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Effort Expectancy, Performance Expectancy, Social Influence and Facilitating Conditions as Predictors of Behavioural Intentions to use ATMS with Fingerprint Authentication in Ugandan Banks

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Keywords: behavioural intentions to use, ATMS, fingerprint authentication.

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Keywords: behavioural intentions to use, ATMS, fingerprint authentication.

I. Introduction

The introduction of technology such as the ATM has enabled banks to improve service delivery (Olatokun & Igbinedion, 2009). Currently, ATMs are being used to perform a number of functions, ranging from traditional cash dispensing, cash deposits, account transfers, mini statements and even payment of bills. The adoption of ATMs has enabled customers to access their accounts any time and day of the week in the shortest time possible (Das & Jhunu, 2011). However, the ATM has its own limitations (Selvaraju & Sekar, 2010). For example, there are information security flaws are reflected in the form of "ATM frauds" (Adepoju & Alhassan, 2010). The ATM frauds problem is global in nature (Adeoti, 2011) and its consequences have been felt in Uganda as well (Namutebi, 2013). It is estimated that information security attacks have resulted in financial losses to banks (Jain, Prabhakar & Chen, 1999). As the ATM technology is advancing, fraudsters are devising different skills to beat the security of ATM operations. Various forms of fraud are perpetuated, ranging from ATM card theft, skimming, pin theft, card reader techniques and forced withdrawals (Luftman et al, 2006). Managing the risk associated with ATM fraud as well as reducing its impact is an important issue that faces financial institutions as fraud techniques have become more advanced with increased occurrences.

The ATM insecurity situation is not different from Uganda. An increasing number of Ugandans are losing money from their accounts through ATMs (Bank of Uganda, 2015). For example four Bulgarians were convicted for ATM Fraud in Uganda (Kasoma, 2012).Since January 2013 customers' money has been stolen from at least 20 banks through ATM (Chimp reports, 2015). Among these, include Centenary bank, Global Trust, Finance Trust, Stanbic bank, Orient bank, KCB, Barclays among others. Therefore, there is the need to enhance the ATM security system to overcome these challenges by adopting fingerprint based authentication for ATMs. Biometric technology has recently attracted more and more attention as a viable solution to enhancing ATM transaction security (Musleh & Ba, 2012). Given that the process is automated, biometric decision making is very fast, taking only a few seconds in real time in most cases (Emuoyibofarhe et al., 2011). According to Emuoyibofarhe et al. (2011), biometrics could provide a more secure, easier to use alternative to PIN. Ideally, biometrics prove the claimed identity of the card holder, cannot be forgotten, have very high variability and cannot be transferred or stolen.

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Biometric systems have replaced card/PIN in many physical access security systems, but do not have widespread use in self-service terminals, particularly ATMs (Pat & Knudsen, 2005).Fingerprint biometrics is a preferred choice for enhancing ATM transaction security. According to Jain (1999), fingerprint biometrics are reliable since majority of the population in the world have fingerprints and every human being has a unique fingerprint, they also require only a small amount of storage and offer more accuracy when compared to other biometrics. Fingerprint acquisition, operations and maintenance are relatively inexpensive in nature, and they are permanent in nature; their characteristics do not change over the course of time. They are formed in the fetal stage and it remains structurally unchanged.

Despite the strengths of fingerprint biometric authentication systems, Ugandan banks are still using the traditional method which is password-based authentication only using cryptographic techniques (BoU Report, 2015; Kasoma, 2012). In a conventional cryptographic system, the user authentication is possession based (BoU Report, 2015). Furthermore, the weakness of such authentication systems cannot assure the identity of the maker of a transaction; it can only identify the maker's belongings (that is cards) or what he remembers (passwords or PINs) (Awotunde, Tolorunloju & Adewunmi-Owolabi, 2014). Therefore, encouraging adoption of fingerprint authentication for ATMS in Uganda remains a virgin research area.

Studies establishing the importance of Effort Expectancy, Performance Expectancy, Social Influence and Facilitating conditions in enhancing technology adoption exist (Venkatesh and Balla, 2008; Chau, Stephens & Jamieson, 2004; Davies, 1989). However, there is no specific research done to encourage adoption of fingerprint authentication for ATMs in Ugandan Banks. Previous literature investigated users' acceptance of E-Health, E learning portals and E-commerce (Harby, Qahwaji and Kamala, 2010) But all these studies seem to overlook the adoption of fingerprint authentication for ATMs which is an increasingly important mechanism to verify user identity in the banking industry. This is basically a knowledge gap that this study intends to fill.

Consequently, the study sought to examine the determinants of behavioral intentions to adopt fingerprint authentication for ATMs based on the unified theory of acceptance and use of technology (UTAUT) proposed by Venkatesh, Morris, Davis and Davis (2003).

This study is significant since it provides critical literature on the influence of Effort Expectancy, Performance Expectancy, Social Influence and Facilitating conditions on bank customers' behavioral intentions to use ATMs with Fingerprint Authentication in Uganda. It has been noted by Parket al.(2007) that there is need to test constructs in the IT adoption and acceptance models in different cultural settings since they play a significant role in impacting IT acceptance.

II. Problem Statement

The security of the current ATM technology in Ugandan banks has been compromised leading to a lot of interest from banks regarding Closed Circuit Television (CCTV) security solutions for ATMs, deploying security guards at ATMs and sensitizing their customers about ATM security (BoU Report, 2015). Despite, these efforts, there have been complaints by users of ATM facilities in banking industry in Uganda on the fraudulent activities being carried out in their accounts that necessitated this study. ATM fraudsters use high-end techniques to rob Ugandans of hard-earned cash (Masaba, 2013). Presently in Uganda, ATM crimes have become a threat not only to customers, but also to bank operators (BoU Report, 2015). Moreover, the security layout of ATMs in Uganda is still at password-based authentication only using cryptographic techniques (BoU Report, 2015; Kasoma, 2012). Furthermore, the weakness of such authentication systems cannot assure the identity of the maker of a transaction; it can only identify the maker's belongings (that is cards) or what he remembers (passwords or PINs) (Awotunde, Tolorunloju & Adewunmi-Owolabi, 2014).Therefore, biometrics-based authentication systems that use physiological and/or behavioral traits are good alternatives to traditional methods. These systems have not been used to enhance ATM security in Uganda banks (BoU Report 2015) yet they are more reliable (biometric data cannot be lost, forgotten, or guessed) and more user-friendly (there is nothing to remember or carry) (Uludag, 2006). Recently, fingerprint authentication is the most popular authentication in developed countries (Ndife et al., 2013). Therefore, it becomes imperative to embrace a more robust technique like fingerprint biometric authentication, that is, to integrate encryption key with fingerprint biometrics for easy identification and authentication of users to reduce the propensity to ATM security limitations in Ugandan banks. Hence the need to examine predictors of Behavioural Intentions to Use ATMs with Fingerprint Authentication in Ugandan Banks.

III. Objectives of the Study

1) To examine the relationship between Performance Expectancy and Behavioural Intention to use fingerprint biometrics based authentication for ATMS in Uganda.
2) To examine the relationship between Effort Expectancy and Behavioural Intention to use fingerprint biometrics based authentication for ATMS in Uganda.
3) To examine the relationship between Social Influence and Behavioural Intention to use

fingerprint biometrics based authentication for ATMS in Uganda.

4) To study the relationship between Facilitating Conditions and and behavioural intention to use fingerprint biometrics based authentication for ATMS in Uganda.

a) Hypothesis

H1: Performance expectancy has a positive influence on the Behavioral intention to use fingerprint-based authentication for ATMs in Uganda.

H2: Effort expectancy has a positive influence on the Behavioral intention to use fingerprint authentication based ATMs in Uganda.

H3: Social influence has a positive influence on the Behavioral intention to use fingerprint-based authentication for ATMs in Uganda.

H4: Facilitating conditions has a positive influence on Behavioral intention to use fingerprint-based authentication for ATMs in Uganda.

IV. Related Literature

a) ATM PIN based Authentication

People use the ATM for transactions such as cash withdrawal, balance inquiry, mini statement and statement request (Emuoyibofarhe et al., 2011). ATM is the most convenient way to access the accounts and funding transactions. According Ravikumar (2013) ATMs have two input devices (a card reader and keypad) and four output devices (display screen, cash dispenser, receipt printer, and speaker). An invisible communications mechanism to the client links the ATM directly to an ATM host network (Thyagarajan, 2006). The ATM functions much like a PC given that it comes with an operating system and specific application software for the user interface and communications (Fengling, Jiankun, Xinhuo, Yong &Jie, 2005).

The ATM uses magnetic strip cards and PINs to identify account holders. The ATM forwards information read from the client's card and the client's request to a host processor, which routes the request to the client's financial institution. If the cardholder is requesting cash, the host processor signals for an electronic funds transfer (EFT) from the customer's bank account to the host processor's account (Leigh, 2013). Once the funds have been transferred, the ATM receives an approval code authorizing it to dispense the cash. This communication, verification, and authorization can be delivered in several ways (Thyagarajan, 2006). Leased line, dial-up, or wireless data links may be used to connect to the host system. In this case, the PIN is an important aspect in protecting an individual's ATM transaction account. This PIN is shared between a user and the system and can be used to authenticate or identify the user to the system (Babatunde & Akinyokun, 2013). Therefore, the ATM system authentication of the customer is based only on the PIN he/she supplies (Ravikumar, 2013).

b) ATM PIN based Limitations

The limitations of the PIN based ATM authorization process include theft, unauthorized access, forgetfulness, card swallowing and damages due to bending (Das & Jhunu, 2011; Sunday, 2012; Akinyemi, Omogbadegun & Oyelami, 2010). The potential for the theft of PIN by unsuspecting criminals is a major disadvantage to the operation of ATM. While fraudsters place card readers, called skimmers, over the authentic reader to transfer numbers and codes, password voyeurs use spy cameras to collect access codes (Babatunde & Akinyokun, 2013). Burglars also use cloning devices to gain access into customer's account. Forgetfulness is mostly experienced when user makes frequent attempts to protect his or her PIN from people's guess and in the process, end up forgetting it (Subh & Vanithaasri, 2012). Occasionally, an ATM may malfunction resulting in swallowing of card, which may pose a number of inconveniences to the user. Damaging may be because of injuries caused to cards in wallets or hip pockets with no adequate attention or care (Babatunde & Akinyokun, 2013).

c) Fingerprint Biometrics as a Means for Enhancing ATM Transaction Security

Among all the biometrics, fingerprint based identification is one of the most mature and proven technique and has been the most widely used during the 20th century. Because fingerprint-based authentication offers several advantages over other authentication methods, there has been a significant surge in the use of finger print biometrics for user authentication in recent years (Akwaja, 2010). At the time of transaction, fingerprint image is acquired at the ATM terminal using high resolution fingerprint scanner. The choice of fingerprint for this research is premised on the fact that it is the most popular biometrics mode for its uniqueness (no two people with identical print) and consistency (it may change in scale but not in relative appearance) (Awotunde, Tolorunloju & Adewunmi-Owolabi, 2014). It also enjoys high availability (it is naturally fixed on all individuals) and universality (possess by every individual irrespective of gender, age or race) (Fatai, Awotunde, & Matluko, 2014; Jeroen, Ileana, Koen & Emile, 2011; Wang, Hu & Phillips, 2007). In addition, fingerprint cannot be forged, stolen, misplaced or forgotten and in cases of damages, it reproduces in short interval of time (Iwasokun, 2012; Iwasokun, Akinyokun, Alese & Olabode, 2012; Fengling, Jiankun, Xinhuo, Yong & Jie, 2005; Das & Jhunu, 2011). Fingerprint technologies are also supported by numerous and existing fast computing devices, high recognition rate and speed, explosive growth of network and Internet transactions and the heightened awareness

of the need for ease-of-use as an essential ingredient of reliable security (Babatunde & Akinyokun, 2013).

Fingerprint recognition is an active research area nowadays (Maltoni, Maio, Jain & Prabhakar, 2009). An important component in fingerprint recognition systems is the fingerprint matching algorithm. According to the problem domain, fingerprint matching algorithms are classified in two categories: fingerprint verification algorithms and fingerprint identification algorithms. The aim of fingerprint verification algorithms is to determine whether two fingerprints come from the same finger or not. On the other hand, the fingerprint identification algorithms search a query fingerprint in a database looking for the fingerprints coming from the same finger.

Since security measures at ATM centers play a critical and contributory role in preventing attacks on customers, several authors have used fingerprint to shift from PIN to biometric based security (Kuykendall & Lee, 2003). Das and Jhunu (2011) and Yun and Jia(2010) focused on vulnerabilities and the increasing wave of criminal activities occurring at ATMs and presented a prototype fingerprint authentication for enhancing security. The systems adopt the same measure as the current work by formulating modules for fingerprint enrolment, enhancement, feature extraction and database and matching.

Subh and Vanithaasri (2012) proposed a highly authenticated biometric security system. The work is similar to the current work with its use of conventional fingerprint static points (features and minutiae points) for authentication during ATM access. The static points of fingerprint were considered for increased matching scores against the distortions and non-linear deformations. Consecutive steps processed include preprocessing and key points generation (KPG). KPG is based on the iterative process of evaluating the costs of each fingerprint and iris simultaneously using the cryptosystem features for identification of valid users from the database. The work however lacks the strength to exclude false feature and minutiae points from its extracted list.

Santhi and Kumar (2012) proposed an ATM security enhancing method with secured Personal Identification Image (PII) process. A detailed study on various existing biometric systems is also presented stating the strengths and limitations. In the same manner of the current research, they used the characteristic features of fingerprint to overcome the limitations of the PIN based ATM authentication. However, the proposed method lacks adequate implementation and evaluation to back-up the performance claim. Bhosale and Sawant (2012) and Ibiyemi, Obaje and Badejo (2012) present innovative models for biometric ATMs, which replaces card system with biometric technology. The proposed systems hybridize feature-based fingerprint, iris and PIN to provide reliable and fool-proof ATM authentication.

Singh, Tripathi, Agarwal and Singh (2011), through a formal verification of existing models, have proposed for ATM transaction through fingerprint with the help of Real Time Constraint Notation (RTCN). The technology is related to the current work by utilizing the uniqueness of epidermis of fingers for user's identification. In addition, in a way similar to the current work, the user is expected to keep the finger on a sensory pad, which reads the ridges of epidermis of finger and try to match it with available data of the finger with the bank. The relative advantages of the technology over Sequence Diagrams (SDs), Finite State Machine (FSM) in areas of branching, state information and composing SDs are presented.

d) Predictors of Behavioral Intentions to use ATMs with Fingerprint Authentication

Performance Expectancy: Performance expectancy refers to the extent/degree to which an individual believes that using the system will help him/her to attain gains in job performance (Venkatesh et al. 2003). This factor is similar to perceived usefulness from TAM and is recognized to be a fundamental attribute in influencing individual's attitude towards using any system (Chau, Stephens & Jamieson, 2004). Ho, Stephens & Jamieson (2003) further define performance expectancy as the degree to which a person believes that using a particular biometric system would fulfill the organization's security access requirements in a particular domain. According to Venkatesh et al.'s (2003) studies, Performance expectancy is found to uniquely, significantly and positively influence one's behavioral intension to accept and use an IT system. Performance expectancy can be explained by security (confidentiality, integrity and availability of information used), reliability (the probability that the system remains successful in achieving its intended objectives) and identity assurance (the assurance that only authorized individuals are given access) (Ho et al. 2003). Therefore, in this study security, reliability and identity assurance explained the performance expectancy of the intention to use fingerprint-based authentication.

Effort Expectancy: Venkatesh et al., (2003) define effort expectancy as the level of easiness related while using any system. This means that effort expectancy refers to the effort needed to use the system, whether it is simple or complicated. User-friendly technology could be easily accepted and adopted by users. Most users prefer technology that provide them flexibility, usefulness, and ease of use. According to Giesing (2003) effort expectancy is a factor that is highly significant in influencing intention to use. In the present context, effort expectancy refers to the perception of ease using fingerprint-based authentication in ATMs. Clodfelter (2010) explains that three constructs from the existing models capture the concept of effort expectancy: perceived ease of use (TAM/TAM2), complexity (MPCU), and ease of use (IDT). Ho et al. (2003) say fingerprints

are easy to use in authentication since there is no need to remember, hide, replace or repair. Therefore, If users expect ATMs to perform excellently with the fingerprint authentication system, they are more likely to use the system.

Facilitating Conditions: Facilitating conditions are defined as the degree to which an individual perceives that organizational and technical infrastructure exist to support use of the system (Venkatesh et al., 2003). In the context of this study, it referred to the objective factors like infrastructures and resources that influence intention to use fingerprint-based authentication in ATMs. Venkatesh et al (2013) argue that there is a positive relationship between facilitating conditions and behavioral intention to use and adoption of technology. However, the relationship was moderated by Age and experience with the result being stronger for older workers with increasing experience. For the case of this study, people will be willing to use ATMs with fingerprint based authentication if they believe the infrastructure and resources exit to support use of the system.

Social Influence: Social influence is defined as the degree to which an individual perceives that important others (such as relatives, peers and subordinate) believe that he or she should use the new system (Venkatesh et al., 2003). According to Pietro et al. (2012), word of mouth is influenced by reference groups and it includes friends and IT experts, which in turn play a major role in the adoption of communication technologies. Social influence can be either subjective norm, social factors, or image. Image refers to the improvement of solitary image or class in social system using the apparent new system (Venkatesh et al., 2003). Constructs of subjective norms (Ration action theory, planned theory, and decomposed planned theory and Technology acceptance model 2), social factors (PC utilization model) and image (innovation diffusion theory) were influential in formation of the social influence variable (Giesing, 2003). For the case of this study, subjective norm measured social influence. A person's subjective norm is determined by his or her perception that salient social referents think he/she should or should not perform a particular behavior (Ajzen and Fishbein, 1980). A person is motivated to comply with the referents even if he/she does not favour the behaviour. The referents may be superiors like parents, employers or teachers or peers like friends, workmates or classmates. This study considered that most users tend to have their decision making reliant on others' suggestions, therefore social influence should play a more important role. Venkatesh et al. (2003) explains that the relationship between social influence and behavioral intention to use is strong, hence the following hypothesis.

Venkatesh et al. (2003) recommended that future research applies and examines the applicability of the Unified Theory of Adoption and use of Technology (UTAUT) constructs in different contexts hence this study examined the influence of Effort expectancy, Performance expectancy, Social influence and Facilitating conditions on Behavioural intentions to Use which helped to understand the predictors of Behavioural intentions to Use ATMs with Fingerprint Authentication in Ugandan Banks.

Measurement of Variables: The items used to measure performance expectancy, effort expectancy, social influence and behavioural intention were adapted from Venkatesh et al(2003).In the context of this study, factors such as security, reliability and identity assurance were used to measure performance expectancy of the intention to use fingerprint-based authentication as suggested by Ho et al. (2003). Complexity and ease of use were used to measure effort expectancy (Clodfelter, 2010). Social influence variable was measured by subjective norm (Venkatesh et al., 2003) and facilitating conditions was measured by technical infrastructures and resources that encourage the usage of fingerprint-based authentication in ATMs.

V. Methodology

a) Research Design

A cross- sectional field survey research design was adopted and thus quantitative research techniques were used during data collection. A cross-sectional field survey research design was used, given that researchers are able to collect data on beliefs, practices or situations from a random sample of subjects in the field using survey questionnaires (Bhattacherjee, 2012). Questionnaires used were tested for reliability and validity before the survey.

b) Study Population, sample size and Sampling technique

ATM users were the population for this study. Due to the large sizes of population and limited financial, human and time resource resources, this study was not able to cover all the banks but only used accessible population. This is in line with Amin (2005) definition of accessible population referring to it as the portion of the population to which the researcher has reasonable access. In this study customers of Stanbic Bank, Barclays Bank, KCB and Centenary Bank were the access population. The four banks were selected over the rest considering the maturity of the banks, big numbers of customers, exposure of the customers and the fact that they have faced fraudulent activities. A total of 275 questionnaires were administered to ATM users (respodents) who were selected using convenience sampling from the four banks and 211 questionnaires were returned. This sample is in line with Roscoe's (1970) rule of thumb that states that a sample size between 30 and 500 is sufficient. Data were analyzed and then presented in the tables. The study used

descriptive statistics, correlation and regression analyses. According toJanssens et al.(2008), descriptive statistics is important because it provides a simple way of presentation of results, and it is easy to understand the results when presented

c) Validity and reliability tests

Validity tests determine how well a research instrument used measures the concept for which it was intended (Miller, 2010). Content Validity Index was used to test for validity of the questionnaires (Saha, 2008). Two questionnaires were developed with a five point likert scale of Not relevant, Somewhat relevant, Quite relevant, Relevant and Very relevant and distributed to 4 experts to test for content validity. The experts were asked to indicate the extent to which each variable was valid and investigated what they were intended to measure. The result showed a content validity of 0.85 which was an evidence of good content validity according to Polit et al (2007). Whereas reliability tests measure the consistence and stability of a research instrument. Cronbach Alpha Coefficient was used to test for reliability (Carcary, 2008). The researcher used Cronbach Alpha Coefficient (Cronbach, 1951) to measure reliability. Questionnaires were administered to thirty respondents to check for the reliability of the questionnaires. The questionnaire items were analyzed using Cronbach's Alpha reliability test in SPSS software as shown in Table 1

Table 1: Reliability Statistics

Variable	Number of Items	Cronbach's Alpha
Performance Expectancy	3	0.821
Effort Expectancy	4	0.701
Social Influence	4	0.821
Facilitating Condition	3	0.691
Behavioral Intention	5	0.707

Findings in Table 1 show that all items under each of the variables measured were found to have a coefficient of 0.691 and above which according to Nunnaly (1978) is acceptable in research.

VI. Ethical Considerations

Informed Consent: The researcher ensured prospective research participants were fully informed about the procedures and risks involved in research and they gave their consent to participate.

Respect, confidentiality and privacy: The researcher assured participants of the confidentiality and privacy of the information provided. More to that, participants were not asked to write names on the questionnaires. Research participants were given freedom to choose how much information about themselves they would reveal and under what circumstances. So the researcher was so careful when recruiting participants for a study and only those that were willing were given the questionnaires.

a) Findings

This section entails of the analysis of the data collected on the study variables and the interpretation of the analysis based on the research objectives and questions.

b) Background Characteristics

The background characteristics that were analyzed included; age and level of education.

Age

Table 2: Age of Respondents

Age Groups	Frequency	Percent
18-28 years	81	38.4
29-39 years	72	34.1
40-50 years	54	25.6
Over 51 years	4	1.9
Total	211	100.0

Results in Table 2 show that the respondents in the age category 18-28 years contributed the majority of respondents with (Freq=81, % =38%). This was followed by 29-39 years category with (Frq = 72, % = 34%). 40-50 years category followed with (Freq = 54, % = 25%) while above 51 years category was the last with (Freq = 4, % = 2%)

Academic qualification level of respondents

Table 3: Academic Qualification

Qualification	Frequency	Percent
Certificate	8	3.8
Diploma	31	14.7
Bachelor's degree	108	51.2
Master's degree	43	20.4
Post graduate	21	10.0
Total	211	100.0

The results in Table 3 show that most of the participants (bank customers) in the study (Freq = 108, % = 51%) were bachelor's degree holders. This was followed by those who were master's degree holders (Freq = 43, % = 20%) and diploma had (Freq = 31, % = 15%). Post graduate had (Freq = 21, % = 10%) whereas certificate holders scored less with (Freq = 8, % = 4%).

VII. Descriptive Statistics

a) Performance Expectancy

Table 4: Descriptive Statistics for performance expectancy for bank customers

Code		Mean	Std. Deviation	Meaning
PE1	I think a fingerprint authentication for ATM will improve identity assurance	4.4313	.61626	Agree
PE2	I think fingerprint authentication based ATM will be useful in carrying out transactions	4.2322	.69564	Agree
PE3	I think fingerprint authentication based ATM will improve security of money in the system	4.5403	.60320	Agree

Findings in Table 4 show that there are positive perceptions on performance expectancy in regards to PE1 (mean = 4.5403), PE2 (mean = 4.4313) and PE3 (mean = 4.2322). All the means are 4 and above, an indication that performance expectancy influences the adoption and use of biometric fingerprint technology for ATMs in Uganda.

b) Effort Expectancy

Table 5: Descriptive Statistics for Effort Expectancy

Code		Mean	Std. Deviation
EE1	I think my interaction with the fingerprint authentication based ATM will be clear and understandable.	4.218	0.71704
EE2	I think the fingerprint authentication based ATM will be easy to use	4.2701	0.80357
EE3	I think learning to operate the fingerprint authentication based ATM will be easy for me.	4.2559	0.73088
EE4	I will not need high effort to use fingerprint authentication based ATM	4.3223	0.77486

Results in Table 5 show that here are positive perceptions on effort expectancy in regard to EE1 (Mean = 4.3223), EE2 (mean = 4.2701), EE3 (Mean = 4.2559) and EE4 (mean = 4.2180). All the means are 4 and above, an indication that effort expectancy influences the adoption and use of biometric fingerprint technology for ATMs in Uganda.

c) Social influence

Table 6: Descriptive Statistics for Social Influence

Code	Factor	Mean	Std. Deviation	Meaning
SI1	I think people who are important to me will recommend me to use fingerprint authentication based ATM	3.6398	0.82412	Agree
SI2	I think the use of fingerprint authentication based ATM will elevate my class	3.6682	0.97291	Agree
SI3	I think my peers will expect me to use fingerprint authentication based ATM	3.7014	0.88959	Agree
SI4	I think people who influence my banking behavior will recommend me to use fingerprint authentication based ATM	3.9289	0.88354	Agree

Results in Table 6 show that there are positive perceptions on social influence in regards to SI1 (Mean= 3.9289), SI2 (Mean = 3.7014), SI3 (Mean = 3.6682) and SI4 (Mean = 3.6398). All the means are 3.6 and above, an indication that social influence influences the adoption and use of biometric fingerprint technology for ATMs in Uganda.

d) Facilitating Conditions

Table 7: Descriptive Statistics for facilitating conditions

Code	Factor	Mean	Std. Deviation	Meaning
FC1	I think my bank has the hardware and software required for implementation of the fingerprint authentication based ATM	3.5735	0.90399	Agree
FC2	I think my bank has enough money to implement and maintain a fingerprint authentication based ATM	3.8768	0.7892	Agree
FC3	I think my bank has a team in charge of championing Information Technology innovations.	3.9858	0.76519	Agree
FC4	I think a banking policy will be established to encourage use of fingerprint authentication based ATMs.	3.872	0.85508	Agree

Findings in Table7 indicate that there are positive perceptions on facilitating conditions in regards to FC3 (Mean =.3.9858), FC2 (Mean = 3.8768), FC2 (Mean =.3.8720), FC4 (Mean=3.8720) and FC1 (Mean = 3.5735). All the means are 3.5 and above, an indication that facilitating conditions influence the adoption and use of biometric fingerprint technology for ATMs in Uganda.

e) Behavioural intention to use

Table 8: Descriptive Statistics for Behavioural intention to use

Code	Factor	Mean	Std. Deviation	Meaning
BI1	I will take time to help others learn how to use fingerprint authentication based ATM	3.6872	0.93441	Agree
BI2	I think fingerprint based authentication will be a basis for future ATMs	4.1991	0.70926	Agree
BI3	I intend to use the fingerprint authentication based ATM in future	4.2986	0.7111	Agree
BI4	I am open to learning how to use fingerprint authentication based ATM	4.4171	0.7148	Agree
BI5	I think fingerprint authentication based ATMs will be interesting to use	4.3412	0.7414	211

Findings in Table 8 show that there are positive perceptions on behavioral intention to adopt in regards to BI4 (Mean = 4.4171), BI5 (Mean = 4.3412), BI3 (Mean = 4.2986), BI3 (Mean = 4.1991) BI1 (Mean = 3.6872). All the means are 3.6 and above an indication that bank customers are willing to use ATMs with fingerprint authentication now and in future and would also recommend and help their friends to use them.

VIII. Normality Test

Normality test of the study variables involved the use of PP plots, QQ plots, and Histogram. The PP and QQ plots showed most of the data points are on and close to the straight line an indication that the study variables were fairly and normally distributed as shown in Figures 1 to 10. The histogram in figure 11 shows that most of the bar charts are within the normal curve, an indication that the data are fairly and normally distributed for all variables being measured.

IX. Relationship between Study Variables

a) Correlation and Regression

Hypothesis 1: Results in tables 12 and 13 of correlation and regression outputs indicated a significant positive relationship between Performance Expectancy and Behavioural Intention(Beta = .230** $p < 0.01$, r=.316** $p < 0.01$) to use fingerprint biometrics based

authentication for ATMS in Uganda. Therefore, the hypothesis that performance expectancy has a positive influence on the Behavioral intention to use fingerprint-based authentication for ATMs in Uganda was supported.

Hypothesis 2: Results in tables 12 and 13 ofthe correletation and regression outputs indicated a significant positive relationship between Effort Expectancy and Behavioural Intention (Path Beta = .230** P < 0.01, r = 304** p < 0.01) to use fingerprint biometrics based authentication for ATMS in Uganda. Therefore, the hypothesis that effort expectancy has a positive influence on the Behavioral intention to use fingerprint authentication based ATMs in Uganda was accepted.

Hypothesis 3: Results in tables 12 and 13 of the correletation and regression outputs indicated a significant positive relationship between Social Influence and Behavioural Intention (Beta = .153* P < 0.01, r = .271** p < 0.01) to use fingerprint biometrics based authentication for ATMS in Uganda. Therefore, the hypothesis that social influence has a positive influence on the Behavioral intention to use fingerprint-based authentication for ATMs in Uganda was accepted.

Hypothesi 4: Results in tables 12 and 13 of the correletation and regression outputs indicated a significant positive relationship between Facilitating Conditions and and behavioural intention (Beta = .254**, P < 0.01, .387**, p < 0.01) to use fingerprint biometrics based authentication for ATMS in Uganda. Therefore, the hypothesis that facilitating conditions has a positive influence on Behavioral intention to use fingerprint-based authentication for ATMs in Uganda was accepted.

Table 9: Zero order Correlation matrix for the study variables

Variable	PEXP	EEXP	SOINF	FCON	BINT
PEXP	1				
EEXP	0.128	1			
SOINF	0.019	.198**	1		
FCON	.255**	.217**	.284**	1	
BINT	.316**	.304**	.271**	.387**	1

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

Findings in Table 9 show a significant F value an indication that there is a significant linear relationship between the study variables.

Table 10: Hierarchical multiple linear Regression for Behavioral intention

	Model 1		Model 2		Model 3		Model 4		Model 5	
	B	Beta	B	Beta	B	Beta	B	Beta	B	Beta
Constant	4.207**		2.910**		2.081**		1.651**		1.397**	
Age	-.027	-.051	-.007	-.014	-.030	-.055	-.027	-.050	-.008	-.015
Gender	.023	.025	-.024	-.026	-.044	-.047	-.042	-.046	-.068	-.074
Qualification	.002	.005	-.024	-.049	-.026	-.053	-.019	-.040	-.030	-.063
Bank	.030	.059	.011	.022	-.066	.011	.008	.016	.003	.007
Service duration	-.040	-.075	-.028	-.053	-.032	-.060	-.034	-.663	-.041	-.078
Performance expectancy			.328**	.315**	.288**	.277**	.287**	.276**	.239**	.230**
Effort expectancy					.260**	.285**	.219**	.241**	.187**	.205**
Social influence							.154**	.281**	.108*	.153*
Facilitating conditions									.221**	.254**
R square	.018		.108		.186		.231		.283	
Adjusted R square	-.006		.082		.082		.200		.251	
R square change	.018		.090		.090		.045		.052	
F- Change	.736		20.610		19.402		11.885		14.562	
Sig F Change	.597		.000		.000		.001		.000	
F	.736		4.107		6.610		7.579		8.807	
Sig	.597		.001		.000		.000		.000	

Findings in Table 10 show a significant F value an indication that there is a significant linear relationship between the study variables.

X. Discussion

This study focused on examining factors for adoption of fingerprint based authentication for ATMs in Uganda. Variables of performance expectancy, effort expectancy, social influence, facilitating conditions were identified as factors influencing behavioral intention to use fingerprint based authentication for ATMs in Uganda.

Results from the study indicated that there is a significant positive relationship between Performance Expectancy and Behavioural Intention to use fingerprint biometrics based authentication for ATMS in Uganda. Thus if ATM users believe using an ATM with fingerprint authentication is useful, will improve identity assurance and security of their money while carrying carrying out transactions, it will then improvr thisr behavioral intentions to use.Therefore, the findings coincide with (Ho et al. 2003) who argue that performance Expectancy significantly and positively influences one's behavioral intention to accept and use a system. Venkatesh et al. (2003) also agrees that there is a positive relationship between performance Expectancy and behavioral intention to use. Chua et al., (2004) postulates that performance expectancy factor is similar to perceived usefulness from TAM and is recognized to be a fundamental attribute in influencing individual's attitude towards using any system.

Also results from the study indicated that there is a significant positive relationship between Effort Expectancy and Behavioural Intention to use fingerprint biometrics based authentication for ATMS in Uganda. This implied if people believe that interaction with the fingerprint authentication based ATM will be clear and understandable and easy to use, it will improve their behavioral intentions to use. This is in line with Giesing (2003) who posits that effort expectancy is a factor that is highly significant in influencing behavioral intention to use. Clodfelter (2010) also explains that the extent to which an individual perceives the system to be easy to use has been found to significantly affect intention to use. Venkatesh et al., (2003) and Ho et al., (2003) also explain that there is a positive relationship between effort expectancy and behavioral intention to use.

Thirdly, results suggested a significant positive relationship between Social Influence and Behavioural Intention to use fingerprint biometrics based authentication for ATMS in Uganda. This implies that if ATM users believe that people who are important to them will recommend them to use fingerprint authentication based ATM, use of fingerprint authentication based ATM will elevate their class and peers will expect them to use fingerprint authentication based ATM it will will improve their Behavioural Intentions to use. This is in agreement with an argument by Venkatesh et al. (2003) that the relationship between social influence and behavioral intention to use is strong. Pietro et al. (2012) argue that person's subjective norm is determined by his or her perception that salient social referents think he/she should or should not perform a particular behavior. Also Giesing (2003) explains that social influence influences behavioral intention to use.

Finally, results from the previous chapter indicated that there is a significant positive relationship between Facilitating Conditions and behavioural intention to use fingerprint biometrics based authentication for ATMS in Uganda. Thus it seems necessary to provide required resources, information and also continous support to encourage users. The findings of this study concur with Venkatesh et al., (2003) who argue that there is a significant positive relationship between facilitating conditions and behavioral intention to use a certain system. Venkatesh et al. (2003) also explain that there is positive relationship between facilitating conditions and behavioral intention to use.

The study's theoretical contribution is that it provides critical literature on the influence of performance expectancy, effort expectancy, social influence and facilitating conditions on bank clients' behavioral intentions to use ATMs with fingerprint authentication. To the practitioners, the study provides recommendations on how to enhance ATM users' behavioral intentions to use ATMs with fingerprint authentication.

XI. Conclusion

The study established positive relationships between performance expectancy, effort expectancy, social influence, facilitating conditions and behavioral intention to use ATMs with fingerprint biometric based authentication. This is an indication that performance expectancy, effort expectancy, social influence, facilitating conditions have the ability to influence ATM users' behavioral intentions to use ATMs with fingerprint authentication.

XII. Recommendations

Banks should implement fingerprint based authentication systems for ATMs that improve identity assurance, reliability (up all the times customers need to access their money) and secure so that customers will be willing to use them hence high rates of adoption. More to that, Banks should also make sure they implement fingerprint biometrics based authentication systems for ATMs that are user friendly in order to improve ease of use of ATMs with fingerprint biometric based authentication since users are more willing to

easy systems. Finally, Facilitating conditions such information, continued support, right hardware and software should be purchased and put in place by banks in order to encourage use ATMs with fingerprint authentication. More to that, clients should be sensitized on how to use those systems

XIII. Limitation of the Study

Considering that data was mostly collected from banks, the researcher faced a problem of people fearing to share information. However, this was solved by the researcher seeking permission from management and explaining to the respondents the purpose of the information they provided.

XIV. Areas of Further Research

Future researchers should consider studying the role played by the moderating factors: Gender, Age, Experience and Voluntariness while studying factors for adoption of fingerprint based authentication for ATMs.

This research only put into consideration Barclays, KCB, Stanbic and Centenary banks in Kampala City, future research should also bring more banks on board considering all the regions in Uganda.

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Appendices

PP Plots

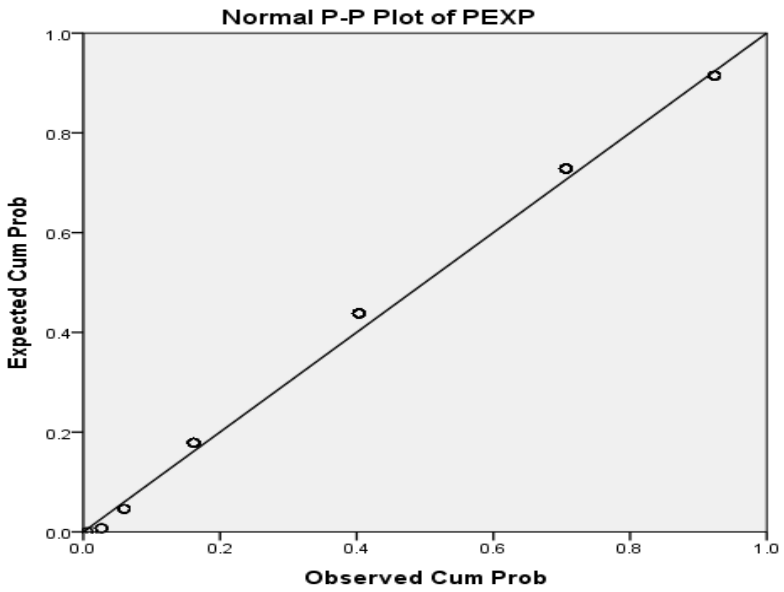

Figure 1: PP Plot for Performance Expectancy

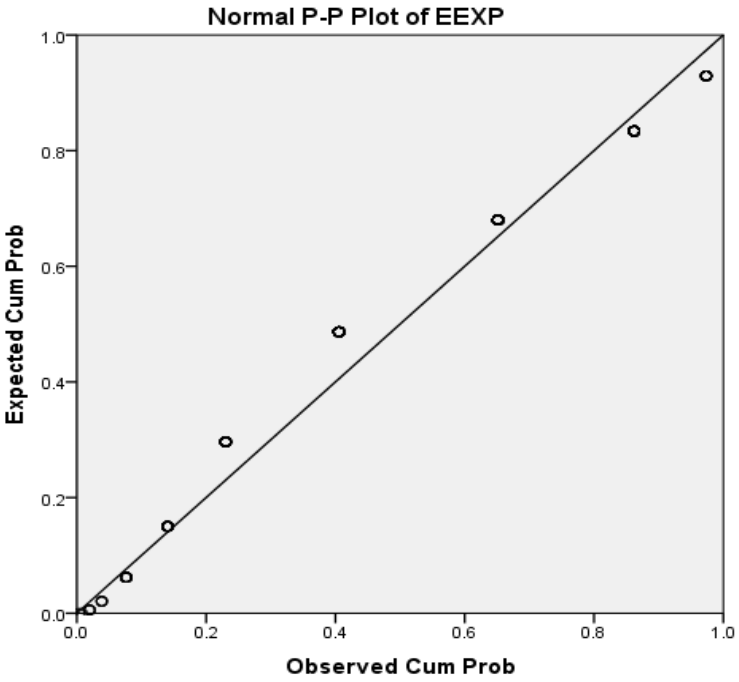

Figure 2: PP Plot for Effort Expectancy

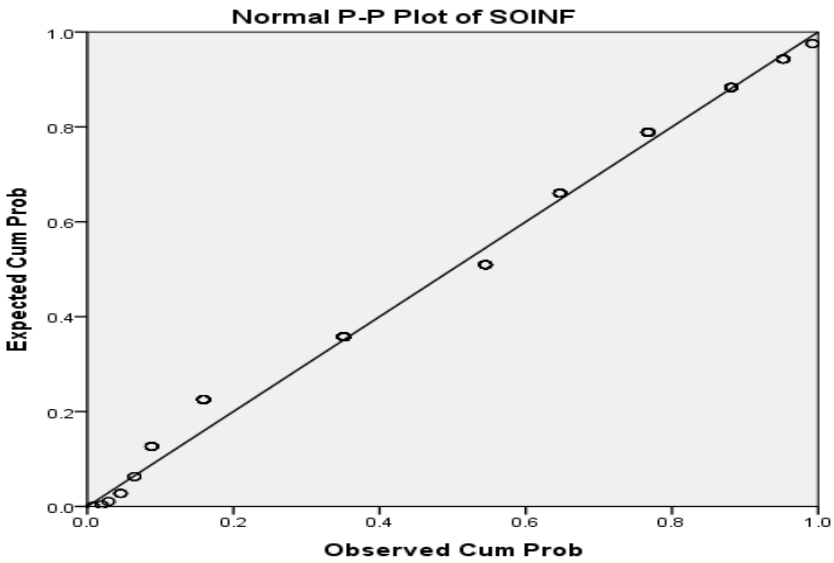

Figure 3: PP Plot for Social Influence

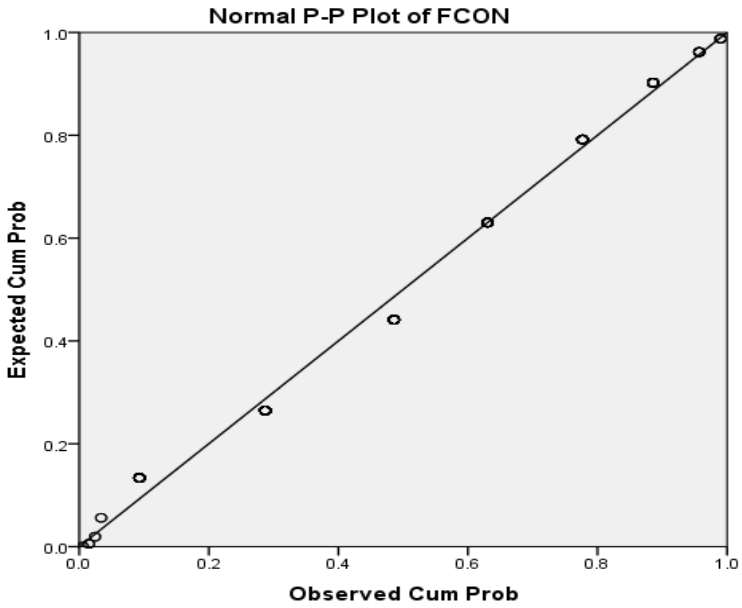

Figure 4: PP Plot for Facilitating Conditions

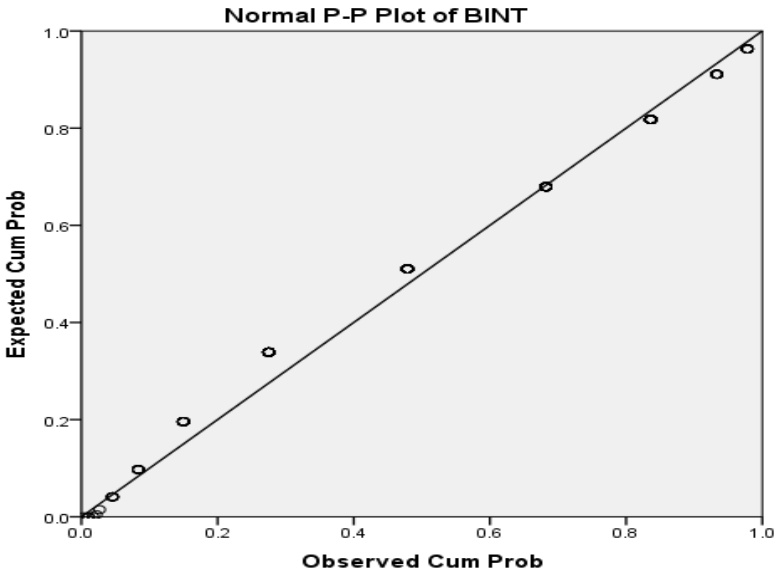

Figure 5: PP Plot for Behavioral Intention to use

QQ Plots

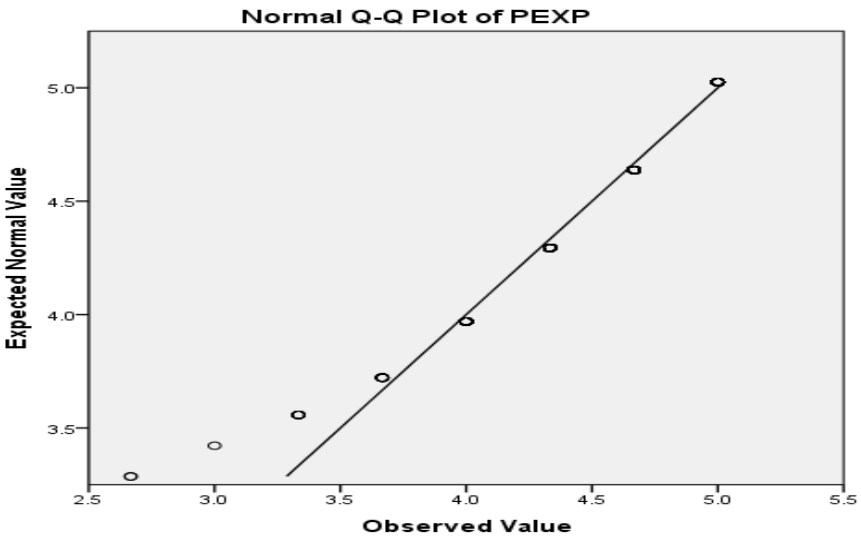

Figure 6: QQ Plots for Performance Expectancy

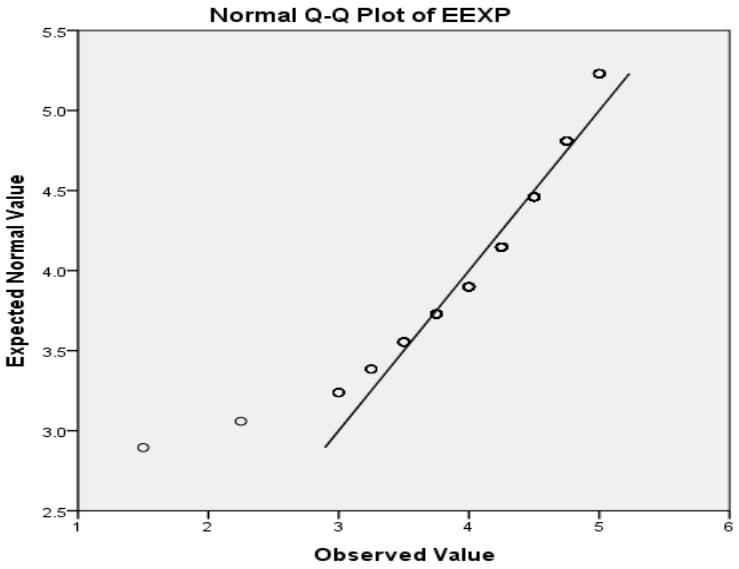

Figure 7: QQ Pots for Effort Expectancy

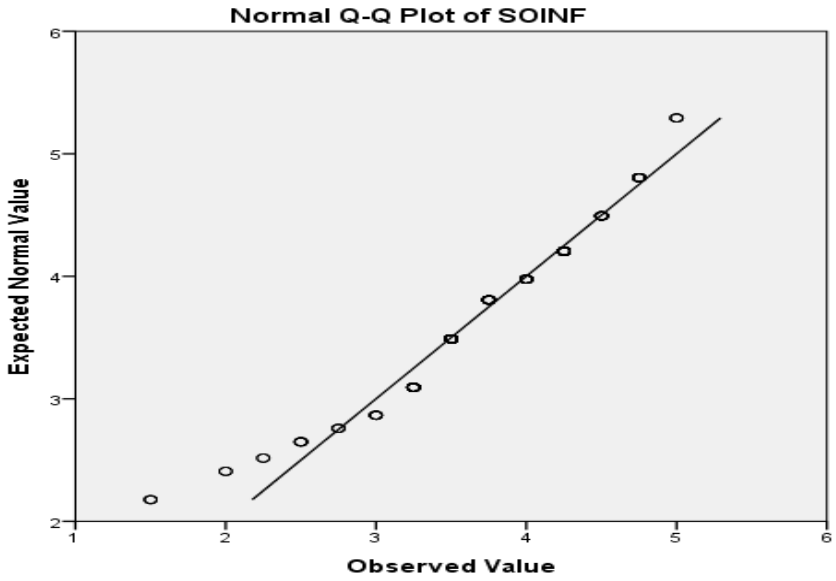

Figure 8: QQ Plot for Social Influence

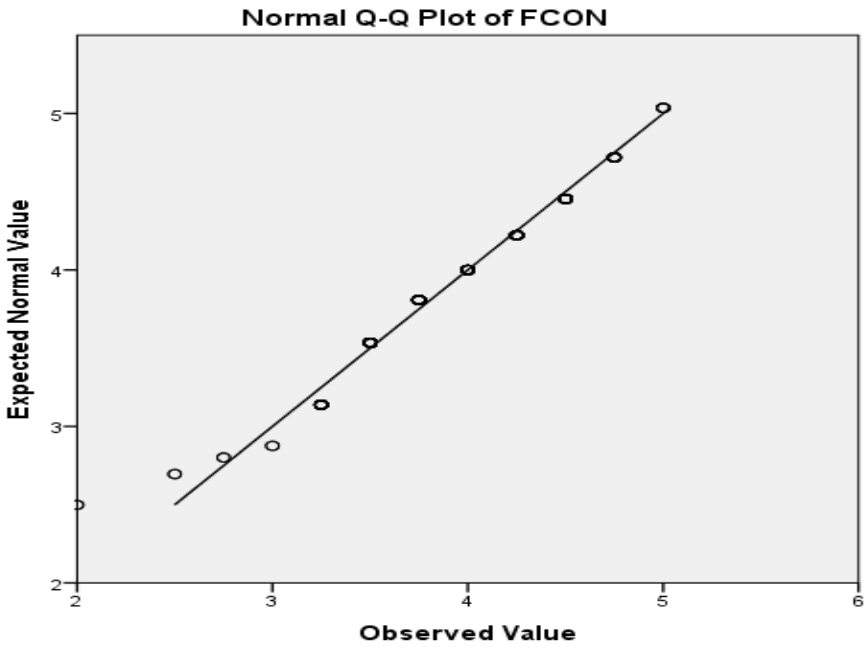

Figure 9: QQ Plot for Facilitating Conditions

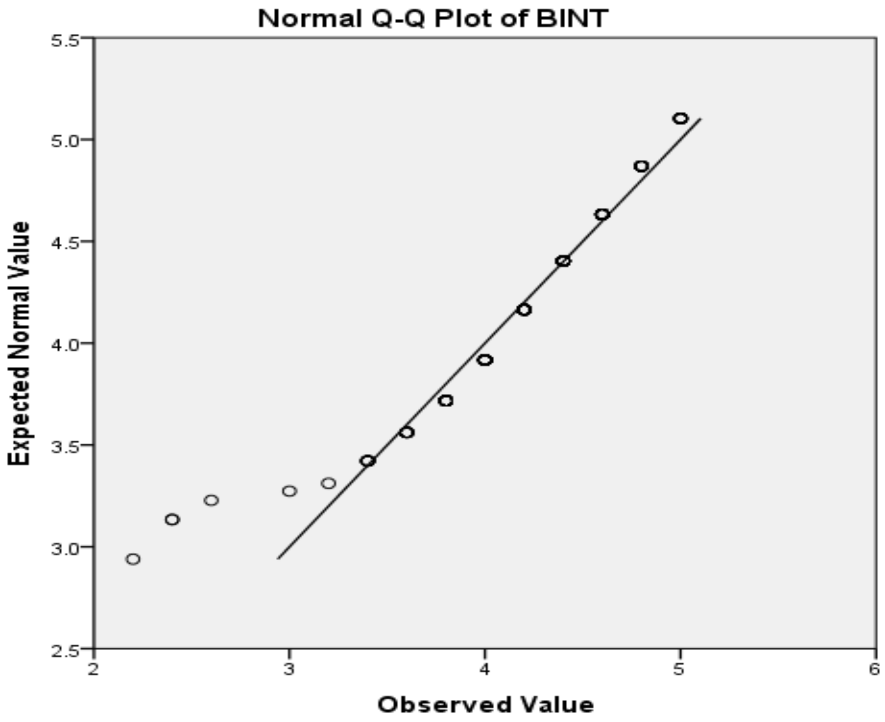

Figure 10: QQ Plot for Behavioral Intention

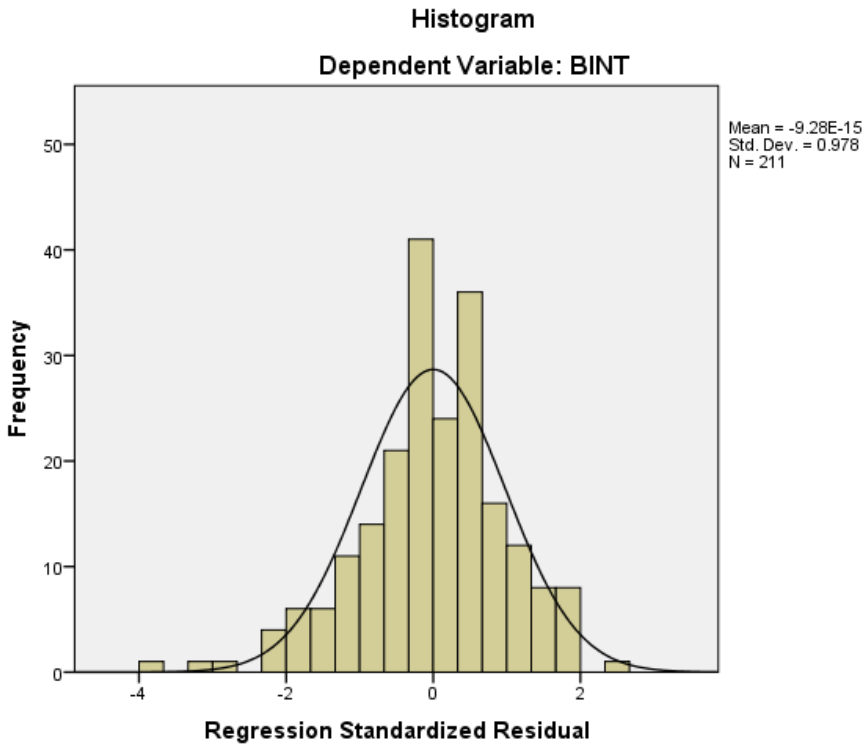

Figure 11: Histogram for Behavioral intentions to use

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