a person believes that using the secure cryptographic QR will be free from effort. The secure QR must be easy to use or users to find it easy to learn. Other earlier studies have postulated that PEOU has a significant direct effect on PU. This means that for users to accept a system or application as being useful they must find it easy to use (Davis, 1993).

2.3.2 Social Norms

Social norms are defined as the degree to which an individual perceives that most people who are important to him think he should or should not use a system (Venkatesh & Bala, 2008). Social influences associated to a person can make them cause another person to change their feelings, attitudes and behaviour either deliberately or unintentionally. Previous literature has
indicated that a person’s behaviour is frequently influenced by their friends, family, or colleagues because they want to maintain social status or a good image in a given group (Jung, Somerstein & Kwon, 2012). This social influence is defined as a subjective norm in the Theory of Reasoned Action (TRA) which is also explained as observability: how people will perceive the adoption of a new idea in a social system. In their study to identify factors that influence students demand for smartphones, consumers are very much concerned if their friends like the brand of smartphones they are using and they can buy smartphones if it would help them fit in their social group (Suki, 2013).

Park (2009) also indicates prior studies have shown the importance of determining the effect of social influences on user commitment in the use of a system in order to understand, explain and predict the use of the system and the behavior to accept its use. It is further explained that social context is one of the categories of the variables relating to behavioural intention and it means the social influence on an individual’s acceptance to use a technology. The DOI theory mentions that social influence can be classified into interpersonal influence which is derived from a network of peers, friends and other individuals one interacts with. Additionally, Ajzen and Fishbein (1975) note that an individual’s beliefs or opinions can be influenced by what they believe most people important to them think. Therefore, if the said individual has placed great importance with other people or groups, their beliefs about the usefulness of a system can be influenced by opinions that show what the others believe about the system rather than facts. According to Park (2009), a person is highly likely to suggest a service to other people if they are satisfied with it. It has also been pointed that social influence had more impact on a person’s acceptance in a study on acceptance of m-commerce than on PEOU and PU. In this study, social norms is defined as the degree to which an individual perceives that most people who are important to him think he should use the secure QR application.

In context of QR code technology, a study conducted by Jung, Somerstein, and Kwon (2012) on consumers motivation to scan the codes in advertising shows that people might use the codes for their advertising since their peers talk about it or if they think that using these QR codes will improve their self-image among their peer group. They also observed that many young consumers tend to be influenced by opinions of their peer groups and thus social influence has the capability to convince young individuals to scan QR codes.
Several studies have been conducted to show the positive association of social influence with behavioral intention in adoption of m-learning in countries like Taiwan and Malaysia with some being based on Unified Theory of Acceptance and Use of Technology (UTAUT). In these studies, factors influencing adoption of m-learning were integrated with social norms, individual differences and different experience levels and the results showed a positive relationship (Jing, Yue, Hwa, Kuan, & Shin, 2014). Furthermore, Jing et.al, (2014) continue to indicate that subjective norms are also positively associated with customers’ behavioral intention to accept QR code. This is because social influence is important in the early stages of technology use.

Makhal (2015) also agrees that social norms are integral to social influence since they are important determinants of usage intentions. The social norms direct peoples’ perceptions of whether those who are significant in the society approve of the usage of a new technology or performance of a given behaviour. She further explains that QR code technology can be seen as a type of social media due to its direct affiliations to social networks such as Twitter and Facebook and other social media platforms in products used. She agrees that social norms are fundamental to social services.

Subjective norm is a component of Theory of Reasoned Action (TRA) and is the degree to which significant people that includes family, relatives, friends or colleagues tolerate an act. TRA also indicates that behaviour is determined by a person’s intention and motivation to do a particular act. Therefore, subjective norm also affects behavioural intentions (Ertekin & Pelton, 2014).

Ertekin and Pelton (2014) have mentioned that in Theory of Planned Behaviour (TPB), rational contemplations direct peoples’ behaviour and choices and the extent to which they feel they can engage in a certain behaviour also affects their intentions and behaviour.

2.3.3 Computer Self-Efficacy

Computer self-efficacy is defined as the degree to which an individual believes that he or she has the ability to perform a specific task/job using the system (Venkatesh & Bala, 2008). While investigating factors that affect consumer usage of QR codes, Ozkaya et. al, (2015) maintains that ownership of electronic devices indicates more frequent use of QR codes and further findings showed that technology ownership was the strongest predictor of adoption of laptops. This was attributed to the fact that individuals with electronic devices are likely to
have more experience with technology and thus a stronger self-efficacy to try a new technology. While investigating if service quality of an information system had an effect on perceived ease of use, findings indicated it had a positive effect and proficient system efficacy was among the functions that affected the perceived ease of use of the system under study (Chen et. al, 2014).

Self-efficacy has been indicated as among the important factors affecting the intention to use QR code reading applications (Louho, Kallioja, & Oittinen, 2006). The concept of self-efficacy proposes that peoples’ behaviour is strongly influenced by their confidence that they can perform the target behaviour for instance in this case adopting the secure cryptographic QR for counterfeit goods authentication. From the study, individuals who interacted with QR code to advertise needed them to perform a number of technological tasks that included access of QR code reader, scanning the code while waiting for information to be displayed then traverse through to ensure the sites have useful information. Therefore, lack of computer self-efficacy among individuals can make them feel less confident in achieving tasks (Jung, Somerstein & Kwon, 2012). Other studies have gone to mention the importance of understanding the antecedents of perceived ease of use since they play a major role in influencing use and acceptance of a system. Park (2009) also mentions that computer self-efficacy acts as a factor that determines perceived ease of use before and after using a system. It can be used to predict perception of users and their use of systems in various organizations. Some beliefs hold the fact that usability features of a system such as its design solely determine the perceived ease of use of a given system. This then forms the basis of accepting or rejecting the system (Venkatesh & Davis, 1996).

To extend other studies, computer self-efficacy has also been defined as a person’s judgement of their ability of effective computers’ use which was identified to play a positive role to shape perceptions of perceived usefulness, perceived ease of use and eventually intentions to use a given system (Holsapple & Sasidharan, 2005). This study focuses on the fact that users strongly attribute their perceptions of ease of use about a system to their computer self efficacy. Other studies have further explained that computer self efficacy is a key factor in determining a person’s decision to use computers. Computer self efficacy impacts a person’s expectation on the outcome of using a computer and eventually affects their decision to use the system or computer (Hill, Smith & Mann, 1987). Notably, persons with high level of computer self-efficacy have been studied to use computers and systems more
ferquently and also resulted to enjoying more from this use. Also computer self efficacy is generally represented as the degree to which an individual believes that he or she has the ability to perform a specific task/job using the secure cryptographic QR. This study thus suggests that high levels of computer self-efficacy among users lead to more positive perceptions on ease of use and eventually their intention to use the application.

2.3.4 Intention to Use

According to Pousttchi and Wiedemann (n.d), intention to use is defined as the attitude towards system usage and is influenced by perceived usefulness and perceived ease of use. These two important factors influence consumers to use a technology as described in TAM. Many previous studies have indicated the effect of these two factors on consumers’ attitude towards using a technology and how their attitude influences their behavioural intention to use the technology such as transacting through e-commerce platforms or in making online purchases (Hwang & Chung, 2015).

Other factors highlighted in the study on effect of sport consumers’ intentions to scan QR codes indicate that intention to use would be based on attractiveness of the content of the codes that is spectators will most likely scan the codes if the design was attractive and identifiable with less effort. The appearance of the QR codes could also be made informative to directly match the interests of the consumers (Hwang & Chung, 2015). According to Hwang and Chung (2015), studies of how consumers shaped their attitudes toward QR codes showed that they lacked prior experience and knowledge on how to scan these codes: this affected their behaviour to scan. Their behaviour of scanning were based on the experience they had before and the confidence in using QR technology.

Shin, Jung, and Chang (2012) state that perceived usefulness and perceived ease of use are key drivers of attitude and that the attitude towards QR codes positively influences the intention to use these codes. According to Lo (2014), personality traits and attitudes combine to give intentions which results to behavior as explained in several theoretical frameworks such as the TRA, TPB, and TAM on why many users accept or reject use of a service. The TRA states that a person’s behavior can be anticipated based on their behavioral intention that is as a result of personal and social mechanisms. Behavioral beliefs refer to the probability that a behavior leads to certain outcomes. Therefore, TRA emphasizes that
behavioral beliefs envisage an individual’s attitudes on innovation and this in turn predicts their behavioral intention.

Several factors were used to investigate intention of users for using QR codes and research was based on TAM. Findings showed that quality of QR codes affects intention and behavior of individuals towards using the QR codes (Demir, Kaynak & Demir, 2015). Some findings on respondents on occurrence of using QR codes and perceived usefulness, perceived ease of use, participants enjoyment and attitude towards QR codes and the intention to adoption this technology shows respondents saw the codes as easy to use and interact with. They would also be willing to recommend this technology to others and also use it in future (Santos, 2015).

Towards understanding the behavioral intention to use an information system, Jackson (1997) also indicates what needs to be understood in order to come up with a base knowing the concepts and processes that determine a user to accept or reject information technologies. This is by having a focus on the users’ attitude. The behavioral intention to use (BIU) an information system is well explained in the Theory of Reasoned Action (TRA) as proposed by Ajzen and Fishbein (1975) to explain that behavior towards using a system or information system is best forecast by intentions. They further explain that these intentions are determined by the attitude of the user and subjective norms that regard the behavior.

This study thus focused on the behaioiural intention to use the secure QR rather that on the actual usage of the same application. Attitude towards a system or entity has been mentioned to have an influence on intentions which ultimately influences behaviour to the entity and in this case the actual use.

2.4 Government Factors on Adoption of Secure QR Technology

Hsieh, Rai and Keil (2008) conducted a study to understand digital inequality through comparison of use of behavioral models. They mentioned governments that come up with initiatives to curb digital inequalities have expectations that these mediations should indeed help citizens in accessing and using ICT. Other studies mention that governments can use efficient methods to raise citizens’ awareness and also their interest (Hsieh et al. 2008). Some of the methods include use of media channels such as print, television, radio, the internet or conducting public forums to explain the benefits of ICT use.
In this study, government influence was studied under three constructs namely policy, awareness and enforcement. Government influence can be defined as the perceived expectation from the government institutions for persons to perform the behavior of interest (Keil, Garret, & Kvasny, 2003). The government and other affiliate institutions play an important role in formulating and enforcing policies to combat production, distribution and sale of counterfeit goods. From the perspective of citizens, the efforts of the government and institutions in creating the policies, awareness and enforcement delivers the message that the government is dedicated to their interests. It also shows that their welfare and requirements have been taken into account.

2.4.1 Policies

The problem of counterfeits has continued to thrive and prevails at the same time being labelled as the crime of the 21st century. Trafficked counterfeit goods has become a worldwide criminal enterprise with an estimated value of US$ 600 billion annually (Muthiani & Wanjau, 2012). A report by the Government of Kenya [GOK] (2009) describes that the most counterfeited products include dry cell batteries, biro pens, cosmetics, pharmaceutical products, consumables such as food & beverage items among others. Kenya Association of Manufacturers [KAM] (2008) claims that counterfeit goods have resulted to a cost of US$ 650 million to the SMEs in the country and a resulting loss of US$ 250 million in terms of taxes to the government as at 2008. Karingu and Ngugi (2013) observes in their study that Kenya has put in place statutes to deal with counterfeit issues specifically the Anti-Counterfeit Act, 2008 that established the Anti-Counterfeit Agency (ACA) which is mandated to administer anti-counterfeiting policy and law in the country. ACA main functions and mandates include enforcing the provisions of the Anti-Counterfeit Act, 2008, educating the public on counterfeiting issues and lastly combating counterfeiting activities in Kenya. The Anti-Counterfeit Act has gone ahead and outlined the powers of enforcement officers under the ACA to perform its mandate efficiently (Ongola, 2014).

The Kenya’s Penal Code (Cap 63) gives a general framework for various anti-counterfeiting criminal laws.

2.4.2 Enforcement of Policies

Ongola (2014) in his report mentions that enforcement involves compelling compliance with the law, mandate, command or decree with a bias on ensuring observance of various
intellectual property rights. This enforcement is in light of various anti-counterfeit laws that exist to fight counterfeits which include intellectual property doctrines, copyright law, patent law, trademark law and the Anti-Counterfeit Act, 2008. These laws against counterfeits are in existence but the major issue is lack of enforcement thus resulting to proliferation of counterfeits (Eaton, 2015). The report emphasizes on need to train regulatory authorities on how to spot counterfeits and educate users and the general public on the dangers of counterfeit goods.

Asuamah, Prempeh, and Boateng (2013) conducted a investigation in Ghana on how counterfeit goods are purchased and consumed and recommended policy makers to put their study findings into consideration in the production and regulation of counterfeit drugs. This approach can also be adopted in mitigation efforts to identify and authenticate other counterfeit goods especially the FMCGs. They also emphasized on need for consumer training to create awareness.

A study conducted by Macrothink Institute gave several recommendations that the government can adopt in the fight against counterfeit goods; that is review of the ACA Act 2008 that has issues of consumer reporting which is an important factor that will be used to get redress once cases are reported (Musamali, 2014). Consumers should not be intimidated but rather be empowered to report any issues arising from violation of their rights when they access counterfeits. ACA should also be allocated more resources so that they can increase their personnel countrywide thereby enabling consumers access ACA premises and report their issues. Odung (2006) in her thesis reports that lack of funds hinders operations such as market surveillance.

ACA also needs to conduct countrywide campaigns to create awareness of counterfeits through media that is easily accessible by most people. These campaigns and education programs will be aimed at enabling consumers distinguish counterfeits from genuine goods, how to authenticate these products using various tools such as mobile phones, dangers of consuming counterfeits among others and also where to report this cases to relevant authorities (Musamali, 2014).

According to Ongola (2014), he mentions various challenges faced by ACA that inhibits its ability to discharge the duties such as limited powers from courts to handle counterfeit cases. Musamali (2014) also suggests the need for various authorities to collaborate and eradicate
counterfeits. The operations of these bodies can be harmonized to establish a common platform for addressing issues related to counterfeits such as identification and authentication. These include ACA, KEBS & KRA. This also agrees with Karingu and Ngugi (2013) who in the literature review indicate the mandate of the government to fight counterfeit products by re-strategizing their operations and review on the laws governing counterfeits.

Other measures have been in various Chinese firms that are aggressive advertising such as through product websites to indicate the damaging effects of counterfeits to the public. They have also adopted investigation and surveillance by hiring private firms to apprehend counterfeiters and anyone involved in this trade. The offenders have been apprehended and their products and assets seized after their operations are uncovered (Hoecht & Trott, 2014).

The United Nations in their report (UN, 2012) indicate that mechanisms should be created to collect data and evidence of counterfeiting activities and this data would be used to analyze the strategises used by the entities involved in counterfeiting, distribution channels and also get ways of protecting consumers. The government and regulatory agencies can also allocate resources to strengthen the registration procedure that will ensure all products are assessed for safety and quality before being released in the market (El-Jardali et al., 2015). El-Jardali in his report indicates that pharmaceutical drugs including those from domestic manufacturers can be maintained in updated list that to indicate which ones are registered with the government and authorities.

Apart from the measures stated above to fight counterfeits, Odung (2006) says that penalties in place for this illegal trade of counterfeits are inadequate. These should be revised and tightened to act as a deterrent for the violators. The legal systems are also not fully equipped to deal with cases regarding counterfeits.

In order for the secure cryptographic QR to be adopted in authentication of counterfeit goods, the government needs to enforce already established polices to fight this menace once and for all. Muthiani and Wanjau (2012) indicate that the government should complement legislation with law enforcement to develop strategies that will reduce corruption, criminal activities and foster collaboration with regulatory institutions mandated in fighting counterfeits.
2.4.3 Awareness

Awareness is defined as a period where an individual acquires information about existence of a technology but they possess little understanding about it (Daberkow & McBride, 2003). Most people become aware of technologies through various communication channels such as the media. Awareness of technology is also influenced by individual characteristics, social-economic aspects and access to awareness channels such as communication media (Straub, 2009).

This section therefore reviewed how awareness of technology can influence people on its adoption. Prior studies have cited lack of awareness and a major reason of non-adoption of technology; Devi and Ponmarasi (2009) who mentioned this as the main problem in adoption of modern production technology by farmers in their research. From their population, lack of awareness that hindered adoption of the technology was attributed to lack of training and experience among the farmers. AlAwadhi and Morris (2009) also conducted an investigation to establish determinants of adopting their technology based on use of e-government services. They established that lack of awareness was one of the factors that influence adoption of this technology. They further reported that lack of awareness was attributed to failure of participants not knowing the benefits they will gain from the e-government technology and also how to use it. This indicates the importance of making aware the benefits of a technology to users so that they are able to evaluate its usefulness with other conventional options.

Furthermore, Baker and Bellordre (2004) posited that lack of technology awareness or knowing the benefits associated with it as a key concern related to adoption of information technology. Users should be able to know the importance of the technology inorder to use it. However, lack of awareness of a technology among people can be attributed to other factors based on age, accessibility and also affordability. If consumers are not aware of the technology in question, then they are highly unlikely to use it (Chen & Dimitrova, 2006). During initial stages of implementing a technology, awareness at this level increases users’ inclination to adopt the technology (Jaruwachirathanakul & Fink, 2005).

Moreover, Huber, Michael, and McCathie (2007) also cited lack of awareness as a barrier to adoption of RFID technology to satisfy needs in the supply chain. The level of awareness of the technology among the population under study was low due to failure of recognizing the
potential of RFID technology. The suggestion was involvement of more bodies such as those enforcing standards, the government and manufacturers of products in order to create awareness of the technology (Huber, Michael, & McCathie, 2007).

2.5 Develop a Prototype of Secure QR Technology

The secure QR prototype was developed to enable alcohol vendors authenticate goods thereby indicating the security aspects that make it suitable for adoption. The prototype was based on blockchain technology as described earlier in section 2.2.7

In summary, while the above literature review identified a number of known factors mentioned in previous studies such as TAM that determine the adoption of a given technology such as perceived usefulness, perceived ease of use, social norms and trust, comparatively little is known about whether there are other factors that can be added to the model. To address this gap, this study explored these additional factors such as government influence and system characteristics that determine the adoption of the secure cryptographic QR through empirically collecting data and analyzing it using alcohol vendors in Nairobi and its environs as subjects.

2.6 Theoretical Framework

This section discussed theories that pertain to adoption of new technology which are theory of reasoned action, innovation diffusion theory, unified theory of acceptance and use of technology and the technology acceptance model.

2.6.1 Theory of Reasoned Action (TRA)

The TRA tried to explain a person’s action that is determined by their behavioural intention to do it. According to this theory, behavior intention is explained by people’s attitudes towards that behavior and the subjective norms. A person’s attitude towards a behavior also includes their behavioural beliefs that is assessing the behavior consequences, subjective norms motivation and normative beliefs which must be explained (Ndumba & Muturi, 2014). The theory further explains that as long as a person voluntarily controls their behavior, behavior can explain the factors that would influence adoption of a technology. In 1989, Davis extended TRA to the TAM and further linked it to user acceptance of a system.
2.6.2 Innovation Diffusion Theory
Innovation Diffusion Theory also pertained to adoption of new technology and was proposed by Everette Rogers in 1983. In his article, Inman (2000) mentions that Rogers defines diffusion as the process by which an innovation is conversed using particular channels over time by members of a social system. Rogers also states that innovation is an idea or practice that is alleged new by a person or component of adoption. Rogers further explained five characteristics innovation should have that explain their adoption rate namely: relative advantage, compatibility, complexity, trialability and observability. Relative advantage is the degree to which an innovation is perceived as better than the idea it replaces, compatibility is the degree to which an innovation is alleged as being consistent with existing values, past experiences and the needs of those who want to adopt the innovation while complexity is the extent to which an innovation is perceived hard to comprehend and use. Trialability has been defined as the degree to which an innovation may be tested on a limited basis while observability is the extent of visibility of innovation results to other people (Inman, 2000).

2.6.3 Unified Theory of Acceptance and Use of Technology
Prior research has been conducted on individual research and use of IT and established this to be one of the most established stream of IS research. Research has also been conducted on adoption of technology by various persons and organization and concluded that a person must first use a given technology before they can get the anticipated outcomes such as improved performance of employees and so on (Venkatesh, Thong, & Xu, 2016). The Unified Theory of Acceptance and Use of Technology (UTAUT) was formed after a review of constructs from eight previous models which had been studied to explain information system usage behavior. These are theory of reasoned action, theory of planned behavior, innovation diffusion theory, social cognitive theory, technology acceptance model, motivational model, model of PC utilization and the combined theory of planned behavior-technology acceptance model. UTAUT further proposes four key factors and moderators that relate to prediction of behavioural intention to use a particular technology and the actual use of technology in organizations context. The factors are facilitating conditions, social influence, effort expectancy, and performance expectancy while the moderators include gender, age, experience and voluntariness. According to Venkatesh, Thong & Xu (2016), performance expectancy, effort expectancy and social influence were hypothesized and found to have an influence on behavioural intention to use a technology. On the other hand, facilitating conditions and behavioural intentions define technology use.
2.6.4 Technology Acceptance Model

The Technology Acceptance Model (TAM) was proposed by Davis (1989) and adapted from the Theory of Reasoned Action (TRA). It is an empirical test of user acceptance on information technology. TAM model has been adopted in many areas of research to establish user intentions to adopt and use new technologies. This model included two main constructs: perceived usefulness and ease of use. Perceived usefulness is defined as the degree to which a person believes that using a particular system will enhance his or her job performance, Venkatesh and Bala (2008), and ease of use is the degree to which a person believes that using a particular system would be free from effort (Venkatesh & Morris, 2000). These two factors determine whether users adopt and are actually using the technology being proposed. TAM thus proposes that these two constructs define one’s behavioural intention to use a technology. In this study, TAM for adoption of secure QR was an extension of the original TAM that was proposed by Davis (1989) and it included additional variables such as trust (in encrypted QR code characteristics construct), perceived usefulness (in user attitudes construct) and intention to use. Other studies have also discussed what influences intention to use to actual system use (Govender & Sihlali, 2014). However, this study focused on factors influencing the adoption of secure QR. This was consequently greatly influenced by the variables trust, cost, reliability, perceived usefulness, perceived ease of use, computer self-efficacy, social norms, policies and enforcement of these policies. The figure below shows an extension of TAM for intention to use Davis (1989) was extended for this study.

\[\text{Figure 2.4: Extension of TAM for Intention to Use}\]
2.7 Conceptual Framework & Hypotheses Testing

The research model described below was developed by combining TAM model that is mostly adopted to develop information technology applications. The important dimensions in this study were encrypted QR code characteristics, user attitudes and government factors. Through the literature review, a framework tailored for secure QR application was developed and illustrated in Figure 2.5. The purpose of this study was to investigate the factors that influence the adoption of secure cryptographic QR in counterfeit goods authentication.

Figure 2.5: Conceptual Framework for Secure Cryptographic QR Solution

From the Figure 2.5, the independent variables include encrypted QR code characteristics, merchant attitudes and government factors. The dependent variable was behavioural intention to use secure QR. The following hypotheses were identified and tested during the study:

H₁: Perceived usefulness (PU) has significant influence on behavioural intention to use (ITU).
H₂: Perceived ease of use (PEOU) has a significant influence on behavioural intention to use (ITU).

H₃: Perceived ease of use (PEOU) will have a significant influence on perceived usefulness (PU).

H₄: Computer self-efficacy (CSE) of users will positively influence perceived ease of use (PEOU) of the secure cryptographic QR.

H₅: Computer self-efficacy (CSE) of users will positively influence users’ intention (ITU) to use the secure cryptographic application.

Under system characteristics the hypothesis are as follows:

H₆: Perceived cost effectiveness will have a positive influence on perceived usefulness (PU) of the secure QR application.

H₇: Reliability will have a positive influence on perceived usefulness (PU) of the secure QR application.

H₈: Perceived cost effectiveness will have a positive influence on perceived ease of use usefulness (PEOU) of the secure QR application.

H₉: Reliability will have a positive influence on perceived ease of use usefulness (PEOU) of the secure QR application.

H₁₀: Higher levels of trust (TRUST) in secure QR system will be positively related to behavioural intention to use (ITU).

H₁₁: Social norms (NORM) has a positive effect on users’ behavioral intention to use (ITU) the secure cryptographic QR.

H₁₂: Government policy will be positively related to behavioral intention (ITU) to use the secure QR application.

H₁₃: Government awareness will be positively related to behavioral intention to use (ITU) the secure QR application.

H₁₄: Government enforcement will be positively related to behavioral intention to use (ITU) the secure QR application.
2.8 Gap in Literature
In background of the problem section, it has been outlined that previous studies that have been conducted in Kenya and other regions in Africa to investigate factors that influence adoption of technology in various fields. However, it is evident that the investigation on factors influencing QR technology have not been adequate especially in the context of counterfeit goods authentication. Moreover, prior studies considered certain variables that were specific to certain contexts and thus their results do not apply in the context of products authentication. There are few studies which have been conducted on factors influencing QR technology adoption.

This study therefore aimed at investigating the factors that influence the adoption of secure cryptographic QR in counterfeit goods authentication on selected alcohol vendors.

2.9 Chapter Summary
This chapter outlined prior research on factors influencing the adoption of secure cryptographic QR. More specifically, focus was on the specific objectives of the study; the influence of cryptographic embedded QR code characteristics on adoption of secure QR technology, influence of merchant attitudes and government factors on adoption of secure QR technology. The last objective detailed the proposed prototype that was developed. The next chapter discussed the research methodology used.
CHAPTER 3.0: RESEARCH METHODOLOGY

3.1 Introduction
This chapter described the approach that was adopted to achieve the research objectives and it included the research design, population and sampling design, data collection methods, sampling frame and technique used, research procedures and also the data analysis methods. Goddard and Melville (2004) define research methodology as the systematic approach of formulating solutions to addresses the problem stated, collecting, organizing and evaluating data to determine whether the research objectives were met. That is research methodology is termed as a systematic method of defining a problem, coming up with a hypothesis, collecting and analyzing data to come up with solutions that address the concerned problem. The chapter concluded with a summary that described briefly the pertinent issues discussed by the researcher.

3.2 Research Design
The research design followed two approaches that is a behavioral approach in which a quantitative research design using a survey questionnaire was issued to a selected population and an experimental method involving component design and development of the cryptographic QR system. The questionnaire was opted for use since it had the benefit of covering a wider target population and also gave better standardized responses. Additionally, most people are familiar with questionnaires, have reduced bias and the respondents can complete them at their own convenience. The survey questionnaire was administered to a total of 120 alcohol vendors within Nairobi and its environs. Data was also collected from the live system in this case the public ledger that stored product details provided valuable information. This method was selected due to the limitation of time required to complete the study and the fact that respondents provided anonymous feedback that in most cases is honest as opposed to conducting face to face sessions. According to Creswell (2007) quantitative research is the process of collecting and converting data into a numerical way so that statistical calculations can be made and also to draw conclusions. The process involved use of hypotheses which indicated the relationship among variables being investigated.
3.3 Population and Sampling Design

3.3.1 Target Population
The target population of this study consisted of merchants (alcoholic vendors) that engage in trade of alcoholic beverages. This population was drawn from alcohol vendors within Nairobi and the estimate figure is one thousand and one hundred registered vendors as per vendor license statistics from the county office. This research focused on the business activities of these merchants and specifically the products sold from their outlets to consumers.

3.3.2 Sampling Design
This outlined the method the researcher used to select the sample from the population. It was important to select a sampling design that provided the necessary information otherwise the entire process could have been null.

3.3.2.1 Sampling Frame
According to Turner (2003), a sampling frame refers to the set of source materials from which the sample is selected. This basically describes the foundation used by the researcher to obtain their sample. It necessitates running down components of the sample that have relative qualities from the population they are drawn from. In this study, the sample frame was comprised of alcoholic vendors from Nairobi environs with specific focus on those selling alcoholic beverages such as wines, spirits, and liqueurs among others. For this research, the sample frame was a database of products sold by the vendors that had cryptography embedded QR codes.

3.3.2.2 Sampling Technique
Sampling technique refers to the method chosen to select a sample from a given population (Kothari, 2004). The study used simple random sampling which was an ideal method because each item of the population has an equal chance of being selected and all elements of the population have the same probability of being picked to belong to the sample.

3.3.2.3 Sample Size
The sample size constituted alcoholic vendors within Nairobi environs that deal with sale of alcoholic beverages that included but not limited to beer, wines, liqueurs and spirits among others. These vendors were chosen through simple random sampling and were selected since they sell a variety of goods that are easily counterfeited and the fact that these products are
distributed widely. The researcher considered at least 10% of the population as the sample size and this constituted to one hundred and twenty vendors.

3.4 Data Collection Methods
The study applied use of primary data collected using two methods that is use of questionnaires and data from the live system (database or product ledger). Structured questionnaires were used since they are easy to administer. The questionnaires were distributed to the alcohol vendors by hand and were marked appropriately on the sections. The questions also covered the variables detailed in the theoretical framework. Data from the live system was generated from the transaction ledger that recorded all products scanned to determine the counterfeits. It was also necessary to conduct test on reliability and validity to test the goodness of data that was studied.

Demira, Kaynak and Demir (2015) defines reliability as a measure that consistently reflects the construct that it is measuring. All items appearing on the questionnaire survey were constructed on a five-point Likert scale of 1 to 5 with 1 indicating “Strongly Disagree”, 2 indicated “Disagree”, 3 showed “Neither Agree or Disagree”, 4 being “Agree” and 5 indicated “Strongly Disagree”. Specific objectives of the study were used in coming up with the questionnaires. The constructs in the survey were questions drawn from a universal pool that were adapted form previously validated work (Shin, Jung, & Chang, 2012). Therefore, content validity was recognized through review of the literature. For this study reliability of data was measured using Cronbach’s alpha values to identify which items were reliable and if the entire test was consistent. Table 3.1 shows a summary of the questionnaires. The response rate was 87%.

Table 1.1: Summary of Research Questionnaires

<table>
<thead>
<tr>
<th>Description</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Questionnaires distributed</td>
<td>138</td>
</tr>
<tr>
<td>Correctly filled and returned questionnaires</td>
<td>120</td>
</tr>
<tr>
<td>Invalid questionnaires returned</td>
<td>18</td>
</tr>
</tbody>
</table>
3.5 Research Procedures
The researcher distributed the survey questionnaire among the respondents. The structured closed-ended questions made it easy for the respondents to go through and fill in the sections. The instrument was divided into four sections that is the first section contained general demographic information while the other subsequent sections addressed the research objectives. In order to obtain a high response rate, the researcher waited for most respondents to fill in the questionnaires before gathering them; this was a better approach since clarifications could be explained if need be.

3.6 Data Analysis Methods
After data was collected, the researcher perused through the questionnaires to ensure completeness; confirm all questions were duly filled. Data was then summarized and coded in an Excel worksheet. This data was then analyzed using the Statistical Package for Social Sciences (SPSS) package that includes statistical analytical capabilities such as descriptive analysis, factor analysis, reliability analysis, correlation and regression. The results of SPSS were presented in tables, charts and graphs.

3.7 Chapter Summary
This chapter outlined the research methodology by emphasizing on research design, sampling design, sample frame, target population, data collection and analysis methods in order to achieve the research objectives. This next chapter discusses the system implementation employed in the study.
CHAPTER 4.0: SYSTEM IMPLEMENTATION

4.1 Introduction

This section focused on the factors that influence adoption of secure cryptographic QR to authenticate counterfeit goods. The secure cryptographic QR is the application that was developed to authenticate various consumer goods namely alcoholic beverages. In this section, the hypotheses were deduced from the literature reviewed in chapter two on factors that influence adoption of a particular technology by users and is then applied in the context of secure cryptographic QR which in my opinion has not yet been applied. Consequently, a testable theoretical model was proposed that studied various factors that may influence adoption of secure cryptographic QR to authenticate counterfeit goods. Specifically, this chapter investigated the influence of encrypted QR code characteristics and user attitudes and behavioural intention to use secure QR.

4.2 Analysis

This section discussed the literature that was reviewed to evaluate factors that influence behavioural intention to adopt a given technology and in the case of this study the secure cryptographic QR. The constructs that were studied include trust, perceived cost, perceived usefulness, perceived ease of use, system characteristics and user attitude towards intention to use the encrypted QR. It is worthwhile to note that the technology acceptance model (TAM) originally suggested in 1986 by Davis is a renowned model that relates to acceptance of technology and its use. It provides a basis with which individuals’ determine how variables influence attitude and intention to use. The model further posits that a person’s actual use of a system in predisposed by their behavior intentions, perceived usefulness, their attitude and perceived ease of use of the technology or system. There are also external factors that influence intention to use and actual system use by having mediated effect on perceived usefulness and perceived ease of use. These were studied in this investigation and incorporated in the theoretical model that was tested. However, this investigation considered the factors that influence behavioral intention to use the secure cryptographic QR.

According to Ajzen and Fishbein (1980), TAM has been termed as an extension of theory of reasoned action (TRA). Other prior studies have indicated the evolution of TAM over the years to include other factors; through the extension to TAM2. TAM2 extended TAM to describe intention to use a technology by including social influence, experience of users and
reasoning processes (Park, 2009). From the literature review discussed in chapter two, the following theoretical model was proposed; (Figure 4.1).

Figure 4.1: Theoretical Model

The above model gave rise to the hypotheses listed below where the boxes indicate the constructs which were measured using a set of items while the arrows show the hypotheses 1 to 14.

H₁: Perceived usefulness (PU) has significant influence on behavioural intention to use (ITU).

H₂: Perceived ease of use (PEOU) has a significant influence on behavioural intention to use (ITU).

H₃: Perceived ease of use (PEOU) will have a significant influence on perceived usefulness (PU).

H₄: Computer self-efficacy (CSE) of users will positively influence perceived ease of use (PEOU) of the secure cryptographic QR.
H₅: Computer self-efficacy (CSE) of users will positively influence users’ intention (ITU) to use the secure cryptographic application.

Under system characteristics the hypothesis are as follows:

H₆: Perceived cost effectiveness will have a positive influence on perceived usefulness (PU) of the secure QR application.

H₇: Reliability will have a positive influence on perceived usefulness (PU) of the secure QR application.

H₈: Perceived cost effectiveness will have a positive influence on perceived ease of use usefulness (PEOU) of the secure QR application.

H₉: Reliability will have a positive influence on perceived ease of use usefulness (PEOU) of the secure QR application.

H₁₀: Higher levels of trust (TRUST) in secure QR system will be positively related to behavioural intention to use (ITU).

H₁¹: Social norms (NORM) has a positive effect on users’ behavioral intention to use (ITU) the secure cryptographic QR.

H₁²: Government policy will be positively related to behavioral intention (ITU) to use the secure QR application.

H₁₃: Government awareness will be positively related to behavioral intention to use (ITU) the secure QR application.

H₁₄: Government enforcement will be positively related to behavioral intention to use (ITU) the secure QR application.

4.4 Modeling

This study proposed a theoretical framework as mentioned earlier of the target population composed of alcohol vendors’ intention to use the secure QR mainly based on the Technology Acceptance Model (TAM). This section is in line with objectives of the study that analyzed the relationship of these vendors’ intention to use secure QR with designated constructs such as their perceived usefulness, social norms, perceived ease of use, trust, computer self-efficacy including system characteristics such as perceived cost and reliability. A secure QR application was also implemented that provides users with inferences for better
authenticating counterfeit goods. The cryptographic QR was designed using blockchain technology that was discussed in depth in chapter 2. Additionally, it was developed using PHP whose acronym is Hypertext Preprocessor and the framework is Laravel. PHP is an open source language used for developing web based applications and also allows embedding them to HTML. Laravel framework allows developers to implement web based projects by providing tasks such as those for authenticating; this is why the researcher preferred Laravel and also due to its integration to PHP. The database that was used to capture the product and user management details was MySQL which is a relational database based on SQL that enables users to manage their data. The researcher preferred use of MySQL as it is fast in processing data and also maintains some level of reliability which is an important aspect when handling data. The local server for the QR application was XAMPP platform and the text editor adopted was the PHP storm.

4.4.1 How the Cryptographic QR Application Works

i. Adding a Product

Figure 4.2 indicates the overview of the secure QR application with navigation menus such as home page, products section and user management. User management allows one to manage users actions in relation to data manipulation. Under product menu, this is the provision for adding new products in the database by specifying the name, serial number, manufacturer, batch number and miscellaneous description. It also included a provision for uploading the QR code that is appended on the product.
ii. **Editing Product Details**

The secure QR application allowed one to edit product details as desired and this information was updated on the database as described in Figure 4.3.
iii. Product List

This section allowed users to preview all products added with details such as product name, description, serial numbers of items, manufacturer particulars and user actions such as viewing, editing and deleting functions. Vendors could also export this information through Excel and CSV formats.
iv. **Scanning Secure QR Code on a Product**

Figure 4.5 shows how a vendor used the QR code application using their workstation/desktop PC to scan QR code of a product. The process begun when the user launched the secure QR application from their PC; this activated the camera and then scanned the QR code on appended on the product. On scanning the product QR code, the application deciphered the encrypted information of QR code written on the product. This information was then queried by the database as shown in Figure 4.7 and a message was displayed to show the successful authentication.
Figure 4.5: Scanning QR Code of Product

v. Appearance of the Secure QR Code

Figure 4.6 shows how the QR application compared the QR code on the product against that which was stored on the database. As mentioned earlier, the QR code on the product is the unique number that is referenced on the database.
vi. **Genuine Product Scan**

Once the QR code on the product was scanned, a query was made to the database to ascertain if the unique number of the QR code was a valid one. When this unique number matched the details on the database, the product was established to be genuine/ authentic and a prompt showed a message indicating the product was valid; it showed the serial number details and item description. The database then timestamped this query to ensure that the scanned and authenticated item was deducted from its inventory list of all genuine products. This also indicated that the product cannot be duplicated again with the same details and will thus pass off as a fake product if scanned again.
Figure 4.7: Scan Result of Genuine Product

After the product was verified as a genuine one, the vendor could then sell it. The traders were able to capture details of the product such as the name, serial number, manufacturer details and batch number.

vii. Counterfeit Product Scan

In case the QR application was unable to verify the authenticity of the product, a warning message was displayed to the vendor indicating that the scanned product was not valid and thus source was unknown as shown in Figure 4.8. This implied that the product was a counterfeit or the QR code appended on it was a fake one since the details of the unique number did not correspond to those in the database.
Figure 4.8: Scan Results of Counterfeit Product

viii. Registering Users

This process involved capturing credentials for users who interacted with the secure QR application. Details captured included the name, email and also password set.
ix. **User Management Details**

Just like in any typical system or application, it was important to control user actions and access in regards to data management. The user management section of the application allowed one to register new users and update user profile details in order to control what one accessed. From Figure 4.10 details included users’ name, email, last login particulars, their roles and actions such as editing and deleting functions.

*Figure 4.9: Registering Users on QR Application*
x. Database Details

A summary of all product details on the database was summarized as shown in Figure 4.11. The information included the product name, description details, product serial numbers, manufacturer details and action menu that allowed users to perform actions such as viewing, editing and deleting functions. The application also enabled users to export this information into Excel and CSV formats.
4.5 Proof of Concept/Testing

Measurement

In this study, there was need to maximize the measurement reliability of the constructs and these items have been tested in other studies. Reliability of the results was improved by using survey questions that have been previously pre-tested and validated. Thus, the survey questionnaire that was adapted for the study to collect data was from a collection of scales that have been previously validated. The items that measured perceived usefulness and perceived ease of use were adapted from the Technology Acceptance Model (TAM) and it included modifications that reflected the context of secure cryptographic QR. The items for measuring trust, perceived cost effectiveness and intention to use were adapted from Ahmad and Ahlan (2015). To measure trust, perceived cost effectiveness, reliability, perceived usefulness, social norms and intention to use, 5 items, 5 items, 4 items, 6 items, four items and 2 items were used respectively. Also to measure perceived ease of use, government
factors on policy, awareness and enforcement, 5 items, 3 items, 4 items and 4 items were also used respectively. Each items was rated on a Likert scale of 1 to 5 (strongly disagree to neither agree or disagree to strongly agree).

The tabulated data of the theoretical model for the study was analyzed using the Statistical Package for Social Sciences (SPSS) which is a software package that includes data handling and statistical analysis capabilities. SPSS was also used to generate descriptive statistics for the demographic section.

**Validity and Reliability**

Validity describes the ability for a construct to measure what it’s supposed to measure and in this study content validity of the questionnaire was acknowledged through an extensive review of the literature. Construct validity of items in the survey questionnaire was tested using confirmatory factor analysis. It tested the fitness of data to the research model. The researcher adopted it because the study involved testing various hypothesis and there was an interest in exploring the data and thus applied the findings to the collected sample this is generally by descriptive method (Field, 2009). Results obtained after factor analysis showed the scales were reliable and valid for factors being studied. The factor loadings of computer self-efficacy were dropped in the rotation matrix since the values were below the criterion level of .512 as mentioned in (Field, 2009). The loadings for the SPSS loadings of the rotated component matrix are shown below in Table 4.1.

*Table 4.1: Rotated Component Matrix*
| Component | Trust2 | Trust3 | Trust4 | Trust5 | Cost1 | Cost2 | Cost3 | Cost4 | Cost5 | Relia1 | Relia2 | Relia3 | Relia4 | PU1 | PU2 | PU3 | PU4 | PU5 | PU6 | Norm1 | Norm2 | Norm3 | Norm4 | ITU1 | ITU2 | PE0U1 | PE0U2 | PE0U3 | PE0U4 | Pol2 | Pol3 | Aware1 | Aware2 | Aware3 | Aware4 | Enforce1 | Enforce2 | Enforce4 | SQCR1 | SQCR2 | SQCR3 | SQCR4 |
|-----------|--------|--------|--------|--------|-------|------|-------|-------|-------|-------|-------|-------|-------|------|-----|-----|-----|-----|-----|------|-------|-------|-------|-------|------|-----|-------|-------|-------|-------|--------|--------|--------|-------|--------|-------|--------|
|           | 0.605  | 0.677  | 0.724  | 0.721  | -0.102| 0.116 | -0.110| 0.091 | 0.122 | 0.067 | 0.180 | 0.101 | 0.044 | -0.011| -0.008| -0.078| -0.026| 0.045 | 0.132 | 0.160 | 0.096 | 0.106 | 0.070 | 0.007 | 0.000 | -0.029| -0.031 | 0.033 | 0.043 | 0.075 | 0.115 | -0.098| -0.025 | -0.056 | -0.024 | 0.015 | 0.050 | 0.067 | 0.121 |
|           | 0.208  | 0.262  | 0.329  | 0.230  | 0.606 | 0.746 | 0.603 | 0.779 | 0.623 | 0.144 | 0.012 | 0.012 | 0.293 | 0.123 | 0.114 | 0.166 | 0.177 | 0.135 | 0.145 | 0.150 | 0.095 | 0.077 | 0.172 | 0.018 | 0.220 | 0.223 | 0.136 | 0.214 | 0.150 | 0.080 | 0.080 | 0.155 | 0.114 | 0.015 | 0.168 | 0.115 | 0.115 |
|           | 0.015  | 0.138  | 0.127  | 0.158  | 0.225 | 0.277 | 0.276 | 0.084 | 0.079 | 0.773 | 0.002 | 0.116 | 0.079 | 0.067 | 0.166 | 0.116 | 0.379 | 0.187 | 0.150 | 0.183 | 0.176 | 0.021 | 0.022 | 0.098 | 0.055 | 0.288 | 0.224 | 0.121 | 0.060 | 0.222 | 0.168 | 0.095 | 0.060 | 0.116 | 0.129 |
|           | 0.323  | 0.251  | 0.131  | 0.158  | 0.186 | 0.038 | 0.080 | 0.117 | 0.302 | 0.180 | 0.116 | 0.017 | 0.749 | 0.148 | 0.773 | 0.798 | 0.771 | 0.799 | 0.598 | 0.143 | 0.076 | 0.017 | 0.055 | 0.136 | 0.025 | 0.098 | 0.144 | 0.012 | 0.168 | 0.066 | 0.762 | 0.183 | 0.123 | 0.179 | 0.130 |
|           | 0.151  | 0.032  | 0.127  | 0.061  | 0.060 | -0.001| 0.053 | 0.191 | 0.123 | 0.093 | 0.019 | 0.147 | 0.078 | 0.066 | 0.122 | 0.175 | 0.162 | 0.057 | 0.183 | 0.165 | 0.019 | 0.055 | 0.106 | 0.093 | 0.204 | 0.098 | 0.109 | 0.021 | 0.150 | 0.140 | 0.093 | 0.123 | 0.744 | 0.065 |
|           | 0.260  | 0.176  | 0.122  | 0.086  | 0.038 | -0.114| 0.051 | 0.100 | 0.152 | 0.093 | 0.147 | 0.085 | 0.220 | 0.092 | 0.035 | 0.175 | 0.117 | 0.288 | 0.183 | 0.065 | 0.020 | 0.055 | 0.065 | 0.093 | 0.204 | 0.140 | 0.125 | 0.136 | 0.016 | 0.186 | 0.140 | 0.116 | 0.048 | 0.111 |
|           | 0.077  | 0.263  | 0.123  | 0.185  | 0.001 | -0.104| 0.081 | 0.157 | 0.161 | 0.093 | 0.147 | 0.085 | 0.220 | 0.092 | 0.035 | 0.175 | 0.117 | 0.288 | 0.183 | 0.065 | 0.020 | 0.055 | 0.065 | 0.093 | 0.204 | 0.140 | 0.125 | 0.136 | 0.016 | 0.186 | 0.140 | 0.116 | 0.048 | 0.111 |
|           | 0.098  | 0.074  | 0.161  | 0.050  | 0.000 | -0.114| 0.051 | 0.071 | 0.161 | 0.093 | 0.147 | 0.085 | 0.220 | 0.092 | 0.035 | 0.175 | 0.117 | 0.288 | 0.183 | 0.065 | 0.020 | 0.055 | 0.065 | 0.093 | 0.204 | 0.140 | 0.125 | 0.136 | 0.016 | 0.186 | 0.140 | 0.116 | 0.048 | 0.111 |
|           | -0.123 | 0.145  | 0.025  | 0.120  | -0.098| -0.104| -0.114| 0.071 | 0.081 | 0.093 | 0.147 | 0.085 | 0.220 | 0.092 | 0.035 | 0.175 | 0.117 | 0.288 | 0.183 | 0.065 | 0.020 | 0.055 | 0.065 | 0.093 | 0.204 | 0.140 | 0.125 | 0.136 | 0.016 | 0.186 | 0.140 | 0.116 | 0.048 | 0.111 |
|           | 0.228  | 0.123  | 0.114  | 0.601  | 0.183 | 0.098 | 0.051 | 0.035 | 0.035 | 0.035 | 0.147 | 0.085 | 0.220 | 0.092 | 0.035 | 0.175 | 0.117 | 0.288 | 0.183 | 0.065 | 0.020 | 0.055 | 0.065 | 0.093 | 0.204 | 0.140 | 0.125 | 0.136 | 0.016 | 0.186 | 0.140 | 0.116 | 0.048 | 0.111 |

**Rotated Component Matrix**

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 8 iterations.
Cronbach’s alpha was employed to assess the reliability of factors. It was adopted to measure how the items positively correlated to each other. According to Sekaran and Bougie (2014), reliability coefficients that are less that 0.60 are considered as poor, those above 0.70 are deemed as acceptable while those with well over 0.80 are termed as good.

The reliability analysis results of the study are shown in Table 4.2. As indicated below, the alpha coefficients of the analysis exceeded 0.70 and these were regarded as acceptable.

**Table 4.2: Cronbach’s Alpha Coefficients**

<table>
<thead>
<tr>
<th>Construct</th>
<th>Cronbach’s Alpha</th>
<th>N of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trust (TRUST)</td>
<td>.825</td>
<td>4</td>
</tr>
<tr>
<td>Perceived Cost Effectiveness (COST)</td>
<td>.815</td>
<td>5</td>
</tr>
<tr>
<td>Reliability (RELIA)</td>
<td>.751</td>
<td>4</td>
</tr>
<tr>
<td>Perceived Usefulness (PU)</td>
<td>.904</td>
<td>6</td>
</tr>
<tr>
<td>Social Norms (NORM)</td>
<td>.827</td>
<td>4</td>
</tr>
<tr>
<td>Intention to Use (ITU)</td>
<td>.767</td>
<td>2</td>
</tr>
<tr>
<td>Perceived Ease of Use (PEOU)</td>
<td>.869</td>
<td>4</td>
</tr>
<tr>
<td>Policy (P)</td>
<td>.721</td>
<td>2</td>
</tr>
<tr>
<td>Awareness (A)</td>
<td>.888</td>
<td>4</td>
</tr>
<tr>
<td>Enforcement (E)</td>
<td>.803</td>
<td>3</td>
</tr>
<tr>
<td>Secure Cryptographic QR</td>
<td>.848</td>
<td>4</td>
</tr>
</tbody>
</table>

**4.6 Chapter Summary**

This chapter presented an analysis of the literature that was reviewed to investigate the factors influencing the behavioral intention to use the cryptographic QR application. The hypothesis adopted for the study were outlined after review of literature. A theoretical model was also described showing the hypothesis that was tested. The results of confirmatory factor analysis and reliability were also described. The reliability analysis results of alpha coefficients to show correlation of items were also outlined. The next chapter presents the
results and finds of the tabulated data that was analyzed using SPSS and also the information generated from descriptive statistics.
CHAPTER 5.0: RESULTS AND FINDINGS

5.1 Introduction

This chapter outlined the results and findings after analysis on factors influencing the behavioral intention to adopt the secure cryptographic QR application among alcohol vendors in Nairobi environs. This was guided by the research objectives and hypotheses as summarized in the theoretical model adopted for the investigation which were obtained after the testing done in the previous chapter that sought to identify how various factors influence the behavioral intention to adopt the secure cryptographic QR. The test results of general information obtained from demographics have been outlined including the hypothesis results. The investigation targeted vendors who trade in various alcoholic beverages with outlets within Nairobi.

5.2 Demographic Results

This section presented results obtained from the general information and demographics that was available to the respondents on the survey questionnaires. The information stated included gender representation, industry of respondents SME, age of the business, gross turnover of the business, the highest education level and also the nature of business. The information was presented in graphs and charts.

5.2.1 Gender Representation

Figure 5.1 shows that 55% of the respondents were of male gender while 45% were of female gender. This indicates that there is no major disparity between the two genders.
Figure 5.1: Gender Representation

5.2.2 Age of Respondents

The respondents’ age is shown in Figure 5.2 where the age range with the highest percentage was that of 26 to 30 years with 27.91%, the age group of 21 to 25 years had 17.83% of the respondents while those in the age range of 31 to 35 were 13.95%. Additionally, respondents in the age bracket of 36 to 40 years constituted 11.63%, respondents in the 46 to 50 age group consisted of 10.85%. Respondents in the age group of 41 to 45 years were 9.30%. There were no respondents who fell in the 15 to 20 years age group. The least represented age range was 51 or over years which had 8.53% of respondents.

Figure 5.2: Age of Respondents
5.2.3 SME Industry

The SME industry representation as shown in Figure 5.3 indicates that the highest representation of 24.03% was from others category and was closely followed by 23.26% of respondents engaging in wholesale trade of alcoholic beverages. The SME industry of retail constituted to 17.05% of respondents. Apparel industry had the least representation with only 4.65% of respondents.

![SME Industry Representation](image)

*Figure 5.3: SME Industry Representation*

5.2.4 Respondents Highest Level of Education

The study also aimed at identifying the highest level of education among the respondents. The figure below shows that 0.78% of the respondents had certificate as their highest level of education, 10.08% had a tertiary institution diploma as their highest education level, 56.59% of the respondents had a university degree as their highest education level. The respondents with the highest masters level of education were 30.23% and lastly respondents who are doctorate holders as their highest education level were 2.33%. This summary is shown in Figure 5.4.
The gross turnover of the respondents’ business was also taken into account in this investigation. As stated in the Figure 5.5, the highest bracket of GTO of less than one million Kenya shillings was 28.68% of the respondents, the GTO range of 2 to 3 million was 18.60% of the respondents while respondents with GTO of 4 to 10 million were 16.28%. This was closely followed by 15.50% of respondents with a GTO of 1 to 2 million Kenya shillings. The least representation of GTO the brackets of over 10 million Kenya shillings that had 8.53% of the respondents.
5.3 Results of Cryptographic QR Code Characteristics

The aim of objective one was to investigate the influence of cryptographic embedded QR code characteristics on adoption of secure QR technology. The researcher adopted bivariate correlation using Pearson’s correlation coefficient. The confidence interval was 99% with 1% confidence level 2-tailed. Table 5.1 displays the correlation matrix between the independent variables (trust, perceived cost effectiveness, reliability and secure cryptographic QR factors) and the dependent variable (intention to use).
Table 5.1: Correlations of Variables: Influence of Cryptographic QR Characteristics

<table>
<thead>
<tr>
<th></th>
<th>AVG_Trust</th>
<th>AVG_Cost</th>
<th>AVG_Reliability</th>
<th>AVG_SecureQR</th>
<th>AVG_ITU</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVG_Trust Pearson Correlation</td>
<td>1</td>
<td>.456**</td>
<td>.372**</td>
<td>.345**</td>
<td>.288**</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.018</td>
<td>.002</td>
<td>.000</td>
<td>.008</td>
</tr>
<tr>
<td>N</td>
<td>129</td>
<td>129</td>
<td>129</td>
<td>129</td>
<td>129</td>
</tr>
<tr>
<td>AVG_Cost Pearson Correlation</td>
<td>.456**</td>
<td>1</td>
<td>.209`</td>
<td>.380**</td>
<td>.433**</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.018</td>
<td>.002</td>
<td>.000</td>
<td>.008</td>
</tr>
<tr>
<td>N</td>
<td>129</td>
<td>129</td>
<td>129</td>
<td>129</td>
<td>129</td>
</tr>
<tr>
<td>AVG_Reliability Pearson Correlation</td>
<td>.372**</td>
<td>.209`</td>
<td>1</td>
<td>.273**</td>
<td>.233**</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.018</td>
<td>.002</td>
<td>.000</td>
<td>.008</td>
</tr>
<tr>
<td>N</td>
<td>129</td>
<td>129</td>
<td>129</td>
<td>129</td>
<td>129</td>
</tr>
<tr>
<td>AVG_SecureQR Pearson Correlation</td>
<td>.345**</td>
<td>.380**</td>
<td>.273**</td>
<td>1</td>
<td>.409**</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.000</td>
<td>.002</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>N</td>
<td>129</td>
<td>129</td>
<td>129</td>
<td>129</td>
<td>129</td>
</tr>
<tr>
<td>AVG_ITU Pearson Correlation</td>
<td>.288**</td>
<td>.433**</td>
<td>.233**</td>
<td>.409**</td>
<td>1</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.001</td>
<td>.000</td>
<td>.008</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>N</td>
<td>129</td>
<td>129</td>
<td>129</td>
<td>129</td>
<td>129</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

From the output of Table 5.1, there is a positive correlation between trust and intention to use at r = .288 with a significance value of .001 while cost is positively correlated to intention to use at .433 which is significant at p<0.001; the significance value is .000. There is a positive relationship between reliability and intention to use at r = .233 with significance value of .008. There is also a significant positive correlation between secure QR and intention to use at r = .409. The lower the significance value, the more significant a variable is. Therefore, the most significant factors are secure cryptographic and cost.

Regression Analysis on Influence of Cryptographic QR Characteristics

Table 5.2 shows the results of regression analysis on the influence of cryptographic QR code characteristics on intention to use. These are indicated by the r squared ($r^2$) value of .266.
**Table 5.2: Regression Analysis Results on Influence of Cryptographic QR Characteristics**

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.516&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.266</td>
<td>0.242</td>
<td>0.53542</td>
</tr>
</tbody>
</table>

<sup>a</sup> Predictors: (Constant), AVG_SecureQR, AVG_Reliability, AVG_Cost, AVG_Trust

**ANOVA**

The analysis of variance (ANOVA) which was used to test the significance of the model; it indicates whether the model results in a considerably good degree to forecast the outcome variable of the study. Table 5.3 indicates the F-ratio is significant at p < 0.05 since the significance value is .000 which is less than .005 at 95% confidence level. Thus, it is conclusive to state that the regression model was significant in predicting how, perceived cost effectiveness, reliability and secure QR characteristics influence intention to use the secure cryptographic QR.

**Table 5.3: ANOVA Results on Encrypted QR Characteristics**

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Regression</td>
<td>12.874</td>
<td>4</td>
<td>3.219</td>
<td>11.227</td>
</tr>
<tr>
<td></td>
<td>Residual</td>
<td>35.548</td>
<td>124</td>
<td>.287</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>48.422</td>
<td>128</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> Dependent Variable: AVG_ITU

<sup>b</sup> Predictors: (Constant), AVG_SecureQR, AVG_Reliability, AVG_Cost, AVG_Trust

From Table 5.3, it is evident that ANOVA only showed the significance of the entire model that is, it indicated a good degree to predict the outcome variable it but does not divulge on the contribution of each variable. Table 5.4 shows the variables of the model and their significance values.

65
Table 5.4: Parameters for Coefficients: Encrypted QR Characteristics

<table>
<thead>
<tr>
<th>Coefficients^a</th>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
<td></td>
</tr>
<tr>
<td>(Constant)</td>
<td>1</td>
<td>1.260</td>
<td>.450</td>
<td>2.801</td>
<td>.006</td>
</tr>
<tr>
<td>AVG_Trust</td>
<td></td>
<td>.025</td>
<td>.088</td>
<td>.027</td>
<td>.290</td>
</tr>
<tr>
<td>AVG_Cost</td>
<td></td>
<td>.361</td>
<td>.107</td>
<td>.303</td>
<td>3.381</td>
</tr>
<tr>
<td>AVG_Reliability</td>
<td></td>
<td>.078</td>
<td>.074</td>
<td>.088</td>
<td>1.052</td>
</tr>
<tr>
<td>AVG_SecureQR</td>
<td></td>
<td>.260</td>
<td>.086</td>
<td>.260</td>
<td>3.019</td>
</tr>
</tbody>
</table>

^a. Dependent Variable: AVG_ITU

The researcher adapted the formula shown below (Field, 2009).

\[ Y_i = (b_0 + b_1X_{i1} + b_2X_{i2} + ... + b_nX_{in}) + E_i \]

where \( b_0 \) is the constant, \( Y \) represents outcome variable, \( b_1 \) is the coefficient of the first item (\( X_{i1} \)), \( b_n \) represents coefficient of the nth item (\( X_{in} \)) and \( E_i \) is the items predicted and observed value \( Y \) of \( i \)th item. In this investigation, the outcome variable was intention to use the secure cryptographic QR application whereas the predictors \( Xi \) till the nth item are trust, perceived cost effectiveness, reliability, perceived usefulness, social norms, perceived ease of use, government policy, awareness, enforcement and notable characteristics of secure QR. Thus, based on the results of Table 5.4 and taking all independent variables into account at the constant, the regression formula for encrypted QR characteristics is stated as:

\[ ITUi = (1.260 + 0.025(Trust_i) + 0.361(Cost_i) + 0.078(Reliability_i) + 0.260(SecureQR_i) \]

**Significance of Coefficients**

The findings on Table 5.4, show that while holding all other independent variables at the constant, a positive change in trust will lead to a positive change in intention to use by 0.025 units while a positive change in cost will lead to a positive increase in intention to use by 0.361 units. Subsequently, a positive change in reliability will lead to a positive change in
intention to use by 0.078 units while secure QR will lead to a positive change in intention to use by 0.260 units.

At a level of 5% significance, trust had a 0.772 level of significance, cost had a 0.001 level of significance, reliability had a significance value of 0.295 while secure QR had a 0.003 level of significance. From the above data, cost was the most significant factor followed by characteristics of secure QR. Thus, data and secure QR characteristics contributed most to intention to use the secure cryptographic QR application.

5.4 Results of Merchant Attitudes on Adoption of QR Technology

The results of correlation on influence of merchant attitudes on intention to use the cryptographic QR are shown in table 5.5.

Table 5.5: Correlations of Variables: Influence of Merchant Attitudes

<table>
<thead>
<tr>
<th></th>
<th>AVG_PU</th>
<th>AVG_Norm</th>
<th>AVG_PEOU</th>
<th>AVG_ITU</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVG_PU</td>
<td>Pearson Correlation</td>
<td>1</td>
<td>.387**</td>
<td>.536**</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td></td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>129</td>
<td>129</td>
<td>129</td>
</tr>
<tr>
<td>AVG_Norm</td>
<td>Pearson Correlation</td>
<td>.387**</td>
<td>1</td>
<td>.433**</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>129</td>
<td>129</td>
<td>129</td>
</tr>
<tr>
<td>AVG_PEOU</td>
<td>Pearson Correlation</td>
<td>.536**</td>
<td>.433**</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>129</td>
<td>129</td>
<td>129</td>
</tr>
<tr>
<td>AVG_ITU</td>
<td>Pearson Correlation</td>
<td>.454**</td>
<td>.397**</td>
<td>.534**</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>129</td>
<td>129</td>
<td>129</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).

From Table 5.5, the variables perceived usefulness, norm and perceived ease of use are positively related to the intention to use the secure cryptographic QR with correlation coefficients of .454, .397 and .534; their significance values is also less than .001. This indicates that these variables are significant.

Regression Analysis on Influence of Merchant Attitudes

The regression analysis on merchant attitudes that influence intention to use the cryptographic QR had r squared value of .34.6 as shown in Table 5.6.
Table 5.6: Regression Analysis of Merchant Attitudes

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.589a</td>
<td>.346</td>
<td>.331</td>
<td>.50320</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), AVG_PEOU, AVG_Norm, AVG_PU

The results of ANOVA on influence of merchant attitude on intention to use secure QR are shown in Table 5.7 that indicates the F-ratio is significant at p < 0.05 since the significance value is .000 which is less than .005 at 95% confidence level. Thus, the regression model was significant in predicting how perceived usefulness, perceived ease of use and social norms influence intention to use the secure cryptographic QR.

Table 5.7: ANOVA Results on Merchant Attitudes influence on Intention to Use

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Regression</td>
<td>3</td>
<td>5.590</td>
<td>22.077</td>
<td>.000b</td>
</tr>
<tr>
<td></td>
<td>Residual</td>
<td>125</td>
<td>.253</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>128</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. Dependent Variable: AVG_ITU
b. Predictors: (Constant), AVG_PEOU, AVG_Norm, AVG_PU

The results of coefficients significance are shown below in table 5.8

Table 5.8: Significance of Coefficients

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>(Constant)</td>
<td>1.455</td>
<td>.365</td>
<td>3.983</td>
</tr>
<tr>
<td></td>
<td>AVG_PU</td>
<td>.230</td>
<td>.100</td>
<td>.200</td>
</tr>
<tr>
<td></td>
<td>AVG_Norm</td>
<td>.147</td>
<td>.073</td>
<td>.166</td>
</tr>
<tr>
<td></td>
<td>AVG_PEOU</td>
<td>.325</td>
<td>.082</td>
<td>.355</td>
</tr>
</tbody>
</table>

a. Dependent Variable: AVG_ITU

Based on the formula discussed in objective one, the regression formula for encrypted QR characteristics is stated as:
\[ ITU_i = (1.455 + 0.230(\text{PU}_i) + 0.147(\text{Norm}_i) + 0.325(\text{PEOU}_i) \]

**Significance of Coefficients**

The findings on Table 5.8, indicate a unit increase in perceived usefulness will lead to a 0.230 increase in intention to use the secure cryptographic QR. A unit increase in social norm will lead to 0.147 increase in intention to use the secure QR while a unit increase in perceived ease of use will lead to 0.325 increase in intention to use. At a level of 5% significance, perceived usefulness had a significance level of 0.024, norm had a 0.045 level of significance while perceived ease of use had a level of 0.000. Therefore, perceived ease of use factors contribute most to intention to use the secure cryptographic QR application.

**5.5 Results of Government Factors on Adoption of QR Technology**

The correlation results on influence of government factors on adoption of cryptographic QR are shown in Table 5.9.

*Table 5.9: Correlations of Government Factors Influence on Intention to Use*

<table>
<thead>
<tr>
<th></th>
<th>AVG_Policy</th>
<th>AVG_Awareness</th>
<th>AVG_Enforcement</th>
<th>AVG_ITU</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Correlations</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AVG_Policy</td>
<td>Pearson Correlation</td>
<td>1</td>
<td>.692**</td>
<td>.493**</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td></td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>129</td>
<td>129</td>
<td>129</td>
</tr>
<tr>
<td>AVG_Awareness</td>
<td>Pearson Correlation</td>
<td></td>
<td>.692**</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td></td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>129</td>
<td>129</td>
<td>129</td>
</tr>
<tr>
<td>AVG_Enforcement</td>
<td>Pearson Correlation</td>
<td></td>
<td>.493**</td>
<td>.668**</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td></td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>129</td>
<td>129</td>
<td>129</td>
</tr>
<tr>
<td>AVG_ITU</td>
<td>Pearson Correlation</td>
<td></td>
<td>.047</td>
<td>.058</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td></td>
<td>.594</td>
<td>.512</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>129</td>
<td>129</td>
<td>129</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).

Table 5.9 shows correlation coefficients of policy, awareness and enforcement which are .047, .058 and .059 respectively. The \( P \) value of these factors is >0.01.
Regression Results of Influence of Government Factors

The regression analysis results on influence of government factors on intention to use are summarized in Table 5.10. The r squared value is .004.

Table 5.10: Regression Analysis on Influence of Government Factors

<table>
<thead>
<tr>
<th>Model Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), AVG_Enforcement, AVG_Policy, AVG_Awareness

The results of ANOVA as indicated in Table 5.11 on influence of government factors on intention to use secure QR indicates that the F-ratio is not significant at p < 0.05 since the significance value is .913 which is greater than .005 at 95% confidence level. Thus, the regression model did not statistically influence behavioural intention to use the secure QR.

Table 5.11: ANOVA Results on Influence of Government Factors

<table>
<thead>
<tr>
<th>ANOVA(^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>1 Regression</td>
</tr>
<tr>
<td>Residual</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

a. Dependent Variable: AVG_ITU
b. Predictors: (Constant), AVG_Enforcement, AVG_Policy, AVG_Awareness

Significance of Coefficients

In Table 5.12, the findings show that while holding all other independent variables at the constant, a positive change in policy will lead to a positive change in intention to use by 0.009 units while a positive change in awareness will lead to a positive increase in intention to use by 0.020 units. Additionally, a unit increase in enforcement will lead to a 0.029 increase in intention to use the secure QR technology. At a level of 5% significance, policy had a significance level of 0.928, awareness had a significance value of 0.855 and enforcement had a 0.766 level of significance. These results indicated no significance of government factors on intention to use.
Table 5.12: Coefficients Significance of Government Factors

<table>
<thead>
<tr>
<th>Model</th>
<th>Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
</tr>
<tr>
<td>1</td>
<td>(Constant)</td>
<td>4.029</td>
<td>.275</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AVG_Policy</td>
<td>.009</td>
<td>.098</td>
<td>.011</td>
</tr>
<tr>
<td></td>
<td>AVG_Awareness</td>
<td>.020</td>
<td>.109</td>
<td>.026</td>
</tr>
<tr>
<td></td>
<td>AVG_Enforcement</td>
<td>.029</td>
<td>.096</td>
<td>.036</td>
</tr>
</tbody>
</table>

a. Dependent Variable: AVG_ITU

Hypothesis Results

In this section, the researcher presented the results of hypothesis that were obtained after testing done in previous chapter. These hypotheses were in line with the objectives of the study whose aim was to establish the influence of cryptographic QR characteristics (trust, cost effectiveness and reliability factors), merchant attitudes (perceived usefulness, social norms and perceived ease of use factors) and government factors in influencing intention to use the prototype that was developed to be used by vendors who engage in business of sale of alcoholic beverages in Nairobi and its environs. The table below shows a summary of hypotheses results.
Table 5.13: Testing Results of Hypotheses

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>Path</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>PU ---→ ITU</td>
<td>Supported</td>
</tr>
<tr>
<td>H2</td>
<td>PEOU ---→ ITU</td>
<td>Supported</td>
</tr>
<tr>
<td>H3</td>
<td>PEOU ---→ PU</td>
<td>Supported</td>
</tr>
<tr>
<td>H4</td>
<td>Cost effectiveness ---→ PU</td>
<td>Supported</td>
</tr>
<tr>
<td>H5</td>
<td>Reliability ---→ PEOU</td>
<td>Supported</td>
</tr>
<tr>
<td>H6</td>
<td>Cost effectiveness ---→ PEOU</td>
<td>Supported</td>
</tr>
<tr>
<td>H7</td>
<td>Reliability ---→ PEOU</td>
<td>Supported</td>
</tr>
<tr>
<td>H8</td>
<td>Trust ---→ ITU</td>
<td>Supported</td>
</tr>
<tr>
<td>H9</td>
<td>Norm ---→ ITU</td>
<td>Supported</td>
</tr>
<tr>
<td>H10</td>
<td>Policy ---→ ITU</td>
<td>Not Supported</td>
</tr>
<tr>
<td>H11</td>
<td>Awareness ---→ ITU</td>
<td>Not Supported</td>
</tr>
<tr>
<td>H12</td>
<td>Enforcement ---→ ITU</td>
<td>Not Supported</td>
</tr>
</tbody>
</table>

*p<0.05; **p<0.001

Figure 5.6 shows the final model tested; computer self-efficacy was not included as it did not meet the acceptable criterion level of factor analysis.
Summary of Correlation Tables

For this study, the researcher adopted bivariate correlation using Pearson’s correlation coefficient. The confidence interval was 99% with 1% confidence level 2-tailed. The three consecutive tables below display the correlation matrix between the independent variables (trust, perceived cost effectiveness, reliability, perceived usefulness, norms, perceived ease of use, awareness, enforcement and secure cryptographic QR factors) and the dependent variable (intention to use). The matrix was initially split in the four tables because one consolidated table was too large to fit on one page.

From the output of Table 5.14(a), there is a positive correlation between trust and intention to use at $r = .288$ with a significance value of .001 while cost is positively correlated to intention to use at .433 which is significant at $p<0.001$; the significance value is .000. There is a positive relationship between reliability and intention to use at $r = .233$ with significance value of .008. There is also a significant positive correlation between secure QR and intention to use at $r = .409$.

Table 5.14(a): Correlations of Variables

<table>
<thead>
<tr>
<th>Correlations</th>
<th>AVG_Trust</th>
<th>AVG_Cost</th>
<th>AVG_Reliability</th>
<th>AVG_SecureQR</th>
<th>AVG_ITU</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AVG_Trust</strong></td>
<td>Pearson Correlation</td>
<td>1</td>
<td>.456**</td>
<td>.372**</td>
<td>.345**</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.001</td>
</tr>
<tr>
<td>N</td>
<td>129</td>
<td>129</td>
<td>129</td>
<td>129</td>
<td>129</td>
</tr>
<tr>
<td><strong>AVG_Cost</strong></td>
<td>Pearson Correlation</td>
<td>.456**</td>
<td>1</td>
<td>.209*</td>
<td>.380**</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.018</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>N</td>
<td>129</td>
<td>129</td>
<td>129</td>
<td>129</td>
<td>129</td>
</tr>
<tr>
<td><strong>AVG_Reliability</strong></td>
<td>Pearson Correlation</td>
<td>.372**</td>
<td>.209*</td>
<td>1</td>
<td>.273**</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.018</td>
<td>.002</td>
<td>.008</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>129</td>
<td>129</td>
<td>129</td>
<td>129</td>
<td>129</td>
</tr>
<tr>
<td><strong>AVG_SecureQR</strong></td>
<td>Pearson Correlation</td>
<td>.345**</td>
<td>.380**</td>
<td>.273**</td>
<td>1</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.000</td>
<td>.002</td>
<td>.000</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>129</td>
<td>129</td>
<td>129</td>
<td>129</td>
<td>129</td>
</tr>
<tr>
<td><strong>AVG_ITU</strong></td>
<td>Pearson Correlation</td>
<td>.288**</td>
<td>.433**</td>
<td>.233**</td>
<td>.409**</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.001</td>
<td>.000</td>
<td>.008</td>
<td>.000</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>129</td>
<td>129</td>
<td>129</td>
<td>129</td>
<td>129</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
From the Table 5.14(b), the variables perceived usefulness, norm and perceived ease of use are positively related to the intention to use the secure cryptographic QR with correlation coefficients of .454, .397 and .534; their significance values is also less than .001. This indicates that these variables are significant.

**Table 5.14(b): Correlations of Variables**

<table>
<thead>
<tr>
<th></th>
<th>AVG_PU</th>
<th>AVG_Norm</th>
<th>AVG_PEOU</th>
<th>AVG_ITU</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVG_PU Pearson Correlation</td>
<td>1</td>
<td>.387**</td>
<td>.536**</td>
<td>.454**</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td></td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>N</td>
<td>129</td>
<td>129</td>
<td>129</td>
<td>129</td>
</tr>
<tr>
<td>AVG_Norm Pearson Correlation</td>
<td>.387**</td>
<td>1</td>
<td>.433**</td>
<td>.397**</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>N</td>
<td>129</td>
<td>129</td>
<td>129</td>
<td>129</td>
</tr>
<tr>
<td>AVG_PEOU Pearson Correlation</td>
<td>.536**</td>
<td>.433**</td>
<td>1</td>
<td>.534**</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>N</td>
<td>129</td>
<td>129</td>
<td>129</td>
<td>129</td>
</tr>
<tr>
<td>AVG_ITU Pearson Correlation</td>
<td>.454**</td>
<td>.397**</td>
<td>.534**</td>
<td>1</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>N</td>
<td>129</td>
<td>129</td>
<td>129</td>
<td>129</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).**

From Table 5.14(c), there is no correlation between the factors policy, awareness and enforcement with intention to use therefore, these three factors do not influence intention to use. This is evident from the correlation coefficients of policy, awareness and enforcement which are .047, .058 and .059 respectively. The P-value of these factors is >0.01. However, the result above also shows that secure QR is positively related to intention to use with a coefficient r value of .409 that is significant at p<.001. The lower the significance value, the more significant a variable is. Therefore, from the three correlation matrix tables, most significant factors are secure cryptographic QR, perceived usefulness, norms, perceived ease of use, cost and trust. The other factors are least significant as per the results of correlation.
Table 5.14(c): Correlations of Variables

<table>
<thead>
<tr>
<th></th>
<th>AVG_Policy</th>
<th>AVG_Awareness</th>
<th>AVG_Enforcement</th>
<th>AVG_ITU</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVG_Policy</td>
<td>Pearson Correlation</td>
<td>1  <strong>.692</strong>  <strong>.493</strong>  .047</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000  .000  .594</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>129  129  129  129</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AVG_Awareness</td>
<td>Pearson Correlation</td>
<td>.692**  1  <strong>.668</strong>  .058</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000  .000  .512</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>129  129  129  129</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AVG_Enforcement</td>
<td>Pearson Correlation</td>
<td>.493**  <strong>.668</strong>  1  .059</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000  .000  .506</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>129  129  129  129</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AVG_ITU</td>
<td>Pearson Correlation</td>
<td>.047  .058  .059  1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.594  .512  .506</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>129  129  129  129</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).

Regression Analysis on Factors Influencing Adoption of Cryptographic QR

Table 5.15 shows the results obtained after the regression analysis and it was based on the proposed relationships from the theoretical model. In order to investigate the hypothesis, the constructs secure QR, policy, reliability, cost, norm, enforcement, perceived ease of use, trust, perceived usefulness and awareness were simultaneously regressed on intention to use. The r squared ($r^2$) value was .417.

Table 5.15: Regression Analysis Summary of Factors Influencing Adoption of Secure QR

<table>
<thead>
<tr>
<th>Model Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), AVG_SecureQR, AVG_Policy, AVG_Reliability, AVG_Cost, AVG_Norm, AVG_Enforcement, AVG_PEOU, AVG_Trust, AVG_PU, AVG_Awareness

ANOVA

This section presents findings on analysis of variance (ANOVA) which was used to test the significance of the model; it indicates whether the model results in a considerably good degree to forecast the outcome variable of the study. Table 5.16 indicates the F-ratio is
significant at p < 0.05 since the significance value is .000 which is less than .005 at 95% confidence level. Thus, it is conclusive to state that the regression model was significant in predicting how enforcement, perceived cost effectiveness, social norms, reliability, policy, trust, perceived usefulness, perceived ease of use, awareness and the notable QR characteristics influence intention to use the secure cryptographic QR.

*Table 5.16: ANOVA Results Summary*

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>20.207</td>
<td>10</td>
<td>2.021</td>
<td>8.451</td>
<td>.000&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Residual</td>
<td>28.216</td>
<td>118</td>
<td>.239</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>48.422</td>
<td>128</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. Dependent Variable: AVG_ITU
b. Predictors: (Constant), AVG_SecureQR, AVG_Policy, AVG_Reliability, AVG_Cost, AVG_Norm, AVG_Enforcement, AVG_PEOU, AVG_Trust, AVG_PU, AVG_Awareness

From Table 5.16, it is evident that ANOVA only showed the significance of the entire model that is, it indicated a good degree to predict the outcome variable it but does not divulge on the contribution of each variable. Table 5.17 shows the variables of the model and their significance values.

*Table 5.17: Parameters for Coefficients*

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>(Constant)</td>
<td>.967</td>
<td>.438</td>
<td>2.210</td>
</tr>
<tr>
<td></td>
<td>AVG_Trust</td>
<td>-.035</td>
<td>.091</td>
<td>-.037</td>
</tr>
<tr>
<td></td>
<td>AVG_Cost</td>
<td>.158</td>
<td>.108</td>
<td>.133</td>
</tr>
<tr>
<td></td>
<td>AVG_Reliability</td>
<td>-.057</td>
<td>.077</td>
<td>-.065</td>
</tr>
<tr>
<td></td>
<td>AVG_PU</td>
<td>.147</td>
<td>.111</td>
<td>.128</td>
</tr>
<tr>
<td></td>
<td>AVG_Norm</td>
<td>.145</td>
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<td></td>
<td>AVG_PEOU</td>
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<td>AVG_Policy</td>
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<td>AVG_Awareness</td>
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<td>.089</td>
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<td>.082</td>
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<tr>
<td></td>
<td>AVG_SecureQR</td>
<td>.213</td>
<td>.086</td>
<td>.214</td>
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</tbody>
</table>

a. Dependent Variable: AVG_ITU
The researcher adapted the formula shown below (Field, 2009).

\[ Y_i = (b_0 + b_1 X_{i1} + b_2 X_{i2} + \ldots + b_n X_{in}) + E_i \]

where \( b_0 \) is the constant, \( Y \) represents outcome variable, \( b_1 \) is the coefficient of the first item \( (X_i) \), \( b_n \) represents coefficient of the nth item \( (X_n) \) and \( E_i \) is the items predicted and observed value \( Y \) of ith item. The outcome variable is intention to use the secure cryptographic QR application whereas the predictors \( X_i \) till the nth item are trust, perceived cost effectiveness, reliability, perceived usefulness, social norms, perceived ease of use, government policy, awareness, enforcement and notable characteristics of secure QR. Thus, based on the results of table 5.6 and taking all independent variables into account at the constant, the regression formula is stated as:

\[ ITU_i = (0.967 - 0.035(Trust_i) + 0.158(Cost_i) - 0.057(Reliability_i) + 0.147(PU_i) + 0.145(Norm_i) + 0.311(PEOU_i) - 0.031(policy_i) + 0.067(awareness_i) - 0.131(enforcement_i) + 0.213(SecureQR_i) \]

### 5.6 Results of Secure QR Prototype Developed

The secure QR prototype was developed to be used in authentication process of counterfeit goods by the alcohol vendors. The authentication process involved scanning a product by launching the QR application on a workstation PC which then activates the camera which acts as the reader for the QR code appended on the product. Once the product QR code was scanned, the information was queried against what was already stored on the database and results are relayed through a message upon authentication. The vendors were able to scan some of the products and results showed that most beverages were genuine. This is because the QR application was able to query the database and establish that the uniqueness of the QR code to be a valid one since it matched the pre-defined product details in the database. Once the products were successfully authenticated, this query was taken from product inventory to avoid duplication of information.

On the other hand, some products could not be verified by the secure QR application. When the QR code on product was passed on the secure QR application, a message was displayed showing that the product was invalid as its source could not be authenticated. This product therefore passed as a fake one.
5.7 Chapter Summary

This chapter indicated results of the testing done on the factors influencing the adoption of the secure cryptographic QR application. The final theoretical model emanating from the results was outlined. An analysis of the hypotheses tested was also discussed. This chapter aimed at establishing the impact of trust, cost, reliability, perceived usefulness, social norms, perceived ease of use, notable QR characteristics, government policy, awareness and enforcement factors on intention to use the secure QR application. The study targeted vendors of alcoholic beverages around Nairobi and its environs. The subsequent chapter outlines the summary, discussion and key recommendations of the study.
CHAPTER 6.0: DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This was the final chapter of the study report that consisted four major sections namely summary, discussion, conclusions and recommendations. The summary section outlined the key elements such as the specific objectives that were investigated, the methodology adopted and also significant findings of the testing stage. The discussion section captured the major findings from the study based on the specific objectives in comparison to findings of previous literature. The subsequent section outlined the conclusions which were derived from the hypothesis. The last section discussed the recommendations to improve future studies that were based on the specific objectives of the investigation.

6.2 Summary

The aim of this research was to investigate the factors influencing the adoption (intention to use) the secure QR application among alcohol vendors in Nairobi environs. Throughout, the investigation was directed by these objectives: to investigate the influence of cryptographic embedded QR characteristics on the adoption of secure QR technology, the influence of merchant attitudes on the adoption of secure QR technology and also the influence of government factors on the adoption of secure QR technology. The last objective was to develop a prototype of secure QR technology for use by alcohol vendors to enhance the authentication process.

The research adopted behavioral and experimental approaches. Behavioral approach involved quantitative research design of data collection through a survey questionnaire issued to 120 alcohol vendors located in Nairobi County. On the other hand, experimental approach involved component design and development of the secure cryptographic QR. Data collected was analyzed using the Statistical Package for Social Sciences (SPSS version 24) used for statistical analysis such as descriptive analysis, factor analysis, correlation and regression.

The first research objective aimed at establishing influence of encrypted QR characteristics on adoption of secure QR technology. The conclusion was that encrypted QR characteristics (reliability, cost effectiveness, trustworthiness and data privacy) influenced intention to use to a great magnitude. Also, notable secure QR characteristics in terms of security of records in the database is that the application makes it hard for the records to be interfered with. Trust of
the application was explained in that alcohol vendors increased their level of embracing the secure QR by recognizing its trustworthiness.

The second research objective aimed at establishing the influence of merchants’ attitude in adoption of the secure QR. The conclusion was that perceived efficiency and effectiveness of the secure QR application is crucial in business operation when it comes to authenticating products. It was also noted that there is need for easy and navigable applications. Additionally, senior management support is crucial in influencing decision to use the cryptographic QR.

The third research objective sought to establish the influence of government factors in adoption of secure QR technology. The revelations from these showed the inadequacy of current policies formulated by government to combat counterfeit goods in the market. These also includes awareness campaigns that were inadequate in making the masses aware of the benefits of using secure QR applications and bar codes to combat counterfeit goods. The conclusion was that the participation of the government and awareness agencies is crucial in adoption of secure QR which to a large extent revolves around the policies formulated, creation of awareness and enforcement of the said policies and strategies for combating counterfeit goods.

6.3 Discussion

The main purpose of this study was to comprehend important factors influencing alcohol vendors’ intention to use the secure cryptographic QR. Comparable to prior studies as indicated by Park (2009), this investigation established that TAM is a suitable model for explaining the behavioral intention to use the secure cryptographic QR. This study, similar to Davis (1989) is founded on TAM but differs a bit because it included other factors; notable secure QR characteristics, policy, reliability, cost, norm, enforcement, perceived ease of use, trust, perceived usefulness and awareness. The participants of this study included 120 alcohol vendors drawn from Nairobi and its environs. Hypotheses proposed were also tested and were in-line with the specific objectives of the investigation. In as much as most were supported, there were surprising revelations of some findings on the influence of cryptographic QR characteristics, merchant attitudes and government factors on the adoption of secure cryptographic QR. It is also worth noting that the secure QR application was developed for use by the vendors.
6.3.1 Cryptographic QR Characteristics on Adoption of QR Technology

Prior studies have shown that system characteristics have a direct effect on beliefs of individuals (Davis, 1989). These studies have included system characteristics as variables influencing perceived usefulness and ease of use (Pituch & Lee, 2006). System characteristics have played a major role in acceptance of a technology and the secure QR is one of them in regards to this investigation. The characteristics studied included reliability, cost effectiveness and these characteristics were supported implying that reliable authentication applications such as the case of the secure QR should be able to execute transactions quickly and efficiently. The results showed that system characteristics influenced intention to use the secure QR application to a great extent. Their design and verification should also make it easy to verify products. Perceived cost effectiveness ensured that the alcohol vendors saved time while using the application and reduced likelihood of buying counterfeits.

Higher levels of trust were positively related to intention to use the secure QR application; there was a significant effect on the two variables. The explanation is that alcohol vendors will increase their level of embracing the secure QR if they recognize the application to be trustworthy. In this investigation, trustworthiness was also in terms of security offered by the application since the vendors concern is on how the application offers data privacy. It was evident that the users’ intention to use was motivated by the level of trust they attached to the application. The influence of social norms on users’ intention to adopt QR technology were evident. People’s beliefs can be influenced based on what they believe other important people in their lives think of them. Peole are likely to suggest a system to others if it meets their satisfaction. The support that alcohol vendors received from their senoir managers and generally the company influenced their decision to use the application.

6.3.1.1 Correlation Results on Influence of Encrypted QR Characteristics

There was positive correlation between the factors trust, cost, reliability, secure QR characteristics and intention to use with significances value of .001, .000, .008 and .000 respectively. The lower the significance value, the more significant a variable is. Therefore, the most significant factors that influenced intention to use the cryptographic QR application were perceived cost effectiveness of the application and the notable secure QR characteristics.
6.3.3.2 Regression Analysis on Influence of Encrypted QR Characteristics

The researcher conducted linear regression to establish the percentage of the independent variables or the factors influencing behavioral intention to use the secure cryptographic QR to authenticate counterfeit goods as represented by \( r^2 \) value. The results obtained after the regression analysis were based on the proposed relationships from the theoretical model. In order to investigate the hypothesis, the constructs secure QR, reliability, perceived cost effectiveness and trust were simultaneously regressed on intention to use. The results showed that these constructs significantly accounted for 26.6% of variance in intention to use. This means the constructs only represented 26.6% of the factors influencing behavioral intention to use secure cryptographic QR application among alcoholic vendors. The \( r^2 \) value was 0.266. Thus other factors influencing adoption of secure QR application which were not studied in this research constitute to 73.4%.

The hypotheses that emanated from the factors influencing adoption of cryptographic QR are:

\[ H_8: \text{Higher levels of trust (TRUST) in secure QR system will be positively related to intention to use (ITU).} \]

The correlation coefficient between these two variables form the results was .288, with a significance value of the coefficient being .001. This value is less than .01; therefore, the conclusion of an important relationship between trust and intention to use the cryptographic QR. The relationship is positive in that as levels of trust is increased so did the intention to use the secure QR. Thus, this hypothesis was supported.

\[ H_6: \text{Perceived cost effectiveness will have a positive influence on perceived ease of use usefulness (PEOU) of the secure QR application.} \]

The hypothesis above was supported based on the significance value of .000 that was significant at \( p < 0.01 \).

\[ H_4: \text{Perceived cost effectiveness will have a positive influence on perceived usefulness (PU) of the secure QR application.} \]

The researcher also established a positive correlation between perceived cost effectiveness and perceived usefulness with an \( r \) coefficient value of .492 that was significant at \( p = .000 \) and therefore this hypothesis was supported.

\[ H_5: \text{Reliability will have a positive influence on perceived usefulness (PU) of the secure QR application.} \]
There was a positive correlation between reliability and perceived usefulness with coefficient value $r = .454$ that was significant at $p = .000$ and thus this hypothesis was supported.

$H_7$: Reliability will have a positive influence on perceived ease of use usefulness (PEOU) of the secure QR application.

The correlation coefficient between reliability and perceived ease of use from the results was $.470$, with a significance value of $.000$ and thus this hypothesis was supported.

### 6.3.2 Merchant Attitudes on Adoption of Secure QR Technology

The analysis results of the study as stated in TAM revealed that the vendors’ high perceptions of perceived ease of use and usefulness of the cryptographic QR directly heightened the level of their continued intention to use the application. The factor that showed the strongest predictor of intention to use was perceived ease of use. This result implied that usefulness is important among users. It implies that alcohol vendors will use the secure QR application if they actually perceive how efficient and effective the application is in regards to their work. Usefulness to the vendors relates how the application improves their job performance, productivity and increased accomplishment of tasks revolving authentication of products.

It was also noted that the alcohol vendors’ intention to use the secure QR increased when they perceived the authentication process easy to use. This is a strong indication that authentication applications should be easy to use and navigable and free of mental effort. The users should be in a position to authenticate products quickly to accomplish tasks. The intention to use a system maybe decreased if users become frustrated when unable to get the information needed.

Additionally, the perceived ease of use of the secure QR application indirectly enhanced the vendors’ intention to use through perceived usefulness. The explanation could be that alcohol vendors are willing to embrace the secure QR application and it also indicates their focus tends to be on the technology usefulness. As per the results, this influence of ease of use on usefulness was significantly strong. This statement agrees to TAM that if a system is easier to use, it becomes more useful therefore by developing secure QR applications that are easy to use will enhance their usefulness; an indirect increase will result to intention to use.
6.3.2.1 Regression Analysis on Influence of Merchant Attitudes

The constructs perceived usefulness, social norm and perceived of ease of use were simultaneously regressed on intention to use. The results showed these constructs significantly accounted for 34.6% of variance in intention to use an indication that their contribution only represented 34.6% of the factors influencing behavioral intention to use secure cryptographic QR application among alcoholic vendors while 65.4% is explained by other factors not included in this study.

The hypotheses that emanated from influence of merchant attitudes on adoption of cryptographic QR are:

H$_1$: Perceived usefulness (PU) has significant influence on intention to use (ITU).

The correlation coefficient between perceived usefulness and behavioural intention to use was .454 and the significance value for the coefficient (.000) with N sample size of 129. This significance value was less than 0.01 and thus the conclusion that there was a significant relationship between perceived usefulness and intention to use the secure QR. This relationship was a positive one in that a unit increase in perceived usefulness led to a positive increase intention to use. Thus, the hypothesis was supported: perceived usefulness had a significance on intention to use of secure QR application.

H$_2$: Social norms (NORM) has a positive effect on users’ intention to use (ITU) the secure cryptographic QR.

There was a positive correlation between norm and intention to use with coefficient value $r = .397$ that was significant at $p = .000$ and therefore this hypothesis was supported.

H$_3$: Perceived ease of use (PEOU) has a significant influence on intention to use (ITU).

The correlation coefficient between perceived ease of use and behavioural intention to use was .534 and the significance value for the coefficient (.000) with a sample size of 129. This significance value was less than 0.01 and thus the conclusion that there was a significant relationship between perceived ease of use and intention to use the secure QR application. The stated relationship is a positive one: as perceived ease of use increased, intention to use increased and was as per what was predicted. Thus the hypothesis was supported: as perceived ease of use increased so did intention to use of secure QR application.

H$_4$: Perceived ease of use (PEOU) will have a significant influence on perceived usefulness (PU).
A positive correlation between perceived ease of use and perceived usefulness was noted with coefficient value $r = .536$ that was significant at $p = .000$ and therefore this hypothesis was supported.

### 6.3.3 Government Factors on Adoption of Secure QR Technology

Contrary to the researcher’s expectation, the results on influence of government factors in adoption of QR application were not supported in that government policy, awareness and enforcement respectively were not positively related to behavioral intention to use the secure QR application. One possible reason for this outcome may be that the current policies formulated to combat counterfeit goods by the government are not adequate. Additionally, the awareness campaigns do not seem adequate and elaborate in the fight against counterfeit products in the market. Therefore, the government should enhance its enforcement of policies, have adequate agencies that can implement more use of the cryptographic QR and other applications that will be developed in future for authentication. From the perspective of users such as alcohol vendors, the efforts of the government and institutions in creating the policies, awareness and enforcement delivers the message that the government is dedicated to their interests.

#### 6.3.3.1 Results of Correlation on Influence of Government Factors

There is no correlation between the factors policy, awareness and enforcement with intention to use therefore, these three factors do not influence intention to use. This was evident from the correlation coefficients of policy, awareness and enforcement which are .047, .058 and .059 respectively. The $P_{value}$ of these factors is $>0.01$. The other factors are least significant as per the results of correlation.

#### 6.3.3.2 Regression Results of Influence of Government Factors

Linear regression was done to establish the percentage of the independent variables or the factors influencing behavioral intention to use the secure cryptographic QR to authenticate counterfeit goods as represented by $r^2$ value. The results were obtained after regressing government factors on intention to use and showed that these constructs significantly accounted for 0.4% of variance in intention to use. This indicates that the constructs only represented 0.4% of the factors influencing behavioral intention to use secure cryptographic QR application among alcoholic vendors. The other factors not studied contribute to constitute to 99.6%.
The hypotheses that emanated from influence of government factors on adoption of cryptographic QR are:

H$_{10}$: Government policy will be positively related to behavioral intention to use the secure QR application.

The correlation result indicated that there was no correlation between policy and intention to use the secure QR thus the study went ahead to state that enforcement did not influence intention to use. This was evident in the p value of 0.594 that is >0.01. Therefore, this hypothesis was not supported.

H$_{11}$: Government awareness will be positively related to behavioral intention to use the secure QR application.

From the correlation output, there was no positive correlation between awareness and intention to use the secure QR application thus awareness did not influence intention to use. Awareness variable had a p value of 0.512 that is >0.01. Thus, this hypothesis was not supported.

H$_{12}$: Government enforcement will be positively related to behavioral intention to use the secure QR application.

There was no correlation between enforcement and intention to use the secure QR application thus enforcement does not influence intention to use. The evidence was the p value of 0.506 that is >0.01. Thus, this hypothesis was not supported.

6.3.3.3 Regression Analysis on Factors Influencing Adoption of Cryptographic QR

The researcher conducted linear regression to establish the percentage of the independent variables or the factors influencing behavioral intention to use the secure cryptographic QR to authenticate counterfeit goods as represented by r squared ($r^2$) value. The constructs secure QR, policy, reliability, cost, norm, enforcement, perceived ease of use, trust, perceived usefulness and awareness were simultaneously regressed on intention to use. The results showed that these constructs significantly accounted for 41.7% of variance in intention to use. This means the constructs only represented 41.7% of the factors influencing behavioral intention to use secure cryptographic QR application among alcoholic vendors. The $r^2$ value had a value of 0.417. Thus other factors influencing adoption of secure QR application which were not studied in this research constitute to 58.3%.
6.3.3.4 Significance of Coefficients on Factors Influencing Adoption of Secure QR

The findings from significance of coefficients on all the factors specify that while holding all other independent variables at the constant, a positive change in trust will lead to a negative change in intention to use by 0.035 units while a positive change in cost will lead to a positive increase in intention to use by 0.158 units. Additionally, a unit increase in reliability will lead to a 0.057 decrease in intention to use while a unit increase in perceived usefulness will lead to a 0.147 increase in intention to use the secure cryptographic QR. A unit increase in social norm will lead to 0.145 increase in intention to use the secure QR while a unit increase in perceived ease of use will lead to 0.311 increase in intention to use. A positive change in government policy will lead to a negative change in intention to use by 0.031 units. Furthermore, a positive change in awareness will lead to a positive change in intention to use by 0.067 units while a positive change in enforcement will lead to a negative change in intention to use the cryptographic QR by 0.131 units. Subsequently, a positive change in secure QR will lead to a positive change in intention to use by 0.213 units.

At a level of 5% significance, trust had a 0.701 level of significance, cost had a 0.145 level of significance, reliability had a significance value of 0.460, perceived usefulness had 0.188, norm had a 0.052 level of significance, perceived ease of use had a level of 0.001, policy had a significance level of 0.704, awareness had a significance value of 0.461 and enforcement had a 0.112 level of significance. Lastly, secure QR had a 0.014 level of significance. From the above data, perceived ease of use factors contribute most to intention to use the secure cryptographic QR application.

6.3.4 The Secure QR Prototype Developed

The secure QR prototype developed was used by most the alcohol vendors for authenticating counterfeit goods. Authentication process involved scanning a product by launching the QR application that in turn activates the camera which acts as the reader for the QR code appended on the product. After the product QR code is scanned, information is queried on the database. Results after scanning the products indicated that most beverages were genuine. Database queries established the uniqueness of the QR code to be a valid one since it matched the pre-defined product details stored. Once the products were successfully authenticated, this query was taken from product inventory to avoid duplication of information. However, there were instances where some products could not be verified by the secure QR application.
Upon scanning the product QR code, a message was displayed showing that the product was invalid and its source could not be authenticated. Such products that failed authentication passed as counterfeits.

6.4 Conclusions

The aim of this study was to investigate the factors that influence adoption of secure QR application among alcohol vendors in Nairobi and its environs. This study incorporated constructs of TAM to come up with and its results led to the conclusion that the model represented the data that was collected. The conclusions have been described in details below:

6.4.1 Cryptographic QR Characteristics on Adoption of Secure QR

Cost effective QR technologies that enable traders to achieve a competitive edge should also be developed. This will go a long way to encourage businesses to achieve their objectives without compromising on cost effectiveness. In this research, cost effectiveness was in terms of increased job performance and productivity for the alcohol vendors and reduction of cost related to losses as a result of purchasing counterfeit products. Thus, the suggestion is to implement QR applications that include cost effective aspects to increase their level of adoption. Reliability was found to have a relative positive effect on intention to use the secure QR application. Generally, users should develop some level of confidence in the reliability of application they use in their day to day business operations. In this research, this was manifested in the ability of the QR application in having design and navigation features that makes it comfortable for them to verify products at ease.

6.4.2 Merchant Attitudes on Adoption of Secure QR

This research also aimed at identifying merchant attitudes that influence adoption of cryptographic QR by alcohol vendors. By referring to existing literature, the research revealed that perceived usefulness, social norms and perceived ease of use influence the adoption of secure QR by alcohol vendors. Perceived usefulness was an important factor and hence this study proposes that alcohol vendors will use the application once they perceive its efficiency in regards to the authentication process. Social norms should also be taken into account in encouraging adoption of cryptographic QR mostly on the impact of senior management in encouraging use of the application. Based on the results of findings, perceived ease of use was the most significant construct of how merchant attitudes influence
adoption of secure QR application; this implies that authenticating alcohol products through a secure QR application that is easy to use also enhances the usefulness of vendors. Hence, in this research most of the constructs in Davis’ TAM were validated through adoption of the cryptographic QR by the alcohol vendors to authenticate products.

6.4.3 Government Factors on Adoption of Secure QR Technology

The government and other concerned agencies mandated to fight counterfeits in the market should formulate policies especially those that focus on how various technology can be adopted to authenticate products. Some of these policies could accentuate the cost effectiveness, reliability, security and usefulness of the secure QR. The implication is that this study can help government and other relevant agencies to come up with strategies and policies and this would increase users’ intention to adopt use of the secure cryptographic QR.

6.4.4 The Secure QR Prototype Developed

The QR application developed enabled the alcohol vendors to authenticate the products they trade. Other software developers can integrate the secure QR application to mobile platforms especially the android phones to provide the users with an easier and pleasant experience of authenticating products. The applications can also be implemented using other tools and operating systems; the QR application for this investigation was implemented using Windows platform.

From the conclusions, it is evident that perceived ease of use and notable secure QR characteristics were the most significant pointers of alcohol vendors’ intention to use the secure cryptographic QR. There were some implications emanating from this study that is, theoretically, a model was used to identify the factors of vendors adoption of the secure QR while incorporating other elements to the well-known TAM. The research also supported and validated literature of previous studies. In addition, few studies have been done on evaluating these factors among the said target group thus it was unique to the context in Nairobi. Hence, this investigation can be used as a preliminary point for conducting similar research in other areas and with different participants. The outcome of this research therefore guided vendors that engage in trade of alcohol products in authentication process through adoption of the QR application; this information can be used to pursue future profitable opportunities.
6.5 Recommendations

6.5.1 Recommendations for Improvements

6.5.1.1 Encrypted QR Characteristics on Adoption of Secure QR Technology

The results emanating from QR code characteristics investigated on how they influence intention to use the application were strongly manifested. These were constructs of trust, perceived cost effectiveness, reliability and the notable secure QR characteristics. One of the recommendations for improvement would be on the infrastructure of the application to make it more user friendly.

6.5.1.2 Merchant Attitudes on Adoption of Secure QR Technology

The study also investigated how merchant attitudes influence the adoption of secure QR technology in terms of perceived usefulness, social norms and perceived ease of use. These factors were most outstanding based on the results that revealed these greatly influenced intention to use. Thus, the features of ease of use are very crucial in coming up with positive intentions to use a technology. Therefore, users should also be consulted so that their input is incorporated while designing the applications.

6.5.1.3 Government Factors on Adoption of Secure QR Technology

The results showed that government factors did not influence intention to use the secure QR application. There was no correlation of these factors. Therefore, the recommendation is that in future a larger target population should be considered. This could include officials from the government who formulate policies against counterfeits and also the agencies involved in awareness creation to enlighten the general public on benefits of using technologies such as the secure QR application in combating counterfeits. The bodies involved in enforcement should also be considered as the input from the above would contribute greatly for a research.

6.5.1.4 The Secure QR Prototype Developed

The design features can be improved and additional functionalities included in the application. For instance the reports generation can be integrated that can include statistical capabilities to provide more meaningful information that can aid in decision making.
6.5.2 Recommendations for Further Studies

6.5.2.1 Cryptographic QR Characteristics on Adoption of Secure QR Technology

The researcher established there are other factors influencing intention to use the secure cryptographic QR. The regression results showed the r-squared value was .417 whose implication was that 58.3% of constructs influencing intention to use the secure QR were not included in this study. Thus, future research should be conducted to include additional variables in TAM using another population or a different application. This could be use of different technology or platform with a certain group over a given time period. It should be noted that the secure cryptographic QR was implemented on Windows and runs on desktop thus future studies can evaluate how the application runs on other OS platforms and mobile applications due to dynamic nature of technology.

6.5.2.2 Merchant Attitudes on Adoption of Secure QR Technology

Secondly, it is necessary to have further assessments on some TAM constructs whose validity results were quite low; for instance computer self-efficacy had a very low Cronbach’s alpha. Thirdly, it was noted that TAM model was not fully tested in the study because it did not include actual usage of the secure QR application. Thus, it would be ideal to have a future research that includes actual usage so as to examine how applicable TAM would be in predicting acceptance of the application by target users. In short, TAM should be extended to include more variables or use of other models as well in comparison with TAM.

6.5.2.3 Government Factors on Adoption of Secure QR Technology

It would also be necessary to extend research on how government influence of policy, awareness and enforcement affects adoption of other technologies as in this study it was limited to the secure QR application.

6.5.2.4 The Secure QR Prototype Developed

The application can be developed for use in other contexts or fields as it is not limited to the trade sector. Additionally, a different population from a different geographical area can be used and results can be compared.
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APPENDICES

Appendix A: Source Code for QR Application

Code for View Product

```html
@extends('layouts.app')
@section('content')
  <!-- page content -->
  <div class="right_col" role="main">
    <div class="">
      <div class="page-title">
      </div>
      <div class="clearfix"></div>
      <div class="">
        <div class="col-md-12">
          <div class="x_panel">
            <div class="x_title">
              <h2><i class="fa fa-bars"></i> Products </h2>
              <ul class="nav navbar-right panel_toolbox">
                <li>&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;</li>
                <li>&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;</li>
                <li><a class="collapse-link"><i class="fa fa-chevron-up"></i></a></li>
              </ul>
              <div class="clearfix"></div>
            </div>
            <div class="x_content">
              <div class="">
                <ul id="myTab" class="nav nav-tabs bar_tabs" role="tablist">
                  <li role="presentation" class="active"><a href="#tab_content1" id="home-tab" role="tab" data-toggle="tab" aria-expanded="true">All Products</a></li>
                  <li role="presentation"><a href="#tab_content2" role="tab" id="profile-tab" data-toggle="tab" aria-expanded="false">New Products</a></li>
                </ul>
                <div id="myTabContent" class="tab-content">
                  <div role="tabpanel class="tab-pane fade active in" id="tab_content1" aria-labelledby="home-tab">
                    <div class="col-md-12 col-sm-12 col-xs-12">
                      <!-- content for all products -->
                    </div>
                  </div>
                </div>
              </div>
            </div>
          </div>
        </div>
      </div>
    </div>
  </div>
</section>
```

103
All Products

<ul class="nav navbar-right panel_toolbox">
<li>&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&n
<thead>
@foreach($products as $key => $product)
<tr>
<td>{{ ++$key }}</td>
<td>
<a>{{$product->name}}</a><br/>
<small>Expiry Date: {{$product->expiry_date}}</small>
</td>
<td>
<ul class="list-inline">
<li>{{$product->details}}</li>
</ul>
</td>
<td>
<ul class="list-inline">
<li>{{$product->serial}}</li>
</ul>
</td>
<td>{{$product->manufacturer}}</td>
<td class="no-print">
<a href="{{ route('project_details', $product->id) }}" target="_blank" class="btn btn-primary btn-xs"><i class="fa fa-folder"></i> View</a>
<button class="btn btn-info btn-xs" data-toggle="modal" data-target="#myModalEditProject" onclick="fun_edit('{{$product->id}}')"><i class="fa fa-pencil" aria-hidden="true"></i> Edit</button>
<button class="btn btn-danger btn-xs" onclick="fun_delete('{{$product->id}}')"><i class="fa fa-trash-o" aria-hidden="true"></i> Delete</button>
</td>
@endforeach
</tr>
@endforeach
</tbody>
<input type="hidden" name="hidden_view" id="hidden_view" value="{{url('product/view')}}">
<input type="hidden" name="hidden_view" id="hidden_view2" value="{{url('project/view')}}">
<input type="hidden" name="hidden_view" id="hidden_view3" value="{{url('project/view')}}">
<input type="hidden" name="hidden_delete" id="hidden_delete" value="{ url('project/delete') }" />
</div> <div role="tabpanel" class="tab-pane fade" id="tab_content2" aria-labelledby="profile-tab">
<div class="col-md-12 col-sm-12 col-xs-12">
<div class="x_panel">
<div class="x_title">
<h2>Product Information</h2>
<ul class="nav navbar-right panel_toolbox">
<li>&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;\</li>
<li><a class="collapse-link"><i class="fa fa-chevron-up"></i></a></li>
</ul>
<div class="clearfix"></div>
</div>
<div class="x_content">
<form action="addproject" method="post" class="form-horizontal form-bordered" enctype="multipart/form-data">
<div class="form-group">
<label class="col-md-3 control-label" for="example-text-input">Product Name</label>
<div class="col-md-6">
<input type="text" id="name" name="project_name" class="form-control" placeholder="Project Name" required>
</div>
</div>
<div class="form-group">
<label class="col-md-3 control-label" for="example-text-input">Product Serial #</label>
<div class="col-md-6">
<input type="text" id="name" name="client" class="form-control" placeholder="Client Name" required>
</div>
</div>
<div class="form-group">
<label class="col-md-3 control-label" for="location">Manufacturer</label>
<div class="col-md-6">
<input type="text" id="email" name="contact" class="form-control" placeholder="Client Contact" required>
</div>
</div>
<div class="form-group">
<label class="col-md-3 control-label" for="location">Batch Number</label>
<div class="col-md-6">
<input type="text" id="email" name="location" class="form-control" placeholder="Location" required>
</div>
</div>
</form>
</div>
</div>
</div>
</div>
Appendix B: Survey Cover Letter

School of Science & Technology,
Phone: +254-730-116733/729,
Email: sst@usiu.ac.ke,
Nairobi, Kenya.

Dear Respondent,

I am Emily Wanjiru Ruciini a Masters of Science student at USIU- Africa School of Science & Technology under the supervision of Prof. Jimmy K.N. Macharia, Associate Professor of Information Systems & Technology and Dean, School of Science & Technology, USIU-Africa, Nairobi.

I would like to invite you to be a part of my research study entitled: An Investigation of the factors that influence the adoption of secure cryptographic QR in counterfeit goods authentication. The aim of this study is to examine the SME factors, merchant factors, technology and government related factors that influence the use of secure cryptographic QR codes.

This study will require that you complete a four-page questionnaire survey along with providing any additional information requested. Do not indicate your name on the questionnaire and any information you provide will be kept strictly confidential and will not be attributed to the person or company. All responses will be stored securely and the results will be purely used for academic purposes only.

Your contribution will be highly appreciated; thank you very much for your time and cooperation.

Any queries about your participation in this survey may be directed to my supervisor Prof. Jimmy K.N. Macharia through the email address: kmacharia@usiu.ac.ke

Cordially,

---------------------
(Emily Wanjiru)
3rd February, 2017

TO WHOM IT MAY CONCERN.

Dear Sir/Madam,

RE: RESEARCH INTRODUCTION LETTER – RUCIINI EMILY WANJIRU

We wish to inform you that the bearer of this letter, Ruciini, Emily Wanjiru- student ID No. 645302 is a Student at United States International University (USIU) – Africa, pursuing a Graduate Degree program in Information Systems and Technology.

She is currently conducting a Research Dissertation titled: ‘An investigation of the factors that influence the adoption of secure cryptographic QR in counterfeit goods authentication’, which is in partial fulfilment of the requirement to qualify for graduation.

Please, note that any information provided will be treated with confidentiality and at no instance will it be used for any other purpose, other than for this Research Dissertation.

Kindly, accord her the desired assistance and contact the undersigned should you have any queries.

Sincerely,

Francis W. Wambalaba, Ph.D., AICP
Associate Deputy Vice Chancellor Academics-Research
United States International University
P.O. Box 14634, Nairobi, Kenya, 00800
fwambalaba@usi.ac.ke
PH. + 254 20 3606442
Appendix D: Survey Questionnaire

**Instructions:**
The purpose of this study is to examine SME factors, merchant factors, technology and government related factors that influence the use of secure cryptographic QR codes. There is no right or wrong answers. What matters is your personal opinion. The survey should take approximately 10 minutes.

Thank you for taking the time to complete this questionnaire. Place a tick ✓ or circle around the numeric value corresponding to your personal opinion on one option for each statement.

**SECTION A: GENERAL INFORMATION**
Please answer the following questions about yourself and company by checking with a tick ✓ the box in front of the appropriate information or by providing the information requested where appropriate.

<table>
<thead>
<tr>
<th>1. My gender is</th>
<th>2. Please specify your age range.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. □ Male</td>
<td>1. □ 15-20,</td>
</tr>
<tr>
<td>2. □ Female</td>
<td>2. □ 21-25,</td>
</tr>
<tr>
<td></td>
<td>3. □ 26-30,</td>
</tr>
<tr>
<td></td>
<td>4. □ 31-35,</td>
</tr>
<tr>
<td></td>
<td>5. □ 36-40,</td>
</tr>
<tr>
<td></td>
<td>6. □ 41-45,</td>
</tr>
<tr>
<td></td>
<td>7. □ 46-50,</td>
</tr>
<tr>
<td></td>
<td>8. □ 51 or over</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3. What industry is your SME?</th>
<th>4. How many years has the business been in operation?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Retail</td>
<td>1. Sole Proprietor</td>
</tr>
<tr>
<td>2. □ Wholesale</td>
<td>2. □ Private Limited Company</td>
</tr>
<tr>
<td>3. □ Apparel</td>
<td>3. □ Company Limited by Guarantee</td>
</tr>
<tr>
<td>4. □ Telecommunication</td>
<td>4. □ NGO</td>
</tr>
<tr>
<td>5. □ Pharmacy</td>
<td>5. □ CBO</td>
</tr>
<tr>
<td>6. □ Spare parts</td>
<td></td>
</tr>
<tr>
<td>7. □ Other Specify</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5. What is the gross turn over?</th>
<th>6. What is your highest level of education?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. □&lt; 1 million</td>
<td>1. □ Certificate</td>
</tr>
<tr>
<td>2. □ 1–2 million</td>
<td>2. □ Diploma</td>
</tr>
<tr>
<td>3. □ 2–3 million</td>
<td></td>
</tr>
<tr>
<td>4. □ 3-4 million</td>
<td></td>
</tr>
<tr>
<td>5. □ 4-10 million</td>
<td></td>
</tr>
<tr>
<td>6. □ &gt;10 million</td>
<td></td>
</tr>
</tbody>
</table>
# SECTION B: Encrypted QR Characteristics

## SECTION B1: Trust Of Encrypted QR

<table>
<thead>
<tr>
<th>TRUST1. This secure cryptographic QR is trustworthy and reliable.</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree or Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRUST2. This secure cryptographic QR always identifies counterfeit goods.</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRUST3. The information on this secure cryptographic QR is plentiful and sufficient.</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRUST4. The infrastructure of this secure cryptographic QR is dependable.</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRUST5. The secure cryptographic QR offers secure data privacy.</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Section B2: Perceived Cost Effectiveness

<table>
<thead>
<tr>
<th>COST1. Using the secure cryptographic QR system will save me a lot of time. (Rejecting fake products.)</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree or Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>COST2. Using the secure cryptographic QR system will reduce my return transportation of counterweight goods and calling cost</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COST3. Secure cryptographic QR system will increase my productivity (quick identification of fake products)</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COST4. Using the secure cryptographic QR will reduce the chance of buying counterfeit products for sale.</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COST5. Overall, I anticipate the use of the secure cryptographic QR to reduce cost related to losses as a result of buying counterfeit products.</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Section B3: Reliability

1. I face no problems with using the service of the secure cryptographic QR. | 1 2 3 4 5 |
2. The cryptographic QR executes transactions quickly and efficiently. | 1 2 3 4 5 |
3. The cryptographic QR system presents information clearly. | 1 2 3 4 5 |
4. The design and navigation of the cryptographic QR makes it comfortable to do a verification transaction. | 1 2 3 4 5 |
SECTION C: User Attitudes

### Section C1: Perceived Usefulness

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree or Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Using the secure cryptographic QR improves my performance in my job.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. Using the secure cryptographic QR in my job increases my productivity.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. Using the secure cryptographic QR enhances my effectiveness in my job.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. I find the secure cryptographic to be useful in my job.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. Using the cryptographic QR would make it easier to do my job.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. Using the secure cryptographic QR in my job would enable me to accomplish tasks more quickly.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

### Section C2: Social Norms

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>NORM1. People who influence my behavior think that I should use the secure cryptographic QR.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>NORM2. People who are important to me think that is should use the secure cryptographic QR.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>NORM3. The senior management of this business has been helpful in the use of the secure cryptographic QR.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>NORM4. In general, the company has supported the use of the secure cryptographic QR.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

### Section C3: Intention to Use

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ITU1. Assuming I have access to the secure cryptographic QR, I intend to use it.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>ITU2. Given that I have access to the secure cryptographic QR, I predict that I would use it.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>ITU3. I plan to use the secure cryptographic QR in the next few months.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

### Section C4: Perceived Ease of Use

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>PEOU1. My interaction with the secure cryptographic QR is clear and understandable.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>PEOU2. Interacting with the secure cryptographic QR does not require a lot of my mental effort.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>PEOU3. I find the secure cryptographic QR easy to use.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>PEOU4. I find it easy to get the secure cryptographic QR to do what I want it to do.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>PEOU5. It would be easy for me to become skillful at using the cryptographic QR.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>PEOU6. Learning to operate the cryptographic QR would be easy for me.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

### Section C5: Computer Self-Efficacy
<table>
<thead>
<tr>
<th>CSE1.</th>
<th>I feel confident using the secure cryptographic QR.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSE2.</td>
<td>I feel confident learning to use the secure cryptographic QR.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>CSE3.</td>
<td>I am very confident in my abilities to use the secure cryptographic QR.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>CSE4.</td>
<td>I feel confident describing the function of the cryptographic QR.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>CSE5.</td>
<td>I feel confident getting help for problems in the cryptographic QR.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>CSE6.</td>
<td>I find it difficult to get the cryptographic QR to do what I want it to.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>CSE7.</td>
<td>I find working with the cryptographic QR very easy.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

### SECTION D: Government Factors

#### Section D1: Policy

<table>
<thead>
<tr>
<th>P1. The government's policies on using Barcodes and Secure cryptographic QR for combating counterfeit goods are adequate.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>P2. The government of Kenya has elaborate policy on using Barcodes and Secure cryptographic QR for combating counterfeit goods.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>P3. The government of Kenya policies encourages the use of Barcodes and Secure cryptographic QR for combating counterfeit goods.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>P4. There is adequate policies on using Barcodes and Secure cryptographic QR for combating counterfeit goods by the government of Kenya.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

#### Section D2: Awareness

<table>
<thead>
<tr>
<th>A1. The government makes business aware of the benefits of using Barcodes and Secure cryptographic QR for combating counterfeit goods.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>A2. The government of Kenya has elaborate awareness campaign for using Barcodes and Secure cryptographic QR for combating counterfeit goods by SMEs.</td>
<td>1</td>
<td>2</td>
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<td>4</td>
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<tr>
<td>A3. The government of Kenya awareness campaign for using Barcodes and Secure cryptographic QR for combating counterfeit goods by SMEs is adequate.</td>
<td>1</td>
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<tr>
<td>A4. There is adequate awareness campaign for using Barcodes and Secure cryptographic QR for combating counterfeit goods by the government of Kenya.</td>
<td>1</td>
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</table>

#### Section D3: Enforcement

<table>
<thead>
<tr>
<th>D1. The government of Kenya enforces its policies on using Barcodes and Secure cryptographic QR for combating counterfeit goods.</th>
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</thead>
<tbody>
<tr>
<td>D2. The government of Kenya has adequate enforcement agencies for</td>
<td>1</td>
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<tr>
<td>Question</td>
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<tr>
<td><strong>D3. The government of Kenya has a strategy for enforcing its policies on the use of Barcodes and Secure cryptographic QR for combating counterfeit goods</strong></td>
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<tr>
<td><strong>D4. There is adequate enforcement on using Barcodes and Secure cryptographic QR for combating counterfeit goods by the government of Kenya.</strong></td>
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<tr>
<td><strong>SECTION D4: Secure Cryptographic QR</strong></td>
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<tr>
<td><strong>SCQR1. Secure cryptographic QR improves Identification of product details (manufacturer, name, batch etc).</strong></td>
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<td><strong>SCQR2. Secure cryptographic QR improves authentication of fake items using database records.</strong></td>
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<tr>
<td><strong>SCQR3. Secure cryptographic QR improves security of records in the database.</strong></td>
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<td><strong>SCQR4. Secure cryptographic QR makes it hard for business records to be interfered with.</strong></td>
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</tbody>
</table>

End of Questionnaire
Thank you