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**Authentication Technology Methods for E-Commerce  
Applications in Nigeria — A Case for Biometric Digital  
Security Contactless Palm Vein Authentication**

By

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A thesis submitted in fulfillment of the requirements for the degree of  
Doctor of Philosophy at the University of Sussex

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# Declaration

The work described in this thesis carried out in the school of Engineering and Informatics, I hereby declare that this thesis has not been and will not be submitted in whole or in part to another University for the award of any other degree.

Signed: \_\_\_\_\_

Sunday Adebayo Alabi

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UNIVERSITY OF SUSSEX

Sunday Adebayo Alabi

Submitted for the degree of Doctor of Philosophy

**Authentication Methods for E-Commerce Applications in Nigeria — A  
Case for Biometric Digital Security Contactless Palm Vein  
Authentication**

**Abstract**

E-Commerce has become one of the most interesting and beneficial Internet-enabled systems for humanity. E-Commerce has served as an economic enabler and driver for developed countries because of the total adoption by their citizens. However, in Nigeria citizens have rejected E-Commerce due to a lack of trust and inadequate security.

This research identifies several factors that lead to distrust of E-Commerce systems in Nigeria. These factors: perceived fear, security, perceived risk, trust, usability, perceived advantage, and use of web assurance seal services are very important for intention to adopt E-Commerce as an online transaction technology.

This thesis uses a novel Design Fiction and E-Commerce website simulation methodology to show citizens how new and improved security in E-Commerce could increase those citizens' trust and thus increase their intention to adopt E-Commerce. The research surveys a broad demographic sample of citizens from Nigeria who completed a set of tasks associated with the novel Design Fiction and E-Commerce website simulation followed by a detailed questionnaire. The questionnaire, with associated items, was designed to answer the research questions and hypothesis based on the E-Commerce Adoption Model proposed in the thesis.

This new E-Commerce Adoption model is based on the Technology Acceptance Model and uses to comparatively test Digital Signature, Finger Print Identification, and Contactless Palm Vein Authentication technologies in E-Commerce transactions. Results from the survey show that Contactless Palm Vein Authentication leads to greater trust in E-Commerce in Nigeria.

The thesis research findings also indicate that new improved security authentication techniques are overdue. The research indicates that poor E-Commerce adoption in Nigeria is mainly due to a key identified factor, which is security. The conceptual model and trust model are developed for E-Commerce adoption in Nigeria. Therefore, it shows that citizens are willing to accept Contactless Palm Vein Authentication as a solution. In particular, the research results also show that there are strong relationships between all the identified factors and citizens' intention to adopt E-Commerce in Nigeria thus rejecting all null hypotheses.

# **List of Publications**

## **Conference papers**

1. Alabi, Sunday, White, Martin, and Beloff, Natalia, (2020), Contactless Palm Vein Authentication (CPVA) security technique for better adoption of E-Commerce in developing countries. Computing Conference 2020, London, 16-17 July 2020. Published in: Advances in Intelligent Systems and Computing. Springer Nature ISSN 2194-5357.

## **Glossary**

ATM	Automated Teller Machine
ASP	Application Service Provider
CPVA	Contactless Palm Vein Authentication
DI	Digital Identity
DS	Digital Signature
EC	Electronic Commerce
FIS	Fingerprint Identification System
ICT	Information Telecommunication Technology
IT	Information Technology
PVA	Palm Vein Authentication
PVP	Palm Vein Pattern
POC	Proof of Concepts
ROI	Region of Interest
OLTP	Online Transaction Processing
KPCA	Kernel Principal Component Analysis
KICA	Kernel Independent Component Analysis
KLDA	Kernel Linear Discriminant Analysis
TT	Training Time
CPD	Contactless Payment Devices
RA	Recognition Accuracy
FAR	False Acceptance Rate
FRR	False Rejection Rate
RT	Recognition time
EER	Equal Error Rate
MATLAB	Matrix Laboratory
ROI	Region of Interest (ROI)
WASS	Web Assurance Seal Services
DFD	Design Fiction Documentary
DV	Dependent Variable
IV	Independent Variable
AE	Appendix E



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# Chapter I

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## 1. Introduction

This chapter introduces the research background, problem space, aims and objectives, questions to be addressed in the research, method, research activities, motivation, and contribution to knowledge, and outlines the thesis structure.

### 1.1 Research Background Knowledge

A report of the Vision 2020 National Technical Working Group on Science, Technology and Innovation [1] examined the problems of poor E-Commerce growth in Nigeria, a country that has a large source of income and a large population that ought to be more economically developed. However, E-Commerce growth is generally poor in developing countries [15] where issues of security have been identified as a barrier [2]. Therefore, this research work will focus on the security aspect of E-Commerce specifically in Nigeria [1], however, results may scale to other developing countries.

Biometrics is a digital security technique in which characteristics of a person **such** as physiological or behavioural features are used to identify a person [3], [4], [5]. Biometrics techniques can involve taking a sample for measurement or recording of the behavioural traits of their identification [14]. Evidence shows that the physiological or behavioural features that can be used include: facial images, iris, fingerprints, retinal, hand veins, handwriting, palm veins, and voice [4], [5], [6], [7], [11]. Biometric security systems use a personalized technique for person authentication and identification purposes [7]. The fact about these identification techniques is that they cannot be given or lent to another individual. Therefore, customers personally have to go for authentication [7], [8]. Evidence shows that Contactless Palm Vein Authentication (CPVA) methods may likely perform better to enhance security and increase citizens' trust towards E-Commerce [9].

There are several methods of biometric authentication that may be compromised in a complex situation, for instance, old age may affect the images of a Facial Recognition System [10], an illness like a cataract can also change an Iris Vein Image of a person [11]. The damaging of fingertips can also affect images of the Fingerprint Authentication System. Although, these methods are highly secure and very accurate in authentication and identification once their 'Images' are adequately taken and well processed [11], [12]. Biometric Identification techniques are very fast in the authenticating process [13]. All

these techniques are advantageous, many are non-invasive while some are cheap to implement and others can be used in identifying a criminal without their knowledge [14]

This research work looks at the possibility of using internal features of the palm that has resistance to the above-mentioned fingerprint issues. Importantly, this new technology (CPVA) uses a device that distinguishes blood vein patterns in the palm with no need for physical contact. The hand is placed over the sensor of the camera and an infrared ray passes through the palm and captures the vein image [15]. Vein image pattern extracts, processes, and compares with a vein pattern in the database to clarify the identity. This research work considers a scenario where palm images taken using a Near Infrared Camera (NIR) with a Design Fiction Documentary to educate the Nigerian citizen on the efficacy of different security techniques (e.g. CPVA, Finger Print Analysis, Facial Recognition, etc.) and an E-Commerce Web Site Simulation that uses such security techniques followed by a survey to test hypothesis related to intention to adopt E-Commerce.

A Palm Sensor is a device that can be integrated into various equipment. It can be put into the wall for access control to secure an environment, it could be used with electrical equipment, digital devices, to authorize medical facilities usage, its contactless feature makes it suitable in a hygienic environment like hospitals [13], [16]. Palm Vein patterns have a more complex pattern structure than the Fingerprint system and this makes it more secure and environmentally friendly [16], [17]. This research work investigates this technique (CPVA) to see if it will be a more suitable security method for biometric authentication in developing countries, particularly Nigeria, which has an inherent distrust of E-Commerce transactions [2], [17].

The human palm is regarded as the best biometric feature for biometric authentication techniques [8], [17]. It is very convenient to use by the user and has no obstacles like hair and others. It does not affect by the ray of light like facial recognition. The infrared ray camera captures the palm images, the dark lines that are visible in the image represent the blood vessel pattern of deoxidized haemoglobin in the veins [8]. The palm vein method may be better for the authentication of citizens of developing countries, particularly those with large populations of industrial or agrarian workers where fingerprints and hands get damaged in the work process, therefore palm vein images (CPVA) probably increase security, while reducing a citizens' fear of making E-Commerce transactions, and thus increase the rate of adoption of E-Commerce. The next paragraphs also discuss motivations for this research work.

The lack of E-Commerce adoption in Nigeria and the poor growth of online businesses is evidence that the outputs of this type of research will be beneficial to business development [23]. The technological infrastructure presently available in Nigeria is capable of leveraging the commercial capability of the Internet. However, E-Commerce adoption in Nigeria is still experiencing a stunted growth in comparison to developed countries of the world [12].

Research has shown that E-Commerce development in Nigeria is not encouraging. Thus, the research results detailed in this thesis are pertinent to the security aspect of E-Commerce in Nigeria [17]. As security is a persistent barrier to the adoption of E-Commerce, implementing a good security system into an E-Commerce platform will increase the adoption rate of citizens participating in E-Commerce [24], [25]. This research is of importance to the academic community as well because while E-Commerce security has gained the attention of the research community, much work has still not been done to improve the security aspects of E-Commerce [20]. Further, where there is much work that has been done on the improvement of digital signatures and fingerprints [8], [22], [26], [27] not much has been done in using (CPVA) in developing countries' E-Commerce [2]. Therefore, this research work is focused on investigating how CPVA could be introduced into E-Commerce in developing countries [28], and then used to reduce crime associated with password stolen, impostor, forging pin-code, and many other fraudulent activities and how it may increase the participation of citizens in E-Commerce.

## **1.2 Research Contributions**

Research contributions include:

### **1. Contributions from the Literature Survey.**

This research study contributes to the literature in the extensive review of E-Commerce concepts in developed and developing countries. The e-business perspective also reviewed their related benefits in all developing countries. E-Commerce adoptions of both developed and developing countries were reviewed to determine the barriers affecting developing countries' E-Commerce. The conceptual Framework of tiers of E-Business was reviewed to get a better understanding.

Again, the Contactless Palm Vein Authentication (CPVA) method is developed as a conceptual framework in the Design Fiction and the E-

Commerce Web Site simulation that has model formulations that work for the Technology Acceptance Model (TAM). The E-Commerce model of developing countries encompasses the attributes to form a secure concept that will aid the TAM of E-Commerce by the citizens of developing countries. The main contribution of this research to the knowledge is CPVA which gives information about dependent and independent factors that help in the adoption of E-Commerce in developing countries.

Besides, the developed conceptual framework was validated by collecting and analysing primary data from the citizens of Nigeria one of the developing countries. Another important contribution is found because little or no research literature was found in the design fiction, and adoption model in developing countries.

## **2. The research contributions derived from the development of the CPVA E-Commerce Model for Developing Countries.**

There are many methodological research contributions from this research work to the knowledge. These contributions are very important in E-Commerce, E-Business, E-Transactions, and E-Services generally. The contributions will help in future designs. These methodological contributions will reflect positively on the findings. A design fiction approach was used to design a documentary that was used to educate the participants about the authentication techniques. The use of Design Fiction in E-Commerce design will help future E-Commerce design. Primary data of Nigerian citizens were collected to determine the TAM which little or no literature was found and by this, the contribution of this to the research knowledge is a big task and beneficial to the research community.

A research model formulated to investigate the secure adoption of E-Commerce in developing countries is a contribution to the research knowledge. This model will be benefited in future design and in carrying more investigation into the TAM of E-Commerce in future research. There are fundamental concepts derived from the model that comprises determinant factors in which its approach will be of help in future work. The reliability and validity contributions by the model will also play a good role in future conceptual design and investigations.

Also, a comprehensive questionnaire design to get responses is another contribution to the research. The questionnaire was designed to investigate design architecture and authentication techniques. All these contribute to research knowledge. The Survey design consists of demographic data that can help in the future continuation of the investigation. The question is also designed to test: principles of E-Commerce experience, internet, and computer versatilities payment authentication techniques reliability and validity concept that will serve as the bedrock for related research work in the future.

### **3. The Methodological Research Contributions derived from the use of Design Friction.**

Contributions were derived from the research method used in this research work. In the first instance, Design Fiction is used to develop a futuristic architecture explanation for the participants to be able to have basic rudiments knowledge about the technology that is to be accepted. This serves as a better explanation to convince citizens and also to have a pre-knowledge about the new security authentication and its' benefits. Again, quantitative evaluation yardsticks were designed to evaluate the feedback of participants to be statically computable for the inferential determination contributed knowledge examining base to the research communities. Also, the use of Within Subject Design which is economically cheaper and less time-consuming for experimental examination by the participants has not only achieved high statistical power but assisted in rapid conduction of adequate fieldwork and finished shortly before the outbreak of the pandemic.

### **4. Practical and Experimental Research Contributions**

The experimental work conducted inform of the laboratory and fieldwork were other contributions towards the research community. These experimental scenarios were used to get responses from the participants and the finding from the experiment scenarios are based on a comprehensive and developed model. The adoption of E-Commerce which the model developed significantly proven by the result of the experiment:

The Design Fiction Documentary (DFD) was used to educate the participants about different authenticating techniques of E-Commerce that can assist in securing developing countries' E-Commerce. The use of DF in E-Commerce

is a contribution to the research knowledge as little or no literature was found. The principle of DF is completely new in the area of E-Commerce. The DF was designed completely used in targeting the audience in illustrating the scenarios targeting the technique in the authenticating system.

Another major contribution to the knowledge from the experimental aspects of this research is the design of a simulated E-Commerce platform that encompassed 3 different authenticating techniques that are used to give participants a shopping experience. In this practical simulated scenario, participants have a choice of using each of the designed authenticating techniques to determine which exactly is the preferred method. The method will help in the future design and the data collected through the experience will continue to be relevant in the analyses of future design. The practical scenarios were conducted in the pilot studies and fieldwork. The results produced in these practical studies are used in validating the developed model.

Besides, the quantitative method is used together with Within the subject method used in conducting the practical experimental work in the pilot studies and fieldwork. This is another contribution to the knowledge in the research community. All these will be beneficial in the future work of E-Commerce, e-business, and related work.

## **5. Contributions from the survey questionnaire designed**

A questionnaire was designed used in this research work to get feedback from participants after they have successfully carried out the first two experimental tasks (Design Fiction Documentary and Simulated E-Commerce Website for E-Commerce transactions). This questionnaire was designed in line with the hypothesis and research question to test the E-Commerce model proposed and how security has been affecting its adoption in Nigeria. This questionnaire can continuously be useful in any adoption and developmental case.

## **1.2 Research Problems**

There is still stunted growth in E-Commerce in developing countries unlike the rapid growth of E-Commerce in developed countries [18]. The developing countries' rate of E-Commerce participation is still very poor maybe because of the prevalence of barriers that cause distrust of E-Commerce [19], [20]. Non-secure and non-enabling environments have contributed to a lack of participation in E-Commerce, which is further attributed to

the non-adoption of E-Commerce in developing countries. Security is considered as the major barrier that gives rise to identity theft and password-stealing that further leads to high fraudulent activities [2], [4]. Although the introduction of Fingerprint Identification reduces the high rate of theft, its non-effectiveness is still witnessed by having a High False Rejection Rate (HFRR) due to finger disorders of the citizens [22].

### **1.3 Research Aim and Objectives**

This research will focus on the security aspects of E-Commerce transactions and specifically on developing countries using Nigeria as a case study. CPVA technology will be the subject used to design a simulated shopping platform where 3 (Digital Signature (DS), Fingerprint System (FS), and Contactless Palm Vein Architecture (CPVA)) identified security architectures will be used. The research will use a Design Fiction approach (including media assets, e.g. videos, images, etc.) to develop an ‘education tool’ and E-Commerce website to test Nigerian citizens ‘intention to adopt’ (dependent variable) E-Commerce transactions using CPVA.

The research will use a survey method to test the participants’ views after carrying out the experimental activities. The main aim is to investigate the usage of such technology and to find how factors such as security, non-invasive, hygienic, low-cost solution, and adaptability might affect the ‘adoption of E-Commerce’ using CPVA technology in developing countries, such as Nigeria, within existing IT infrastructure.

A summary of the activities that will be carried out in this research includes:

1. The research will have a set of research questions.
2. Hypotheses will be developed to answer the research question and this will form a research model using independent variables (factors, and intermediate variables) and dependent variables (i.e. intention to adopt).
3. A Design Fiction approach will be used to develop a Design Fiction Documentary (DFT) to educate participants on security architecture [2].
4. A simulated shopping E-Commerce platform will be built for the participants to use with the identified security architecture.
5. A survey will be used to get feedback from the participants.
6. Data gathered from the survey will be prepared and analyzed using descriptive and inferential statistics with both Excel and SPSS to describe the data gathered and make predictions on population ‘intention adoption’ E-Commerce using CPVA. In particular, a set of hypotheses are developed to answer the research

questions detailed in Section 1.4.

7. Results will be discussed and conclusions are drawn.

## **1.4 Research Questions**

This research will investigate the possibility of introducing CPVA into developing countries' E-Commerce. The following research questions are designed to serve as a guide in this research work.

1. Will biometric authentication techniques like iris, retina, palm vein, facial image, and fingerprint analysis overcome a citizen's fear and distrust of E-Commerce transactions?
  - a. What are the security factors causing low E-Commerce adoption in Nigeria?
  - b. What biometric systems (i.e. iris, retina, palm vein, facial image, and fingerprint) are more suitable for improving existing E-Commerce security systems?
  - c. What kind of security measures (e.g. digital signature, fingerprint identification, CPVA) can be exploited on E-Commerce platforms to increase adoption?
  - d. Is existing IT infrastructure adequate for the new security paradigm of CPVA?
2. How can digital security provide adequate protection for Nigerian citizens in E-Commerce applications?
  - a. What security awareness do citizens need?
  - b. What are the duties of the Application Service Provider (ASP)?
  - c. How will the impact of this security be felt by citizens?
3. What digital security technology will best improve the security of E-Commerce applications in developing countries like Nigeria?
  - a. Can the introduction of digital security remove the fears of Nigerian citizens?
  - b. How can digital security increase E-Commerce adoption?
  - c. What benefits could citizens derive from E-Commerce adoption?



## **1.5 Research Methods**

In this research work, the following research methods are used to achieve the research objectives.

- Pilot study on E-Commerce development in the UK using a questionnaire.
- Update of the pilot study and main study on E-Commerce development in Nigeria using a questionnaire.
- Surveying different geographical areas in Nigeria where data gathering will be needed.
- Quantitative techniques will be used to gather data and to do an evaluation.
- Qualitative techniques will be used for the qualitative data and to also do the evaluation.
- Design Fiction Documentary and E-Commerce website simulation build deploying the digital security techniques investigated (digital signature, fingerprint identification, CPVA).
- Data analysis will be done using both Excel and SPSS on numerical and non-numerical data respectively.

### **1.5.1 Activities Series of the Research**

Table 1.1 shows the activities series for each research question in this research work.

**Table 1.1 The Activity Series of the Research Questions**

Research Questions	Activities Series	Methods
<p>1. Will biometric authentication techniques like iris, retina, palm vein, facial image, and fingerprint analysis overcome a citizen's fear and distrust of E-Commerce transactions?</p> <p>a. What are the security factors causing low E-Commerce adoption in Nigeria?</p> <p>b. What biometric systems (i.e., iris, retina, palm vein, facial image, and fingerprint) are more suitable for improving existing E-Commerce security systems?</p> <p>c. What kind of security measures (e.g., digital signature, fingerprint identification, CPVA) can be exploited on E-Commerce platforms to increase the adoption</p> <p>d. Is existing IT infrastructure adequate for the new security paradigm of CPVA?</p>	<p>An extensive review of biometric techniques.</p> <p>Review of factors affecting low E-Commerce adoption.</p> <p>Carrying out the empirical study to determine the citizen's experience on E-Commerce security.</p> <p>Analyzing and evaluating the citizen's experience.</p> <p>Providing the discussion on the above findings of the citizen's experience.</p>	<p>1. Literature review</p> <p>2. Survey using a questionnaire.</p>
<p>2. How can digital security provide adequate protection for Nigerian citizens in E-Commerce applications?</p> <p>a. What security awareness do citizens need?</p> <p>b. What are the duties of the Application Service Provider (ASP)?</p> <p>c. How will the impact of this security be felt by citizens?</p>	<p>Review of digital security</p> <p>Examining the existing methods of digital security.</p> <p>Doing empirical study to evaluate intention to adopt E-Commerce.</p> <p>Analyzing and evaluating the citizen's experience.</p> <p>Discussion on the above findings of the citizen's experience.</p>	<p>1. Literature review</p> <p>2. Survey using interview and questionnaire.</p>

<p>3. What digital security technology will best improve the security of E-Commerce in developing countries like Nigeria?</p> <p>a. Can the introduction of digital security remove the fears of Nigerian citizens?</p> <p>b. How can digital security increase E-Commerce adoption?</p> <p>c. What benefits could citizens derive from E-Commerce adoption?</p>	<p>Review of the technological aspect of digital security.</p> <p>Examining feature extraction and algorithms of Palm Vein Pattern</p> <p>Evaluating the empirical study carried out.</p> <p>Designing a simulated CPVA web application to use the proposed authentication architecture.</p> <p>Conducting the study to test the proposed security architecture.</p> <p>Development of DFD and simulated E-Commerce website</p> <p>Conducting pilot and main empirical studies using survey techniques to examine the CPVA.</p> <p>Concluding the research's results.</p> <p>Concluding the evaluation</p>	<p>1. Literature review.</p> <p>2. Development of Design Fiction and associated E-Commerce simulation site based on CPVA.</p> <p>3. Conducting a pilot study.</p> <p>4. Conducting Empirical Study.</p>
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## 1.6 Organization of the Thesis

This thesis is organised as follow:

Chapter II presents the literature review, which surveys E-Business and E-Commerce concepts. Types of E-Commerce were reviewed and their relative technology. Electronic data interchange (EDI) is discussed. E-Commerce in developing countries, their characteristics, governance, and the gap between the developed and developing countries are reviewed. E-Commerce barriers hindering E-Commerce adoption in developing countries are also reviewed. E-Commerce security and its various architectures are studied. Digital signature and biometrics techniques are compared. Then, the use of PIN and Password, Fingerprints, and Palm vein with their respective architectures are studied. In addition, palm vein architecture, vein image processing, features extractions, and matching with the Palm Vein Algorithms are reviewed. The final part of this chapter discusses the architectural design of Palm Vein technologies, algorithms, and associated approaches like line-based, subspace-based, statistical, and others, and looks at the mathematics behind palm vein identification techniques for completeness. Thus, the general framework of palm vein and recognition system development is explained in this chapter. The appearance-based architecture which includes: linear, nonlinear, and kernel analysis are presented.

Chapter III provides the research methodology where the research analysis is discussed. Research type and approach are discussed. The quantitative research technique was employed in this chapter. The research model shows each requirement that consists of a hypothesis formulated through independent and dependent variables. The architectural requirements explain solutions and techniques that improve usability, security, WASS, perceived risk, perceived advantage, etc. Data collection methods consist of primary and secondary sources, and study factors: fear of risk, security, perceived advantage, trust, Web Assurance Seals Services (WASS), Flexible Procedures/Usability are discussed. The performance metrics variables were also discussed.

Chapter IV describes the design of the experiment that includes experimental methodology, factors, tasks, survey design, and the pilot study(s). The research parameter is composed of the participants' sample size, research population, and research sampling methods. The design of the experimental task was also discussed.

Chapter V describes the experimental procedure that describes the experimental tasks that consist of 3 experimental scenarios. Within Subject Design was employed to achieve the experimental tasks. The Use Case Scenario includes a System Execution Diagram and a Palm Vein Architecture, the Design Fiction Documentary, an E-Commerce-based Shopping Website Automation, and a questionnaire-based survey to get feedback from participants. The pilot study results are also discussed in this chapter.

Chapter VI explains the data analysis part of the thesis. The data collected from the fieldwork conducted in Nigeria is analysed. The research variables, data analysis type, descriptive statistics in terms of central tendency were discussed. Also, a standard deviation together with range, variance, and covariance tools was used in the analysis. The data analysis also involves the correlation type and coefficient. The reliability and validity testing were done on the data which include Cronbach Alpha, Skewness, Kurtosis Average inter-item covariance, and Average inter-item correlation. The analysis involves model testing using Chi-square, Alpha, and level of significance testing. In addition, the effect size tool is used to measure the extent of the relationship between variables.

Chapter VII shows the discussions and findings of the thesis. The demographic data which includes gender, age group, income data, educational level of the participants, nationalities, occupation, and the participant's marital status is examined. The dependent and independent variables of the research are explained. The statistical analysis of the study hypotheses is discussed which include: perceived fear and intention to adopt E-Commerce, awareness and previous experience lead to perceived risk, ease of use and the perceived advantage, protection policy and web of assurance seal service, usability relationships, and trust model in E-Commerce. Finally, the extent of the relationship between the contending factors which involve the use of effect size parameters is also discussed.

Chapter VIII concludes the research; the summary overview of this research was discussed. An E-Commerce adoption research model was presented that includes, the dependent variable model and the research E-Commerce model in development were presented. The chapter suggests recommendations for the governments, E-Commerce operators, and also citizens. Lastly, the research contributions to the knowledge were stated together with the research limitations, future research work, and the thesis closing remark.

# Chapter II

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## 2. Literature Review

This is the introduction to the chapter, technology is making the world becoming a global village [25]. A technological revolution in information exchange, clients, and server architecture has taken place within businesses, governments, industries, and homes [23], [29]. Evidence shows that developed countries have established well-defined Information and Communication Technologies (ICT) infrastructures and many developing countries are trying to catch up by investing in ICT such as Information Processing Systems (IPM). Banking services and many transactions are now done electronically [30]. It is estimated that the worldwide internet population is over 4.1 billion [5], [17]. Both communications and interactions between the arms of governments, organizations, and individuals are purely done by electronic means. Evidence substantiates that online communities are the largest audience in the world and more people are joining daily even in the rural area of developing countries [31], [32].

ICT has become an unavoidable tool, which has an impact on every area of life [24]. ICT has been defined as the handling and processing of information for use, through electronic and communication gadgets [17], [33]. The current digital era involves the use of ICTs in most daily activities. Today's businesses are transacted and monitored with the computer and the internet [30], [34]. This paradigm has led to E-government, E-Commerce, E-Banking, E-Medicine, and E-Business [17], [24], [34], [35]. Evidence shows that ICT makes sharing, access, and usage of data much easier for citizens and institutions alike. ICT is regarded as the main medium by which information is being exchanged by people all over the world [36]. This innovation has increased economic, political, technology, and social transformation throughout the world, which has translated into a networked community that is solely dependent on ICT [23]. Evidence [37], [38] has shown that ICT is a crucial part of E-Commerce.

E-business is the bigger picture that comprises E-Commerce as a subset in which virtual transactions are done to acquire goods and services by using the Internet and various computer networks [17], [30], [39]. It provides easy and better ways of a transaction for citizens, organizations, and countries at large. Many companies and individuals rely on the Internet to buy, sell products or services [40]. Evidence shows that

E-Commerce involves: marketing, selling, and delivering goods and services, ordering systems, and online payments [60]. Evidence shows that Internet users are increasing rapidly throughout the world and this has allowed E-Commerce to positively affect economic developmental processes.

In Africa, concerted efforts have been made by the governments of many countries to build ICT infrastructure, initiate Internet connectivity and technology for e-business programs [23]. Africa and Latin America are the last to embrace e-business [24], [30], and [34]. Dolan C. and Humphrey J. argued in [41] that E-Commerce is capable of serving as an economic driver that may increase the developmental growth of developing countries [31]. They described; E-Commerce as an innovation of ICT, which is seen as the most economic growth catalyst for developed countries [42].

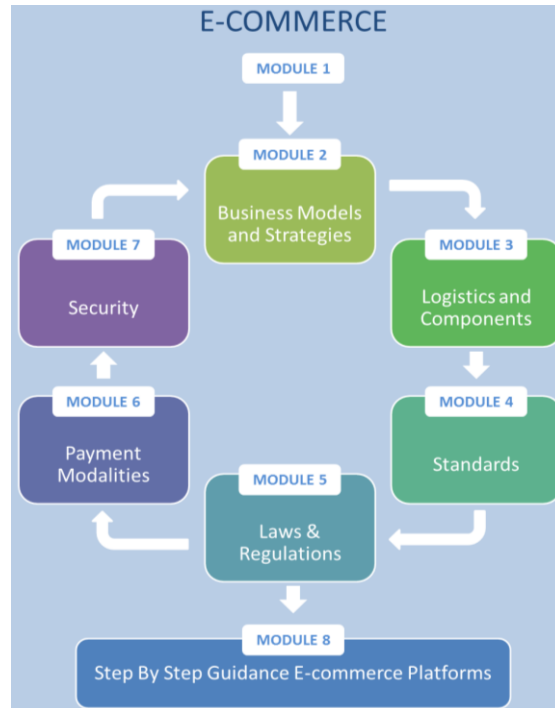
Evidence substantiates that the rapid growth in E-Commerce may help developing countries to overcome their problem of economic recession and meet up with the developed world economically [24]. E-Commerce is important if poverty is to be fought and economic problems are to be solved in developing countries [42]. Security is found to be the major factor affecting E-Commerce growth and preventing total adoption by the citizen [42].

Therefore, this study looks into the security aspects of E-Commerce transactions. The study will focus on Nigeria as a case study. The research study is looking at how, Contactless Palm Vein Authentication (CPVA) technology may increase security and reduce the fear of fraudulent activity perceived by citizens using E-Commerce applications, and thereby increase citizens' participation in E-Commerce [8], [43]. In particular, the following literature review sections 2.1 to 2.18 covers the following topics:

## **2.1 E-Business and E-Commerce Concepts**

Many organizations have websites and this has enabled virtual communities to gain more attention daily [44]. E-Commerce allows a company to create a virtual market presence online [16], or a company may use E-Commerce to create a larger position in the market or use E-Commerce to create cheaper and more reliable delivery methods, so on [34]. E-Commerce consists of processes like order entry and procurement, payment authentication, delivery, and customer support [22], [25], [30], [72]. Evidence shows that the Internet was not so beneficial in the early years of its introduction; it was only used just as a mere tool for email messages [45].

Billewar and Babu investigate the quality of E-Commerce. The authors proposed Total Quality of Management (TQM) suggest that the E-Commerce quality requires more improvement [44]. The author concludes that the quality norms in E-Commerce such as 'organization effectiveness, quality of products, a satisfaction of customers and employee-related issues are relevant in improving E-Commerce quality' [25], [45], [51]. ICTs are used to achieve the goal of a transaction from ordering to delivery [1], [8]. Buyers and sellers engaged in business by electronic means. Both are exchanging information, maintaining business cordialities, and interaction basically by virtual means [56]. Therefore, the issue of trust is very important in this relationship [34]. The typical E-Commerce and its' component activities are denoted in Figure 2.1. Evidence shows that E-Commerce could contribute positively to economic growth [42]. Therefore, this research is looking into the security barrier that is preventing E-Commerce total adoption by developing countries' citizens. The below section discusses E-Commerce types.



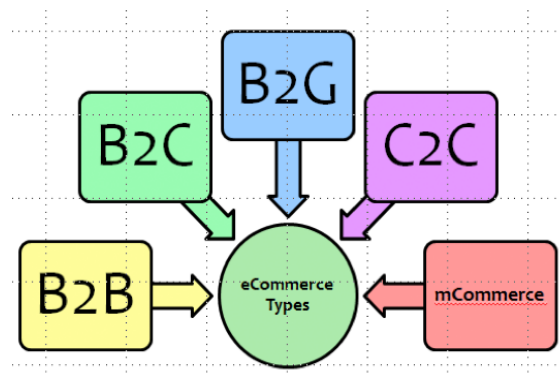
**Figure 2.1 Typical E-Commerce [46]**

## 2.2 Types of E-Commerce

The classification of E-Commerce type can be based on the roles and relationships [42], involved in the trade [40]. However, evidence shows that E-Commerce subcategories can still be generated [25] out of the main E-Commerce categories like: business-to-consumer (B2C) consumer-to-consumer (C2C), consumer-to-business



(C2B), and business-to-business (B2B) [30], [8], [24], [47] . Other main E-Commerce categories may involve relationships with the government, employees, or managers to agree on business modalities. Sub-categories or types can be formed from the main types [8]. Nemat R. in [48] examines different types of E-Commerce. Nature and roles are used with relationships between commerce sides. The research was concluded by categorizing E-Commerce into these categories: C2C, C2B, B2C, P2P, B2B, B2E, B2G, B2M, G2B, G2C, G2E, and G2G [33]. Evidence shows that Business to business type is the most prominent among the type of E-Commerce presently [49]. Although, all types of E-Commerce are also growing rapidly over the last decade. Figure 2.2 shows E-Commerce Type and the following section also describes E-Commerce types.



**Figure 2.2 Types of E-Commerce [50]**

### **2.2.1 Business-to-Business**

Business-to-Business [17], [21] can be referred to as transactions that happen between producers or businesses, and this is the E-Commerce biggest type [36], [48]. Typical B2B transactions involve a relationship between companies, manufacturers, and distributors, [8]. Business interactions between businesses and within companies are modalities of B2B, email exchange and Electronic Data Interchange (EDI) are examples [30], [42]. Several studies conducted by Humphry et al. [42] address the following questions: Does E-Commerce give broad access to global markets? Is there any marginalization happening to develop country manufacturers as a result of E-Commerce introduction? How with developing countries' governments' commerce participation growth exactly like that of the global basis? [13], [23], [51]. The study pointed to many optimistic questions about the B2B E-Commerce widespread and the possibility of incorporating these countries into the global economy [23], [42]. Hawk [42] argued that

many developing countries' E-Commerce and the USA are similar in the mid-'90s [19], [52].

### **2.2.2 Business-to-Consumer**

Business-to-Consumer [21], [53] is all businesses' activities relating to the provision of products or services to final consumers. Ali B. et al. argued in [54] that it is necessary and essential to satisfy consumers in E-Commerce because buyers will not participate in E-Commerce with unsatisfied and insecure technology. B2C E-Commerce has a higher number of transactions than B2B [30]. Companies are trying daily to improve their development to give customers a better experience when interacting with their E-Commerce website environments. Electronic retailing (e-tailing), is the largest transactional part of B2C E-Commerce [8]. The online catalogue of a retail store or shopping centre is part of electronic retailing. In the consumer-to-business of B2C, the end customer is the one completing a business process by offering goods or services to the company [8], [48].

### **2.2.3 Consumer to Consumer**

Consumer-to-Consumer [21], is a type of E-Commerce in which transactions occur between consumers electronically. Evidence [53] shows that this type of E-Commerce may expand because of the cheaper costs of using another company platform in the future [48]. Apart from these four main E-Commerce platforms, other sub-types became popular in one decade [8]. Social networking platforms are used for E-Commerce to gather information and using social media with online stores allows customers to have a wider experience and quick access to goods in a shorter time [8], [25].

### **2.2.4 Business to Government**

Business-to-Government [35], describes E-Commerce transactions that happen between Organization and Government, the economy of a nation can be influenced by the E-Commerce type [23], [30]. There are interrelations between E-Commerce and e-government; government relates to organizations and organizations also relate with the government [55].

Conclusively, this type of E-Commerce needs well-structured and defined policy guidelines in dealing with organizations, especially in developing countries. Also, all

other types build around business and their relationships could turn out to be mutually benefited if are well guided with adequate policy formulations. The next section reviews the benefit of E-Commerce.

## **2.3 Benefits of E-Commerce**

E-Commerce offers buyers convenience [4], [25], [30], [34]. There are chances of visiting websites at all times to compare prices and transact at any time. A seller does not need any logistics to achieve selling, because the transaction has taken place on the global Internet. Selling the product on the internet is global and not restricted. Also, finding new markets becomes easier [65]. More contacts to customers and feedback from customers to companies also become easier. It means that E-Commerce provides numerous benefits to citizens. In an ordered world, what are the actual benefits that citizens could derive from E-Commerce adoption? Nemat R. summarises in [48] the benefits of e-business developments for enterprises, these include:

1. Small and medium enterprises (SMEs) E-business helps and promotes [27] to know their customers' demands and deliver good results with satisfaction [56], [57].
2. Electronic business methods enable an organization to efficiently meet suppliers' and customers' needs using data processing systems.
3. E-business development increases the access time to the customer's request. In other to achieve this, a good Customer Support system is needed.
4. E-business development enables customers to find needed items with ease. Customers can compare producers at lower prices [45].

The below section summarises benefits that may be derived from E-Commerce by citizens.

### **2.3.1 Improved Delivery Processes**

E-Commerce may adequately improve the rate and quick response of the delivery system; therefore, citizens will be able to receive their ordered goods safely and quickly. Sanayei and Rajabion Argued in [58] that an improvement needs to be done to the addresses and poster services to achieve a good delivery system. Goods such as software or audio-visual files download and online tracking of the goods sent by mail or courier is

another benefit of electronic commerce [47]. These services will increase E-Commerce adoption [15].

### 2.3.2 E-Commerce Benefits to Society

There are many E-Commerce benefits to societies in many, either in terms of developmental or convenience creation for citizens' society [34], [23], [29].

1. E-Commerce enhances the quality of life for people in society; they can do many things at their convenience [1], [62]. It also provides less stressful working environments, by reducing environmental risk and pollution because traveling around is greatly reduced for people.
2. Enables people in rural areas to get certain information and this reduces stagnation and exclusion [34], [23].
3. It makes the delivery of certain services easier. For instance, health and government services can be accessed over the Internet, filing, and payment of taxes over the Internet to the appropriate authority [23], [59].

The benefits of E-Commerce for developed countries cannot be overemphasized and are illustrated in Figure 2.3. Such benefits could also be realized by developing countries with a restructured E-Commerce system. The below section discusses E-Commerce Technology.



**Figure 2.3 Benefits of E-Commerce [60]**

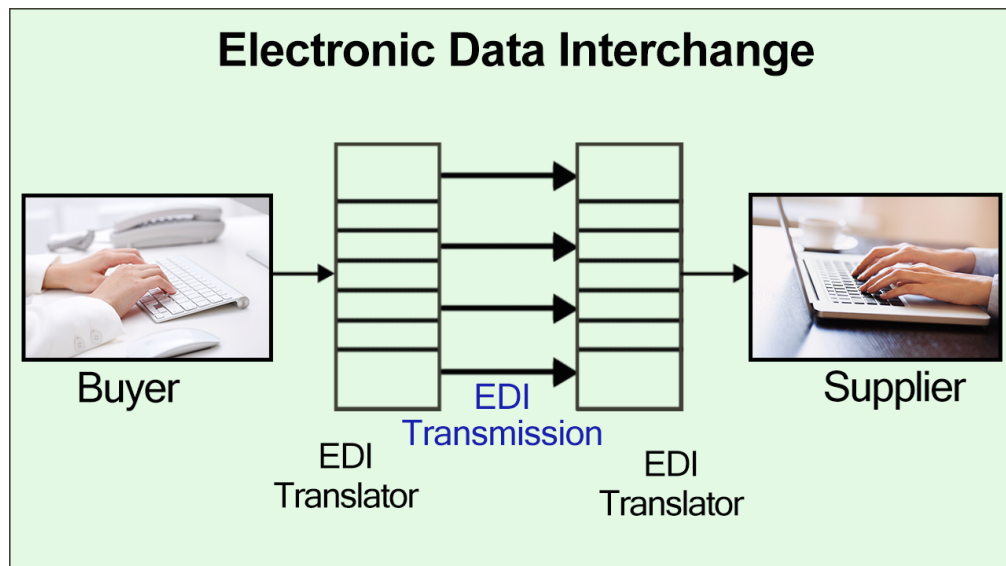
## **2.4 E-Commerce Technology**

E-Commerce technologies focus on putting all E-Commerce systems together in a unified software platform that integrates: online transaction processing, Internet marketing email, Electronic Funds Transfer (EFT), inventory, Electronic Data Interchange (EDI), and delivery system [1], [34]. Management of a company's website, databases, and e-payment systems is done by integrated software developed in this system [27].

Technologies like: telephones, email, mobile devices, and Contactless Payment Devices (CPD) are the tools of E-Commerce [34]. Physical goods involved in E-Commerce are carried out using courier services or through the company delivery methods. Also, transactions are done electronically using information exchanged in EDI between customers and vendors [16], [23], [42].

### **2.4.1 Electronic Data Interchange**

In E-Commerce, EDI is meant for the electronic transmission of information between companies and their customers by electronic methods [24], is also meant to exchange business and documents between organizations and potential patronisers [16], [23], [34]. Uddin J. et al. describe EDI in [61] as a tool that exchanges individual data between customers and sellers when transactions are done on the Internet and computer networks [17], [61]. E-Commerce consists of an online process such as marketing, selling, product delivery, and payment transaction methods that secure and accept the payment after the actual exchange of information [11], [44]. Electronic Data Interchange of E-Commerce is described in Figure 2.4. Literature shows that there are many opportunities and great benefits in E-Commerce for citizens, organizations, and government at large [30], [29]. Therefore, E-Commerce may assist in the economic growth of developing countries. Evidence tells that developing countries' E-Commerce adoption will increase if secure E-Commerce platforms are built. The next section reviews adoption of E-Commerce in developing countries [87].



**Figure 2.4 Electronic Data Interchange [257]**

## **2.5 Adoption of E-Commerce in Developing Countries of the World**

Developing countries are a set of countries that lack growth in the areas of industrialization, information technology, and military science [2], [24]. They can be located in Africa, Asia, South America, and the Pacific regions [1], [24]. The following sub-sections described the nature and characteristics of the developing countries. It's also entailing identifiable problems that prevent E-Commerce adoption in developing countries.

### **2.5.1 Characteristics of Developing Countries**

These countries are characterized by poverty [17] [63], insecurity, and economic instability. Spence R. and Smith M. L. described the developing world as a group of countries that are not developed 'industrially, politically, and economically [63]. They are weak typically characterized by a weak industrial state, poor economies, militarization, mutinies, and domestic insurgencies [61]. Unlike most developed countries that are developed industrially, the developing world is in a total infant stage in terms of development in; political systems, economy, ideology, and culture [24]. S. D. Thapa and Ø. Sæbø [64] investigated ICT growth in developing countries: this research indicated how many projects that are ICT-oriented in these countries failed to achieve their set aims and objectives [44]. Also, the authors identified factors such as poor management, non-

willingness for an improvement, complex IT artefacts, and diffusion in developing countries [64], [81].

### **2.5.2 Developmental Gap between Developed and Developing Countries**

There is a wide developmental gap between developed and developing countries. Areas like: education, technology, military, economy witnessed a stunted growth in developing countries [23]. Many developing countries face crises of governance [65] with high population growth [66] and are largely dependent on developed countries for many bailouts [1]. Even though these developing countries have enormous resources that can be used in transforming their economies, mismanagement and poor governance resulted from their poor economic situations [24]. Evidence shows that there are huge developmental gaps between the developing and the developed nations [61]. However, there are global forums like the World Bank, the World Trade Forum, and the International Monetary Fund [1] that are used to assist developing countries in bridging this developmental gap [67].

### **2.5.3 Governance in Developing Countries**

There are practices of autocracy and anarchy, which lead to economic deficiency and technological deficit in developing countries [24]. However, Biller S. R. and Babu D. H. clarified that many countries of these developing countries are trying to catch up with some developments that will reduce poverty from citizens [44]. These changes include alleviating barriers that limit developing countries' E-Commerce growth [13], [42]. This research will greatly review those barriers that have been improving and the ones that need attention like security in developing countries' E-Commerce.

### **2.5.4 E-Commerce/E-Business in Developing Countries**

E-Commerce's benefits and contributions [54] to the economic growth of developed countries have been substantiated in the literature [68]. It has been stated that functional and secured E-Commerce is capable of being a new economic driver for developing countries [24], [42]. However, many barriers are still battling with developing countries and this has resulted in E-Commerce stunted growth [59]. Thapa D. Substantiates in [64] that despite the efforts of developed countries bridging the economic and digital gap [19],

they are lacking in E-Commerce acceptance [69]. In this modern-day time, the E-Commerce readiness level is not encouraging [64].

Al-Najjar et al. [51] researched the barriers limiting E-Commerce's adoption in Iraqi and the author concludes that the research outcome will assist in enhancing: privacy, security, quality, and cost for online customers services, and improving in Iraq. Therefore, the evidence [53] has shown that the same set of barriers is limiting the growth of E-Commerce [21]. Ali B. et al in [54] investigates the E-Commerce barriers in the Arab region and her findings conclude that the level of technological readiness is poor which affects Arab region E-Commerce adoption [52], [61]. This research will throw more light into the E-Commerce readiness in Nigeria what has been done so far in removing many of these E-Commerce barriers.

### **2.5.5 Barriers Hindering E-Commerce Adoption in Developing Countries**

Building acceptable E-Commerce applications are highly required in developing countries for their economic survival [24], [54]. It has been researched [2] that infrastructural barrier is affecting E-Commerce development negatively in developing countries [31]. Japhet Lawrence and Al-Najjar argued that framework barriers are the limiting factors [24], [34], [42]. Researchers establish that E-Commerce non-performance factors in these developing countries vary, but the most commonly related ones are discussed below in unveiling by the authors. Billewar S.R. and Babu D.H. argued that many of the countries did not have to lay down rules to protect customers from online purchase issues [44]. Therefore, customers secure and not being able to solve any issue or resolve their problem. This research work will look at many salient points in barriers affecting total E-Commerce growth. The below section explains the different barrier types affecting developing E-Commerce.

#### **Infrastructural Barriers**

Bissyandé T. F. et. al identified infrastructure, as a major factor limiting citizens' participation in developing countries' E-Commerce [67]. Some of the barriers are: “poor delivery method, non-trust-worthy online merchants [2], include lack secure and convenient payment means, a legal system that is compromised, and lack of modernized ICT device (broadband) and security of the Internet [1], [24], [67]. However, many developing countries have invested greatly in infrastructural facilities in the last decade



[34], [42]. Private investors have been encouraged to participate and drive the infrastructural facilities while the government is persuaded to give an enabling environment. The evidence [1] showed that much improvement has been done to close the gap caused by these barriers. Meanwhile, the following Infrastructural barriers will be examined.

### Technologies

Evidence [21] showed that among the most pressing infrastructure needed for E-Commerce growth is access to technologies and the cost of the technology. There is a limitation in the use of bandwidth that is why most developing countries are still using MODEM instead of Wi-Fi and WiMAX technologies [45]. Many of the installed equipment is low-grade ICT infrastructures and many of these are analogue which can only transmit voice [2]. Japhet E. stresses that there is still a problem of erratic electricity power supply [24]. But many new technologies are being deployed by private investors [34].

### Telecommunication

Internet connectivity in most developing countries is still in the infancy stage. Many of the private providers are still enjoying a monopolistic market or wide gap with others [54]. The erratic power supply is part of the hazard that disrupts network connections [34]. There has not been total readiness for E-Commerce in many of these countries, in terms of network infrastructure [54]. Evidence [14] has shown that developing countries' E-Commerce success may depend on how quickly these barriers can be removed [24], [25]. Lawrence J. E. in [34] argued that with an absence of basic infrastructural facilities, the benefit of E-Commerce may not be realized [71]. Evidence shows that weak telecommunications infrastructure may slow down the Internet speed or many citizens are not able to connect to the Internet.

Broadband connectivity is a very important ICT development [1], [30]. High bandwidth increases the rate of connection to the internet and fast internet connection encourages customers to patronize and use the internet to do their activities [24]. Oluyinka S. et al. argued in [23] that the provision of broadband technologies, supply, installation, and maintenance require a guided policy that will: Leverage a competitive advantage and continued to emphasize quality and standard infrastructural devices, network services, and applications platforms [59], [70]. Therefore, the evidence has shown that more still

needs to be achieved in the communication network to witness massive turnout in E-Commerce development in various developing countries.

### **High Access Cost of Internet Subscription**

Evidence [71] suggests that the Internet is too costly to access is too for common citizens that are supposed to be participants of E-Commerce. The infrastructural cost also determines the rate of growth [42]. The government of most developing countries just finds it necessary to put the infrastructure in urban and competitive places and without any guided policy that will make the Internet to be affordable [70]. The monthly subscription cost is beyond the imagination and surpassed the benefits that may be derived [49], [78]. The cost of the Internet at a very expensive rate may affect E-Commerce participation negatively in developing countries [70], [78]. High-speed broadband motivates E-Commerce participators and encourages them to spend more time online to do their transactions [23].

Kanyaru P. M. and Kyalo J. K. argued that Internet access prices are a predominant key in E-Commerce adoption by individuals and organizations [72]. Countries with lower Internet costs are likely to have more Internet users are prone to more development in countries with higher Internet costs. Evidence suggests that network infrastructure is necessary for developing countries in E-Commerce global participation [49]. Good communication network development is very necessary for developing countries' E-Commerce [24], [42].

### **Computer Equipment Accessibilities**

Evidence shows that personal computer distribution and usage even within government institutions is not encouraging [56]. The majority of populace in developing countries do not have enough money to have a personal computer. Especially citizens living in rural areas and civil servants with low income [70], [56].

OECD investigates the accessibility of citizens to computer equipment in developing countries, the findings indicate that a large number of potential participants have limited or no computer access and the Internet, especially in rural areas [25], [64], [70]. Evidence shows that the high cost of computer equipment might be one of the factors preventing a wide usage of computer systems [24]. The non-availability of computers at an avoidable price may prevent the citizen's participation in E-Commerce [3]. Infrastructure is a necessity if developing countries will overcome their problems and all necessary deregulation. Besides, even with access to the necessary equipment which many countries

of the developing world have been improved upon, reservation for E-Commerce is likely to occur until they believe in the transactions' integrity [3], [72].

### **Socio-Cultural Barriers**

These pieces of evidence [2], [24], [42], [51], [64], show that most cultures do not like E-Commerce because they do not have confidence in the virtual nature of E-Commerce [73]. The social and cultural beliefs of the citizens developing countries the concepts of E-Commerce and this may affect its adoption [13]. Efendioglu et al. argued in [73] that it will take time to convince citizens of developing countries concerning great value and benefits to the ways of business culture they used [54]. The manner and approach of the business foundation of E-Commerce are different from the local cultural type. Ali B. et. al. have identified [54] many socio-cultural characteristics as a factor limiting developing countries' E-Commerce adoption [67].

### **Transactional Trust**

E-Commerce platform behaviours need to be built on trust. Evidence [3] shows that confidence, trust, and loyalty are very important in electronic commerce. In the virtual environment, the issue of trust is very important than how is it in the real world [67]. Both buyers and sellers transact in an online presence and if the issue of trust is not substantiating it may affect the development of E-Commerce [34], [42], [67].

Jerneck A. and Olsson L. argued that adaptation to a new technological environment becomes a problem in developing countries [74]. Due to a lack of good legal protection for an individual like that of the developed world. Citizens refuse E-Commerce because they felt insecure due to what they saw, heard, or perceived. Therefore, citizens are not willing to provide sensitive data on E-Commerce platforms [1], [44]. Providing personal sensitive information on account details to businesses operating on the Internet becomes a problem and this is affecting E-Commerce development in developing countries [89].

Also, a non-competent dispute resolution mechanism to settle e-dispute between customer and producer may strongly affect online transactions [70]. The evidence clearly showed that a lack of definite policy constitutes a limitation in E-Commerce growth [2]. Undefined legal proceedings regarding contract projects and different terms might be causing a barrier for both entrepreneurs and customers to adopt E-Commerce [44].

### Shopping as a Social Place

Evidence [13] has shown that shopping is seen as an avenue to meet friends and relatives, vendors with conversations and this cultural attitude have been in existence for long period. Efendioglu et al. argued in [73] that a long-term friendship between the parties gives good social bonding and most businesses are also done in local ways [54] [57]. Therefore, evidence suggests that there must be convincing benefits of E-Commerce to citizens of developing countries to witness total adoption.

Conclusively, this set of barriers [2] is impeding E-Commerce in these countries [29]. Although many countries including Nigeria have done lots of things to reduce some of these barriers, Application Service Providers (ASP) have been implored to leverage the gap created by these barriers. Meaning that what are the duties of the Application Service Provider (ASP) in reducing these barriers and how would they be guided? The below section described the barriers preventing E-Commerce total adoption in Developing countries. Below section reviews E-Commerce Barriers.

## **2.6 E-Commerce Adoption Barriers**

E-Commerce growth and citizen participant depend [70] on how the problem of these barriers is resolved [8], [25], [64]. The idea of carrying out virtual transactions will require convincing trust, benefits, and even take some time before adapting to it because developing countries' citizens have been used to face-to-face transactions throughout their lifetime. Besides, relationship, familiarity, and product negotiation are also involved in the existing business methodology of developing countries. Therefore, all these scenarios may be incorporated into the E-Commerce platform to reflect their adaptive cultural traits and social behaviours [34], [75].

Abou-Shouk M. et al. investigate adoption drivers in the traveling agents of developing countries' E-Commerce, he also categorized E-Commerce drivers to internal and external factors [75], [76]. He concludes the investigation by arguing that there are different options about drivers and boundaries of E-Commerce [77]. The adopters seem to agree [77] in line with these drivers while non-adopters did not [78]. The interpersonal trust with E-Commerce operators is not seen physically when transacting online is not yet a norm for developing countries' citizens [2]. Therefore, there may be a concept to facilitate such trust to reduce their confidence in face-to-face transactions [34]. Evidence shows that most entrepreneurs in developing countries build confidence with their

customers by meeting them face to face, especially, when the relationship is at the initial stage [1]. Therefore, evidence suggests that a good online Customer Support System (CMS) may assist facilitation of gaining customers' confidence [23], [55], [79].

Alqahtani M. A. et al. investigate enablers and disablers of E-Commerce regarding customers' perspectives in Saudi Arabia [18]. The research states that: security, cyber-law, fraud, trust, hacking and postal services are the barriers that directly affected citizens to adopt E-Commerce in developing countries [12], [29], [66].

### **2.6.1 Language Content**

Fraser, Lawrence, and Oluyinka argued [3], [21], [24] that language is another barrier that prevents citizens to adopt E-Commerce. Most people in these areas have a low level of education, especially in rural areas [19] which may be having limited comprehension of information accessed over the Internet. Language may be the barrier to information dissemination on the E-Commerce platform [44]. Also, many citizens are not opportune to improve their skills in computer and online transitioning [48]. Language is crucial in information dissemination and knowledge transfer in this digital era [63]. The major language for the building of the Information Technology paradigm that led to E-Commerce platforms and the language used in web design is English [6], [43]. Therefore, evidence shows that level of English language development must be increased in developing countries to witness the massive participation of the citizens.

### **2.6.2 Socioeconomic Barriers**

Evidence shows [21] that many socioeconomic problems need to be addressed before participating in global E-Commerce. It is argued that barriers such as economic conditions, payment systems, educational systems, and delivery systems to transfer goods are part of a socioeconomic problem [63].

### **2.6.3 Economic Condition**

The unfavourable economic condition of citizens in these concerned countries may prevent their involvement in E-Commerce [1]. The evidence has shown earlier that the initial cost and monthly subscription of Internet access have decreased in the last 5 years, but it remains a significant barrier that prevents E-Commerce growth because of the economic situation of these countries [51]. Spence R. et al argued that low income earning may affect Internet affordability, especially for a larger part of citizens that are in

rural areas [63]. There is always a disparity in the technology availability and usage between rural and urban areas [2]. Evidence shows [13] that in urban areas, ICT equipment is fairly available while is not like that in rural areas. The evidence suggests that improvement in economic conditions may affect E-Commerce positively.

#### **2.6.4 Educational System**

Abou-Shouk M. and Mohammed I. E. argued that the educational system in many developing countries is not encouraging. The non-availability of functioning educational skills is likely to be a reason why citizens have not been realized the benefits of computers and the Internet [44]. Evidence shows that in most developing countries, many schools teach computer studies in this digital era. Evidence suggests that early teaching of computer education is so important for citizens to be enlightened at an early age. The author substantiates that computer knowledge has a greater impact to know the value of computers and participate in E-Commerce. Evidence showed that the Internet may offer a great benefit to developing countries if it is given adequate attention by focusing on those who are not opportune for education [24].

#### **2.6.5 Payment System**

The availability of reliable payment channels is important in E-Commerce Oxley and Yeung cited in [34]. Also, having good infrastructural facilities behind every payment is crucial. It is the infrastructural facilities that made the payment to be possible without any problem. E-Commerce requires a good and secure infrastructure to avoid problems and illegalities. A functional e-payment infrastructure is required for an E-Commerce application. An effective payments system can facilitate the growth of E-Commerce [24], [34], [54].

Oxley and Yeung cited in [34] argued that few countries in developing countries have good payment platforms but lack good rules and guidelines to protect or support a customer in E-Commerce. Efendioglu et al. substantiate in [73] that there is no refund policy in case of any fraud to the credit card like a developed world. Lawrence and Efendioglu et al. argued that this leads to customers denying information about their credit cards. Evidence [1] suggests that getting maximum E-Commerce benefits depends on the ability to transact from a customer's account at any time. This research work is looking into the security aspect of E-Commerce of these countries, every aspect of E-Commerce

[6] including payment mechanisms must be very reliable to witness total adoption by citizens.

### **2.6.6 Timeliness of Delivery**

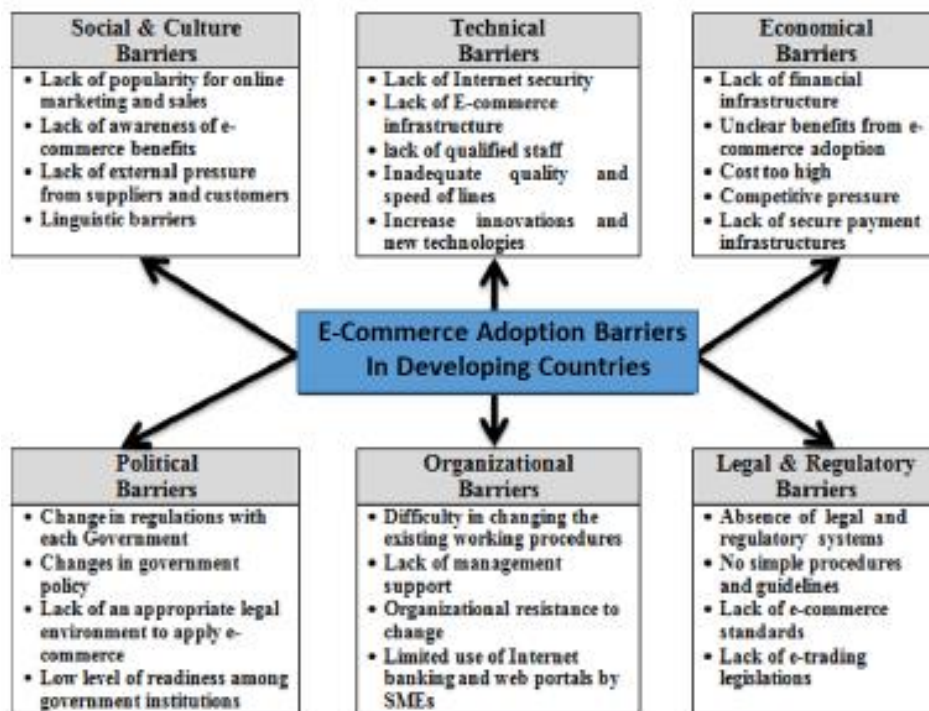
Japhet et al. argued that a good structured and effective delivery system is needed for E-Commerce to witness massive adoption [6], [24]. In E-Commerce, good delivery and distribution systems are very important [40]. A delivery system that satisfies citizens' expectations needed will be needed in E-Commerce [21]. Evidence suggests that precisely timed delivery systems are needed. The author argued that the non-availability of good transportation and postal services are major problems facing a quick delivery system which may lead to the non-growth of electronic commerce in developing countries [71]. Therefore, guidelines to facilitate prompt delivery are needed.

### **2.6.7 Political and Governmental Barriers**

Evidence [2] shows that there are no adequate policies to guide the provisioned bandwidth and other internet services [23]. The author argued that progress may not be possible where there are no clear policies [49], [17]. Evidence shows that the government must contribute maximally to the growth of E-Commerce. Authors suggested that government contribution Creates a competitive and conducive environment for network operators with the policies that will make them effective [80].

The monopolistic market is creating a barrier. ICT equipment with high import duty also has negative effects on E-Commerce development [1], [34], [42]. Communication infrastructure must be de-regulated to experience connectivity expansions [1]. Assistance can be done by the government in contributing to the Internet service provision by reducing import duties which may lead to cheaper and affordable Internet costs [6]. Also, good ICT policies need to be formulated to witness good E-Commerce development [80]. The evidence shows that the government is not fully participating in ICT development in developing countries [13].

Therefore, this study will refill the necessary steps that have been taken in Nigeria for the past years in removing the barriers facing E-Commerce adoption. Figure 2.5 below shows the summary of the E-Commerce barriers in developing countries. The next section describes Nigeria's current level of E-Commerce adoption and its problems. The section below reviews E-Commerce adoption in Nigeria.



**Figure 2.5 E-Commerce Barrier in Developing Countries [81]**

## 2.7 E-Commerce Adoption in Nigeria

Apulu R. et al. argued that almost all observations noted and substantiated for developing countries regarding the barriers affecting E-Commerce adoption, Nigeria also is not left out [57]. The same metrics are associated with developing countries in terms of poverty, economic deficit, insurgencies, poor infrastructural facilities, etc. But many developing countries are improving on these negative areas and Nigeria is one of such [17], [25].

Ayo C.K et al investigate factors that are affecting E-Commerce adoption in Nigeria Using the acronym "PEST" which means; Political, Economic, Social, and Technological factors [17], [65], [82]. His findings suggest that many notable reforms like telecoms deregulation and Banks merger have been witnessed. Further clarifies that more needs to be done in the area of economy as over 2/3 of Nigerians are poor. Over half of the population of citizens are having smartphones with subscribed data to use the Internet [83]. He concludes by saying more improvement and positive attention need to be given to "PEST" to witness E-Commerce growth in Nigeria.

The evidence is shown that Nigeria the country of interest in this research work, accounts for the highest number of users of mobile phones in Africa as of November 2007



till date, and over half of the population are connected to the internet which is 50% penetration and 49.096% of internet growth from 2000 to 2017 [23], [84]. The impact of ICT development in recent years in the field of ICT is most significant in the telecommunication sector, which has greatly impacted economic activities (WSIS 2017). This development is part of a process that was formed as part of the current public sector reform plan as stated above [88]. It focuses on liberalizing, deregulating, and privatization of the telecoms industry and facilitating operators' coming into the Nigerian telecom market by removing tax and import duties [2], [54].

Ogunsola and Aboyade observed that Nigeria may be late in starting to use computers, but the rate at which usage has grown is impressive [85]. Agencies, banks, industries, and the private sector also contributed to the information technology revolution. Nigerian universities too are of Information Communication Technology facilities. This helps both lecturer and students to undergo their respective work including research using computers and the Internet.

Apart from the Nigerian government, other funding agencies are assisting higher education in Nigeria to acquire these ICT devices [76]. Such interest has led to the founded of the National Virtual (Digital) Library Project and e-laboratory. An example is the scientific databases [25] laboratory at the University of Ibadan, Nigeria which was established and sponsored by the Federal Ministry of Education and funding bodies [14], [25], [29]. Also, the Tertiary Education Fund (TETFUND) is investing heavily in the ICT infrastructure in Nigeria's higher education and many secondary schools [25].

### **2.7.1 Present Level of E-Commerce in Nigeria**

Nigeria's economy is operated by cash [3] like other developing countries [83]. Ayo and Ukpere argued that the transaction payments by cash show how poorly the cashless societies and this does not help online transactions [86]. The major means of payment is e-payment in E-Commerce.

Ayo C. and Ukpere W. [86] argued that ATM fraud is very alarming in Nigeria due to ATM card cloning, Identity theft, and password stolen [70]. Evidence [44] Government also ordered that all ATMs should be removed from public places to the bank and secure premises. Then CCTV cameras are recommended to be installed in any premises where an ATM is being placed to track the activities of the fraudsters.

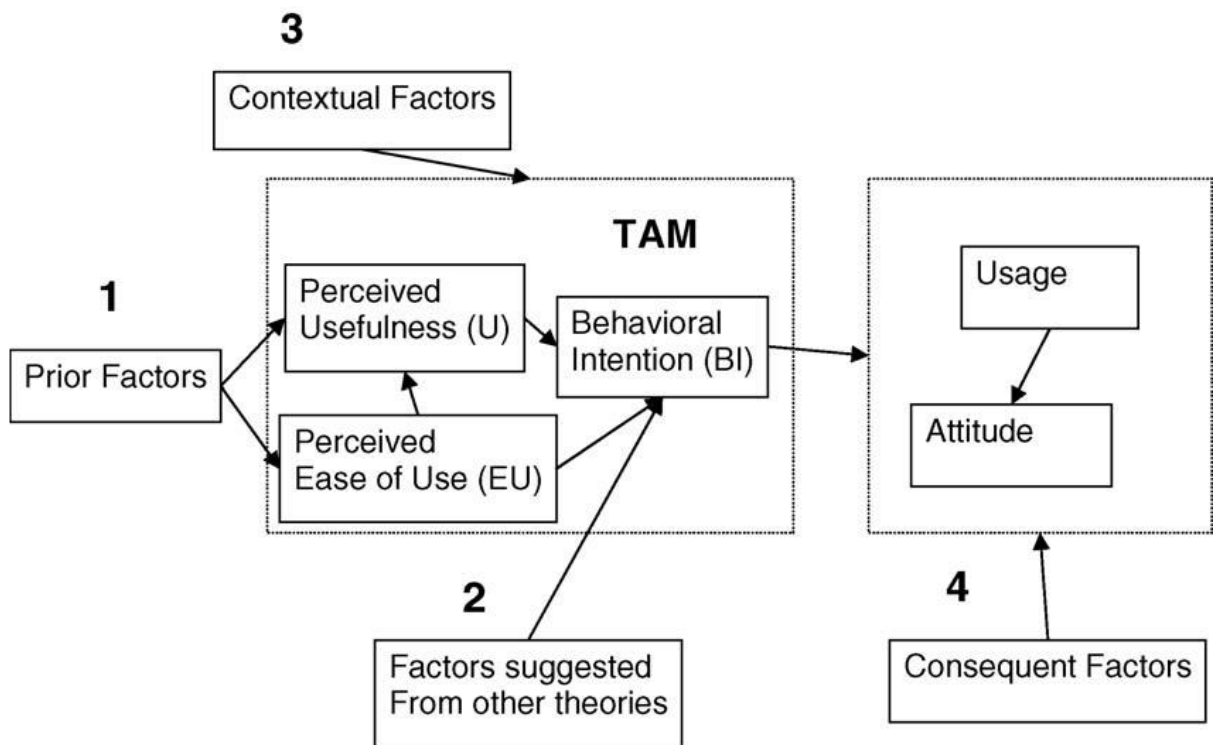
Also, evidence shows that the Fingerprint Identification system reduces fraudulent activities, but the system is being affected by heat and dust in the environment. It was discovered that the High False Rejection Rate and other similar problems are common in this security mechanism. In light of this, this research work is proposing a security mechanism for the E-Commerce of developing countries using Contactless Palm Vein Authentication (CPVA). Therefore, a huge fear of nature by the citizens as a result of a high rate of fraudulent activities may have resulted in the E-Commerce stunted growth in Nigeria.

### **2.7.2 History of Computer Forensic**

The research shows that Computer forensics has been operating in Europe and America for a long time [87], [88]. Digital forensic involves the use of biometric methods to generate digital evidence in proving criminalities [89], [90]. Senthil Kumar Z. M. substantiates that Palm Vein Pattern Biometric Technology is a good method that can be used in forensic and access control applications. The next section discusses E-Commerce Trust and Security [91].

### **2.7.3 Technology Adoption Model**

Information system has some recognising issues which make individuals admit and use systems established and implemented by others. Prototyping and other working innovations have also been invented and applied in solving a problem. The Technology Acceptance Model (TAM) explained the possible people's behavioural purpose to use a technological invention. This innovation was invented by Davis in 1989 [252]. TAM theory is based on the Reasoning Action (RA). TAM has two important factors which are perceived ease of use (EU) and perceived usefulness (U), and the dependent variable behavioural intention (BI), which TAM presumed to be carefully related to genuine performance. TAM is one of the most extensively used models in information system, development, and innovation acceptance. TAM is a prevailing and strong analytical model [253]. TAM has been demonstrated to be a theoretical model in serving to describe and forecast user performance of information technology. TAM has been applied to solve different areas of technology, security, and E-Commerce. Figure 2.6a shows the Technology Acceptance model and its components.



**Figure 2.6a TAM Categories of Modifications [252].**

The two detailed variables, perceived usefulness and perceived ease of use are assumed to be essential factors of user acceptance. Explanations for these two variables were used to progress measure objects that were pretested for content validity and then tested for consistency and construct validity [253].

#### **2.7.4 Adoption of Innovations**

Investigation on the acceptance of inventions likewise proposes a projecting part for perceived ease of use. In their meta-analysis of the connection among the features of an invention and its acceptance. Notwithstanding being the most broadly useful expertise acceptance model, TAM has boundaries and conferring the maximum shared condemnation of TAM absence of actionable control or involvements to experts [252]. [253]. An alternative instance of an acceptance perfect is Technology Acceptance Model (UTAUT) and Design Fiction Innovation (DFI).

#### **2.7.5 Design Fiction Innovation**

Design Fiction is a method for discovering the likely worth of fresh strategy Exertion [254]. It's similar to the methodology of Science Fiction Prototyping (SFP). It promotes inventive discerning and invention in the business and technology advance development [255]. It is claimed that enclosing perception strategies as fictional studies

can offer an interstellar for research-focused analysis and expansion [256]. The Design Fiction Approach will be used in this research as a futuristic predictive design to give the participants practical experience of the kind of security technology they are being introduced to, and to give a comparison with the existing ones to be equipped with adequate information before deciding with a questionnaire that is given to get their feedback.

## **2.8 E-Commerce Trust and Security**

Evidence [41] shows that E-Commerce is growing daily due to its benefit to an individual, companies, and country to an extent of becoming an economic catalyst and this makes it prone to attack. Aleid et al. and Al-Ghaith et al. both cited in [92] clarified that E-Commerce rapid growth makes hackers attacking to be more prone and frequent [20], [41], [93]. The attack is becoming advanced in nature and it has now become a top barrier in E-Commerce growth [13], [51]. In light of this, the security issue is very important, and this research study will be looking at the security aspect of an online transaction by using a Contactless Palm Vein Authentication (CPVA).

Akhter F. argues that online vendors need to protect customers' information against fraudulent activities [92]. There is no specific method for hacker operations; hackers may gain access to a website. Attacking a well-developed E-Commerce platform is a big problem that must be prevented. The fact that E-Commerce comprises of E-Payment, Customer Response System, Products Cataloguing System, Delivery System, etc. All these aspects are integrated to become E-Commerce and required a good security system [92].

Kanyaru and Paul describe various forms of E-Commerce fraudulent activities [72]. Evidence [14] shows that suitable security techniques prevent online fraud [72]. What are the security factors affecting E-Commerce acceptance in these countries? The evidence [23] shows that there are many types of attacks that may be launched on E-Commerce (both operators and users). This research work is focusing on the security aspect of E-Commerce by proposing the Contactless Palm Vein Authentication method (CPVA). Below are the common attacks that E-Commerce must be prevented.

### **2.8.1 Security Threat**

The security threats are the challenges facing e-business and E-Commerce at large. The below -sub-sections describe some of these threats that are facing online transactions.

#### **Phishing**

Kanyaru and Paul Muriku refer to Phishing as illegal accessing of a customer's data to gain access to their account for fraudulent activities [72]. For example, it is the use of fake messages by email pretending as if it is from the source. In another way, an impostor may present as original staff then request secret information on behalf of an organization [5], [94]. They also provide fake links inform of company name, any information supplied into that link is going to the fraudster and they can use this to gain entrance into the customer's account. Evidence shows that lots of identities are stolen through this fraudulent method [7].

#### **Malware**

This can be described as software codes specifically designed to steal customers' data [72]. Micro and Singh [72], [95] substantiated that there are programs that are specially written that are capable of tricking customers to supply their data during online transactions. Evidence [72] shows that malware performs the following operations.

#### **Vishing**

This method is a well-known technique, whereby a fraudster will call customers directly pretends, as an authorized person assigned to request information [92]. Any successful attempts by these fraudsters lead to having access to the customer's account. Evidence shows that Many customers have released important information over phones to fraudsters [72], [95].

#### **Account Hijacking**

Voice cited in [72] argued that customers' browsers may be hijacked by malware, and transfer money without the concept of the customers. Once a customer attempt to login to the website; the browser launches a software menu where a customer may input the parameters. This browser may specifically from fraudsters, thereby gaining access to customers' accounts [5].

#### **Pharming**

This attack involves sending malicious codes into the customer's computer through e-mail or an online network. These codes can be even installed by the customers without

knowing their functionalities [5]. A fake identical website may be presented to the customer information of the original [95]. The customers can be lured to enter their data into a fake website or browser to gain access [96], [97].

#### Account Information Theft

Account information is theft by different methods part of which discussed above. Evidence [92] shows that more customers' information is stolen without customer knowledge and some are done with tricks ideas from the fraudsters [98].

#### Fake Web Site Substitution

This involves the replacement of a legitimate website with a very similar page, but with little variation in the web address. This variation may be inimical to customers. Abubakar A. clarifies that the fraudsters use malicious code to present an identical fake website to deceive the customers [94]. In other words, evidence has shown that what the intruder needed is either to be able to get customer's details or vendor's detail to perpetrate fraud [94].

In the early stage of the Internet introduction, much attention was not given to security. Since the internet was used as a mere exchange of information. The advent of online transactions that commuted to E-Commerce ignites the rate of online fraud [92], [95], [94]. The evidence substantiates that world E-Commerce is over \$5tr [72]. Therefore, investing substantially in the security aspect of E-Commerce is highly needed.

Most of these fraudulent activities are experienced in developing E-Commerce despite the usage of Digital Identity security techniques. In other words, how can digital security provide adequate protection for Nigerian citizens against different E-Commerce fraudulent activities? Evidence describes that in E-Commerce early years and even up till now, Digital Signature and Digital Identity security methods are being employed [62]. This had led to high identity theft and cards stolen which resulted to fear for citizens in E-Commerce participation. An example of a security plan is illustrated in Figure 2.6b.



**Figure 2.6b E-Commerce Security Plan** [99]

### **2.8.2 Security Method - Digital Identity and Digital Signature**

These involve the use of PINs and passwords for user identification on the platform [27]. Evidence [14] shows that there are many methods of this security technique that are currently being used in E-Commerce. In other words, the stolen of pins and passwords has been experienced at high rates. The theft experienced has resulted in E-Commerce non-development in these countries [14], [50]. The economic predicament of developing countries may witness improvement if security and other identified barriers are eliminated [100]. Below are methods of identity representation on the platform.

#### **Password Usage**

This is one of the first methods used in securing data in early computing systems [96] but it's not too reliable [15]. Passwords can be stolen, lost, and compromised [27]. This method also extended to an online transaction and it works to an extent until the use of passwords became vulnerable [72], [27]. The evidence shows that password is expensive to store especially when the customer's database of customers become more voluminous [31]. Wen F. et al. in [101] argued that secure communications and authentication in E-Commerce is necessary and needed, even nowadays that all the businesses rely on computer and the internet in performing their transactions. The insecure channels of E-Commerce need to be improved for the benefit of both vendors and customers. Evidence

shows that the design of security that may withstand all necessary challenges faced in online transactions is highly needed, particularly in the growth of E-Commerce in developing countries [59], [101].

Evidence show threats to E-Commerce are coming up in different forms [59], [60], [61] but evidence shows that measures like digital identity and signature, secure electronic transaction (SET), secure socket layer (SSL) [3], [20], [25], and public-key cryptography were taken to prevent e-transaction from the failing of password security system [95], [103].

### **Smart Card and Personal Identification Number**

This Technique is brought to digital security schemes to replace the use of passwords [94]. This mechanism may be implemented with a password and store data on the memory of the smart card for verification and authentication [31].

Abubakar A. substantiates those fraudsters who have used different methods to get cards hooked into the device and later lay hands on it after the customer has departed from the venue [94]. The criminal is also trying to assist to steal the customer's PIN and have access to do any other transaction without the customer's knowledge. Evidence [79] described the following methods are being used by fraudsters to perpetrate frauds through smart cards and PINs.

#### **Skimming Devices**

Customer's accounts are being accessed by the skimming method in which fraudsters obtain card data illegally [78]. Kibona L. clarifies that information on the card decrypts and reads [104]. The recorded data is now downloaded and used to perpetrate evil. PIN fraud is the commonest thing now, especially in developing countries, where there are no policies compelling card issuers to be responsible for the loss as a result of fraud [72], [95], [103]. The loss is also borne by the customer and this is impeding the E-Commerce development [7].

#### **Fake PIN Pad Overlay**

In this fraudulent method, the fraudster uses the fake pin overlay and puts it on the original. Whenever a customer is pressing the keys of their data, it will be recorded by a fake PIN overlay. This would be taken by the fraudsters and get the PIN downloaded [7].



### PIN Interception

Another way by which fraudsters intercept customers' information is through electronic data recorder [39], [92], [100]. Increment in fraudulent activities by card was stolen and forging PIN led to the introduction of biometrics techniques [104]. This technique can be used with a card, which may reduce fraud. Evidence showed that biometric authentication had been developed in Japan where customer authentication is done using a facial recognition system [72]. In order world, will authentication techniques of biometric like, iris, retina, palm vein, facial image, fingerprints and overcome E-Commerce' supplication fear and distrust? This research is also looking at the possibilities of introducing biometric authentication to the developing countries' E-Commerce by using the Contactless Palm Vein Authentication System (CPVA).

Online frauds are reported across the world especially, fraud associated with the card in online shopping [44], [72]. Prabowo cited in [72] argued that payment methods are a major challenge to online merchants and other developing countries have increased by 72% in the last 5 years [34], [10], [72], [49].

In conclusion, due to the rapid increment in fraudulent activities [27] in E-Commerce in developing countries due to identity theft; this implies that the Digital Signature Authenticating technique of E-Commerce is not effective. Therefore, what technologies and techniques can be adapted to improve the digital security of developing countries' E-Commerce is like Nigeria? This research work is looking at the incorporation of a method Biometrics into E-Commerce in developing countries. Evidence clarifies that; an increment in the rate of fraud as a result of identity theft may pave way for the wide acceptability of Biometrics security techniques.

### **2.8.3 New Security Method - Biometrics Authenticating System**

The combination of biometrics with PIN systems has proved to be effective in virtual transactions [104]. Issues of carelessness are still common to the users of an online business. Fraudulent activities have increased in E-Commerce [30]. The evidence establishes and necessitated the need for a new method to improve E-Commerce security in developing countries. Again, biometrics techniques are used more to get more secure authentications by using individual features for authentication [10]. Physiological and behavioural features are reliable in the authentication and Identification process [52]. Biometrics security is very difficult to forge or replicate [105]. These techniques cannot

be stolen and require an individual to personally undergo verification to be authenticated [4]. The features such as Finger and palm prints, facial, iris, and palm vein are unique features that can identify a person. Literature substantiates that the concept of using the biometric fingerprint and PIN may be effective [106]. Below summarise methods of biometrics and their possible identifying factors.

#### **2.8.4 Identifying Features of Biometrics Techniques**

The techniques of Biometrics identification are similar in nature, processing, and authentication but each of these techniques has its identification features [49]. Literature substantiates that the following features are unique and capable of individual Identification.

##### **Fingerprint Technologies**

This is the first technique of Biometrics and the most acceptable also. It has been in existence since the early 1960 and the US government put it to use by early 1970, [10]. It makes use of the outer layer of the finger, read by a Fingerprint scanner to generate a pattern that is unique to an individual. This technique is very effective and it has reduced the rate of online fraud through cards and pin stolen, [104]. The method is less stressful and very convenient for the users. It has 98% accuracy in its acceptance and rejection [49], [107]. Evidence shows that the Fingerprint method is very useful and is the commonest Biometric technique throughout the world. It is possible to reduce the number of possible matches to a certain fractional part. This means that fingerprint technology is useful in large databases [10], [108].

##### **Shortcomings of Fingerprinting Authentication System**

However, the fingerprint technique has many shortcomings that make it not reliable for developing countries' citizens because of damages they sustain at their fingertips as a result of manual jobs [109], [87]. Due to fingertips damage, the Fingerprint System starts experiencing a High False Rejection Rate (HFRR) [110]. Therefore, Fingerprint Security System at moment may need to be substituted to achieve a secure online transaction. Moisture and dust also prevented the effectiveness of the Fingerprint System by affecting the bitmap image from the scanner [14].

Jr and Z. Riha in [10] argued that fingerprint effectiveness depends on a variety of work and environmental factors. These include gender, age, occupation, and race [10]. For instance, it might be very difficult for an African farmer and mining staff to use

Fingerprint System for Identification. In other words, what kind of security measures can be adopted on E-Commerce platforms? Pieces of literature show that high proportions of the population in developing countries have missing fingers or damaged fingertips.

### **Iris**

Iris can be described as the coloured ring of the eyes. It is a unique feature to an individual that has a complex pattern structure [73]. Evidence shows [36] that iris matching identification accuracy is more than that of DNA. Special camera required to take iris pattern image [5], [6], [7], [15]. Iris camera has a sensor to detect a person's **presence** [72]. The Iris scanner does not need any special light to take the image but it has an automated lighting system [73]. Iris scanning is acceptable to the user and the feature is stable over a lifetime [4], [10]. Iris system authentication is the fastest out of all biometrics techniques. But evidence [72] shows that cataracts and other eye diseases may affect the output result of an Iris Authentication System.

### **Retina**

Retina uses a scanned blood vessel in the eyes. The retina scanning system has been officially launched in 1985 by Eye Densify [9]. But it is not acceptable to the user because of its intrusiveness [16]. Its process is always invasive which needed a laser light to capture the image pattern. Evidence [4] shows that the retina authentication is also accurate [6], [7]. It is not user-friendly, very expensive to build and maintain. Evidence shows that a retinal scanning system has never falsely identified a person [10].

### **Facial Recognition**

This is the biometric identification technique that is natural for the fact that individual human being is different [72]. Facial recognition has just been gaining recognition in the last few years [19]. The facial image effectiveness depends on how better the image from the scanner is [5], [15]. There are special infrared cameras that can be used with a Facial recognition system. The accuracy of facial recognition is yet to experience satisfaction but it is improving [4]. This identification method has a deficiency in identifying identical twins [9]. Any change in hairstyle needs re-enrolment [9].

Evidence shows that this method is not suitable for identification and verification in a security concern situation [7]. Other Biometric features are Palm print, Speaker verification, in [111], DNA, Keystroke dynamics, Ear shape, Body odour, Fingernail bed, and Thermal imaging. Evidence shows that each of these features is a unique identifier with its characteristics, strengths, and weakness in the identification authentication [86].

The below section reviews Contactless Palm Vein Authentication and reasons for using it.

## **2.9 Contactless Palm Vein Authentication - Why Use It?**

Palm vein has a unique feature for an individual [112]. The infrared camera is used to take the image of vein patterns under the palm [4]. Vein tissues transport blood to parts of the body. The vein that carries blood to and from the palm is called Palm Vein [8], [45]. The research is still going on at the hand vein geometry [7], [21]. Therefore, will existing infrastructure IT infrastructure be adequate for these new CPVA security mechanisms? Literature substantiates that the following may be the benefits of the Palm vein technology.

### **2.9.1 Non-Replication**

Palm Veins are livelihood veins through which blood runs the hand, it under the palm therefore, it cannot be forged [16]. The palm vein patterns have complex structures that are practically impossible to copy and are not usually affected by environmental and other physical changes [8], [113].

### **2.9.2 Contactless and Non-Invasive**

The Contactless and non-invasive nature of Palm Vein help greatly [16]. The authentication operation is less affected by external factors [21]. Evidence shows that the accuracy of using Palm Vein technology in authentication is higher than that of Fingerprint and Facial recognition systems [2], [112].

### **2.9.3 High Usability Comfort**

The Palm Vein Technology is adequate [5] probably due to its non-invasive and convenient ways that please the user [16]. This new technology eradicates the fear of non-hygienic that may arise as a result of using the Fingerprint system as a result of a finger touch to the Fingerprint scanner [8], [21].

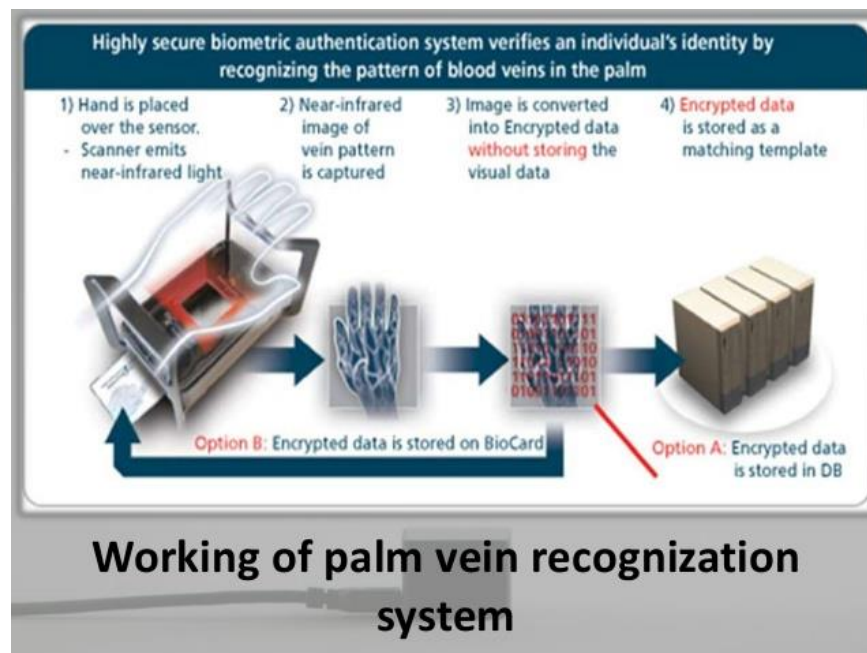
### **2.9.4 Highly Secured**

This biometrics technique is highly secured due to the livelihood nature of Vein pattern use in authentication [16]. Also, authentication using the Contactless Palm Vein method requires the owner to be physically present for authentication as it cannot be

authenticated by proxy [7]. Evidence shows that the false acceptance (i.e. admitting the wrong authentication) rate of the Contactless Palm Vein technique is negligible [2], [112]. The next section summarises the literature on palm vein application areas.

## 2.10 Palm Vein Application Areas

Contactless Palm Vein Authentication system can be applied in every area where authentication is required. The below sections described the applicability of this system. An authentication device that is of very high accuracy that uses internal physiological features to deliver high-level security applications is Palm Sensor Scanner [16], [88]. Evidence shows that the palm vein application is used in system log-in solutions, personal authentication solutions, and access control systems [114]. The diagram in Figure 2.7 illustrates the personal authentication solution of an automated teller machine.



**Figure 2.7 How Palm Vein Works [15]**

### 2.10.1 Access Control

Elnasir S. et. al. clarify in [89] that authentication access into standalone or networked applications can be controlled by incorporating Palm Secure Sensor the system solution [16]. By this, adequate security is provided in such an area. It can be used to secure restricted areas and anywhere where personal confidential security is required [89], [88]. Access control can be authenticated and monitored using Palm Vein Authentication method as shown in Figure 2.8.



**Figure 2.8 Access Control [115]**

### **2.10.2 Automated Teller Machine ATM**

Integrating Contactless Palm Vein into this may yield a good and fruitful security enhancement [116]. Palm Vein image pattern can be stored in the smart card so that when the client scans his Palm, the ATM will compare the scanned Palm image with the Image stored on the smartcard for authentication as shown in Figure 2.9 [16], [83].



**Figure 2.9 Banking ATM using CPVA [117]**

### **2.10.3 E-Commerce & Web Applications**

Literature [35], [71] indicates high increments in how citizens are using the internet for E-Commerce [108], and this requires a very good authenticating security technique [1]. Contactless Palm Vein Authenticating system could be integrated to serve as a means of authenticating techniques in web applications [16]. Kant C. argued that highly sensitive web applications like trading web pages can be authenticated using Palm Secure sensor [108]. Figure 2.13 shows an example of a web page that requires authentication.

## 2.10.4 Identification Cards Authentication

An improvement to an identification card may be done using the Contactless Palm Vein Authentication system to prevent fraudulent activities [16], [116]. Science and Studies also show that biometrics methods (e.g., 3D palmprint classification and features) are best to use for forgery prevention in sensitive identification cards [111]. CPVA could be added to enhance the use of biometrics on an electronic card or passport as many passports already use facial biometrics.

## 2.10.5 System Login

Another good area where the Contactless Palm Vein Authentication system can be applied is in securing sensitive computer networks or personal computers against gaining access by an impostor to steal data on the computer. This system may request authentication during the booting by Basic Input and Output System (BIOS) [16], [83], [114] as shown in Figure 2.10 where the login into the laptop computer is done using palm vein authentication.



**Figure 2.10 System Login using CPVA [118]**

## 2.10.6 Automotive

Ahmed M. A. et. al. substantiates that car theft, plane hijack, and other automotive stolen may be reduced using the Contactless Palm Vein Authentication system [108], [119]. Palm Secure may be integrated into automotive control to request Palm scant authentication of the legitimate driver, pilot, and sailor as the case may be.

## **2.10.7 Patients Authentication**

The Contactless Palm Vein Authentication system is suitable in a medical environment due to its hygienic nature and non-invasive technique. Ahmed M. A. et. al. clarify that medical records require a high level of security because of the confidentiality of their entail [119]. In another scenario, High security is needed in this environment to restrict unauthorized medical officers to have access to the medical record of a patient [119]. This can also be used to control, drug prescription and monitoring of a patient [111]. The section below describes Palm Vein architecture in which stages that are involved are discussed.

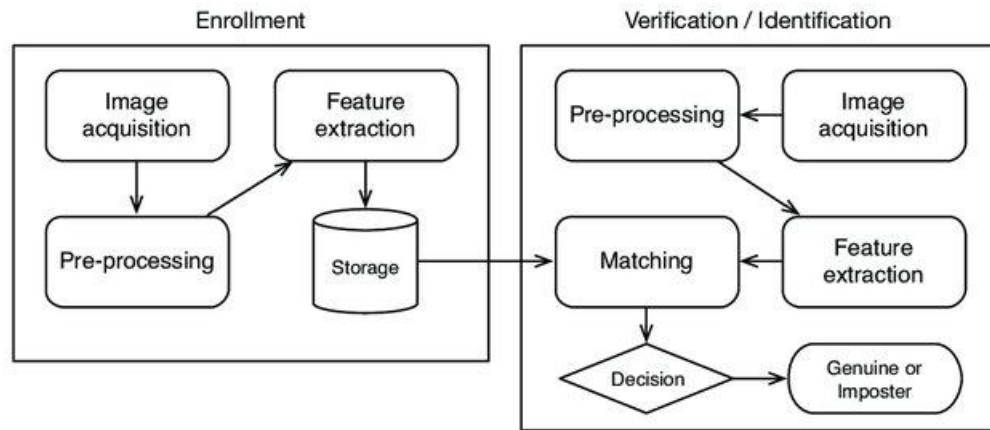
## **2.11 Palm Vein Architecture**

Palm Vein architecture consists of enrolment and verification phases [3]. The pre-processing stage is the first stage of Palm Vein Architecture after image acquisition. The acquired image quality needs to be improved for effective authentication [49], [70]. Also, the acquired image needs to be filtered to remove unwanted parts of it [91]. The extraction of the vein is done from the acquired image after being decomposed to a certain level. The features extracted are kept in the database for authentication and verification [120], [121]. To verify, the stored features are checked and compared with newly acquired processed features, if the features have the same authentication granted otherwise access is denied [79].

### **2.11.1 Pre-processing**

This process gets the vein pattern of the palm images [3] captured through an infra-red camera and it needs to be filtered to remove rackets [7], [61]. The Region of interest (ROI), is the pre-procession stage [48], [122], where the captured image is to be normalized to minimize the changes in the scale [79]. Noise removal is applied after locating the ROI of the Image. Also, it is necessary to make the brightness to be uniform [78]. Then, the normalization method can also be applied to improve image contrast [83], [123]. Figure 2.11 shows the processing stages of the Palm Vein Authentication from an enrolment phase to the verification/ identification phase.

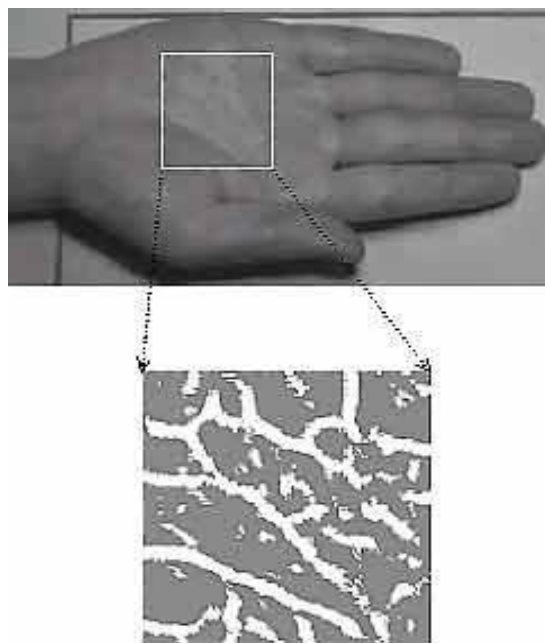




**Figure 2.11 Block Diagram of the Palm Vein System [124]**

### 2.11.2 The Region of Interest

The Region of Interest (ROI), is a specific region of the vein image of the palm that may be used for feature extraction [25], [114]. There are different methods for feature extraction [41], [125]. Figure 2.12 is the diagram showing ROI concerning the portion of the palm needed for feature extraction. Kong A. et al. argue that the ROI needs to be carefully selected to have all the discriminant patterns of the palm or iris [60], [93], [114]. Figure 2.12 also shows pattern recognition of the vein generated from the Region of Interest (ROI).



**Figure 2.12 Image Segmentation and Nominations [126]**

### **2.11.3 Image Acquisition**

Both Near Infrared Camera (NIR) and Far-Infrared Camera (FAR) are used in capturing the image of the palm [127], [128]. The Image of the palm through these devices can be subjected to segmentation, normalization, and enhancement [116], [129].

### **2.11.4 Image Segmentation and Normalization**

Image Segmentation and Normalization are essential to automatically normalize the region so that the image variations between the user and the imaging device can be greatly reduced. If a coordinate can be constructed to accommodate Image variations, the authentication process may be more effective and efficient [111], [91]. Senthil M. & Gayathri R. argued that it's important to map the palm with the coordinate system [47] to get the invariance corresponding to it [91]. The authors emphasized that the key points must be localized to build coordinates and these are seen in touch-based imaging [35], but contactless imaging coordinates may be automatically generated [91].

The Palm region could be separated from the background by binarizing the acquired palm images. Then the distance between the palm images to the boundary of the palm has to be estimated [130]. Senthil & Gayathri further clarified in [35], [91] that the location and the ROI size can be selected from the palm in accordance to the specific measures of the image to cover for the variation in scale changes in a contactless environment. Evidence shows that because additional samplings are not required in this method hence are more computationally efficient. The fixed size region is generated from scaled ROI images after segmentation [91], [123].

### **2.11.5 Image Enhancement**

The images of the palm may be a near-infrared illumination (NIR) acquired through a Near Infrared Camera [130]. This type of image appears to be having low contrast with dark colour therefore, image enhancement is needed [85] to boost texture patterns and enhance the image qualities [91]. Also, the same images could be from far-infrared illumination (FIR). The section below describes the basic processes involved in Palm Vein Technique.

## **2.12 Basic Processes involve in Palm Vein Technique**

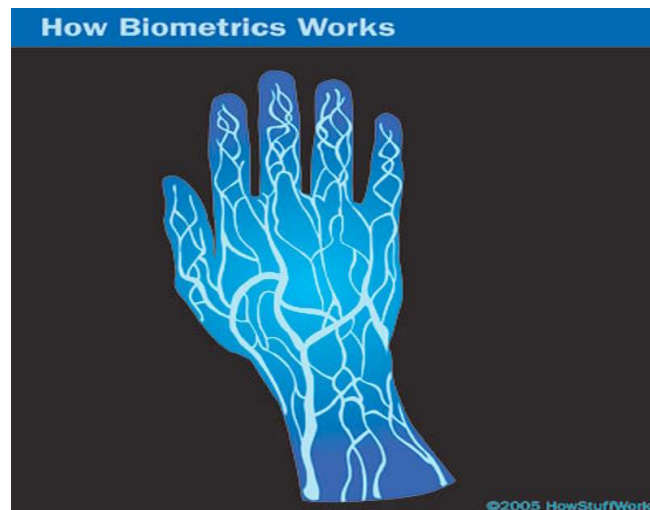
Contactless Palm Vein Authentication uses a psychological feature known as Palm Vein as a unique identifier for an individual identification [16], [131]. An infrared camera is used to acquire a Palm Vein Image of an individual. There is a wrist guild on which the palm will be placed to guild the normalization of the Palm image [132]. The sensor supports the palm to be held at certain centimetres above the infra-red ray scanner, to flash the palm. Image captured by the camera is encrypted and converted to data points [5] using an algorithm, processed, and stored in specialized software for authentication [133].

A personal authentication can now be done by logging in for accessibility. This authentication can be used to gain access to a particular bank account, to enter a secure environment even to board a plane. The newly acquired palm image will be processed and checked with the registered database vein images for verification [16]. The newly processed Vein Pattern will be compared and if the two are the same authentication will be granted otherwise access will be denied [16], [89], [133]. Figure 2.13 illustrates sample images of the Palm Vein.

### **2.12.1 Palm Vein Features Extraction and Matching**

Studies show that the features extraction path is a very essential stage pre-processing stage of the Contactless Palm Vein Authentication (CPVA) system [17], [91], [111], [134]. Extracted features of veins from the Palm Region of Interest (ROI) can be extracted using different methods. can be used to Wavelets are used for multi-resolution analysis, it is a powerful tool widely used in biometric systems [114], [135]. Evidence [90] shows that it is the best extraction method for different resolution images of 2D wavelet transforms. The sub-images are now used to represent the original image [2], [136], [130].

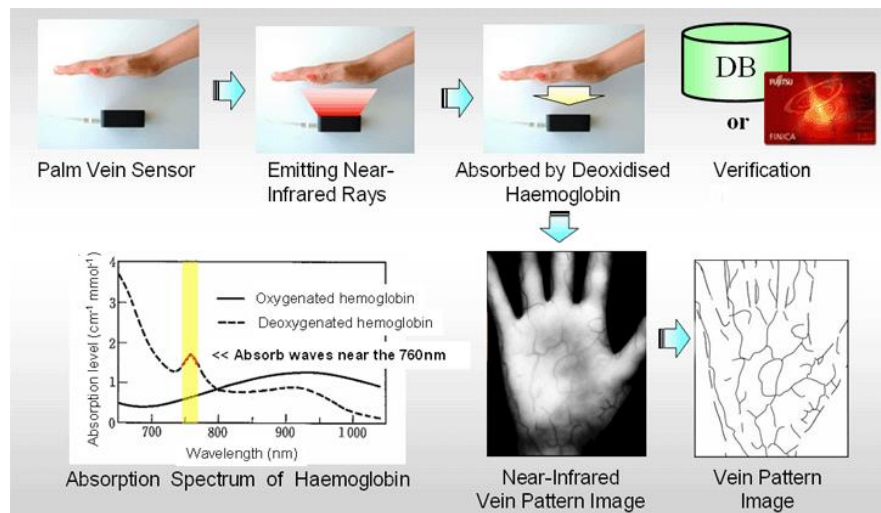
Senthil M.K. and Gayathri R. argued in [91] presents result and suggests that palm-vein authentication using Local Mean based k-nearest Centroid Neighbour classification (LMKNCN) and Kernel Principal Component Analysis feature extraction (KPCA) have better performance over the other [137], [38], [58], [59], [91]. Figure 2.13 shows the typical example of veins in the palm image.



**Figure 2.13 Sample Palm Images [138]**

### **2.12.2 How it works**

Contactless Palm Vein Authentication is used in a hospital to authenticate patients [88], [89]. The infrared camera captures a vein image of the palm. The captured images will undergo both pre and processing stages stored in the database and compared against the newly acquired image to identify a user. This is applicable in the medical record and other areas where authentication and identification are needed. Figure 2.14 shows how palm images are being acquired using a Near-Infrared camera (NIR) [6]. Laadjel M. et. al signifies in [114], Mallikarjuna A. & Madhur S. cited in [16] discusses that Vein patterns will not be easy replicate because of their complex structure and the authentication needs livelihood veins; these authors argued that the Vein pattern may probable to be secured than a fingerprint system [114]. Figure 2.14 illustrates the palm image and palm vein census.



**Figure 2.14 Palm Image and Palm Vein Census [258]**

Evidence showed that Vein patterns are very personal to an individual [116].

- Contactless Palm Vein Authentication system is using the newly acquired image to compare with individual pre-registered images kept in the database. Blood liveliness is important in the veins' palm pattern.
- Contactless authentication is non-invasiveness, and this makes it to be acceptable by the user lively hood blood veins make the method to be reliable.
- Very difficult to replicate or changed and through this, the technique is highly dependable.

### 2.12.3 Palm Vein Security Strength

Several types of research have been carried out in which Palm image samples were acquired processed and tested with corresponding samples. Evidence [16] shows that this Contactless Palm Vein system had a negligible False Acceptance Rate (FAR) that is not up to “0.00008% and a False Rejection Rate (FRR) of 0.01%” [26], [88], [116],. Also, evidence shows that there is a possibility of pattern modification amid the right and left veins of the palm. Therefore, it is better to authenticate with a registered palm. Another advantage of the Contactless Palm Vein Authentication system is that vein patterns do not change over the entire period of life, users can use the profile that registered as a child throughout their lifetime [16]. Research has shown that vein patterns are formed in the womb and no two people have the same vein pattern in the world [112]. Figure 2.15 shows how authentication is to be done using Palm Vein. The next section summarises studies on palm vein algorithms.



**Figure 2.15 Preparing Patient's ID from Scanner [139]**

## **2.13 Palm Vein Algorithms**

There are different algorithms to use in Palm Vein authentication depending on the extraction method employed. Wavelet transform is very good for multi-resolution analysis [119], [140]. It degenerates the ROI into two sub-bands [111]. It has a low sub-generated level that is a coefficient of the original image [3], [91]. High-frequency sub-bands always with the noise data [4], [88]. Below are the summarised ways of how the vein pattern of the palm can be generated.

1. Acquired the original image through an infrared camera
2. The acquired original image should be converted to a binary image through a threshold.
3. The image pass-through filtering process removes noises.
4. Decomposition of the original image to sub-image by Wavelength
5. Decomposition to level X, palm vein decomposed to  $3x+1$  sub-Image is  $[A_k, (H_i, V_i, D_i), i=1, 2, \dots, k]$ .  $A_k$  is the best approximate to the inventive image.  $H_i$ ,  $V_i$  and  $D_i$  are known as components of high-frequency and in the directions of the vertical, horizontal, and diagonal [141].
6. Sub energy image is computed and the feature vector is constructed.
7. Energy feature is formed by normalizing the vector.
8. Then the Euclidean distance in the feature vectors is computed to fix the similarity [2].

The Evidence [3] shows good Palm Vein algorithm functionalities Includes:

Increment in the Correct Recognition Rate (CRR) [5], [130], [142] Reduction in the False Rejection Rate (FRR) [143], [144].

Also, the absolute total reduction in the False Acceptance Rate (FAR) [22], [144].

To minimize Equal Error Rate (EER) [3], [10], [90], [119], [145], [146].

The detail of Palm Vein architecture is described in the following sections.

The below section describes the Palm Vein recognition approaches that are used in the algorithms construct.

## **2.14 Palm Vein Recognition Approaches**

There are various approaches to the palm vein recognition system depending on the nature or domain to which the palm images are to be applied. This includes:

### **2.14.1 Line-Based Approach**

The existing edge detection methods are used by line-based approaches to extract palm lines. The matching of palm lines is directly in a specific format [147]. Palm lines are detected using the canny edge operator approach. The first-order derivatives are identified through zero-crossings by using edge points and corresponding directions [148]. The scale of the lines is said to be the size of the second-order derivative. Palm lines are valleys and this is why positive magnitude is only retained. A feature vector is regarded as the amount of the weight of local directional magnitude inform of an element [145]. The gradient of the images is obtained by “Sobel masks and morphologic operators that detached feature extractors” [145]. Neural networks are used to classify these feature values.

### **2.14.2 Subspace-Based Approach**

The appearance-based approach is known as the subspace-based approach in biometric research [149]. They make use of principal component analysis (PCA), independent component analysis (ICA), and linear discriminant analysis (LDA) [147]. Features are also known as subspace coefficients. Features are compared with various distance measures and classifiers. Many methods of image-processing are combined to extract palm vein features. Then neural networks are employed as standard classifiers to take a final decision [145]. “Images are decomposed by two-dimensional dual-tree complex transform” on the pre-processed palm veins. Wavelet transforms traditional

weaknesses are resolved by the proposed dual-tree complex and is not pattern recognition shift-invariant. Therefore, the Fourier transform is applied on each sub-band and features are the “spectrum magnitude” [145]. SVM is used as a classifier.

### **2.14.3 Statistical Approach**

Statistical approaches can be in terms local or global. Local statistical approaches split the transformed images into numerous insignificant areas after the images had been transformed images into another domain [145]. Features are gotten by calculating the mean and variance of each small region as local statistics [150]. Fourier transforms, wavelets and Gabor have to be applied. The small regions can be elliptical or circular but always be informed of a square. More so, in describing local regions by statistics, histograms are used by local as features [132]. Transformed images are used by global statistical approaches to compute statistical features directly.

### **2.14.4 Other Approaches**

Other approaches may not easily be classified because they extract palm vein features by combining several image-processing methods and also employ some standard classifiers to make the final decision using neural networks [151]. The next section describes the general framework of the palm vein recognition system.

## **2.15 General Framework of Palm Vein Recognition Systems**

Palm vein is good for personal authentication technique (PAT) which consists of enrolment, authentication, identification, and decision in its architecture [152].

### **2.15.1 Enrolment**

Enrolment is referred to as the registration process and it is the operations of capturing palm image, processing of the image, and the extraction of the feature. Then the database is used to store the generated image templates [152].

### **2.15.2 Authentication**

Authentication is the procedure of confirming a taken image against the stowed images in the database. Matching processing is always one-to-one. The palm vein images must initially be taken, processed, generate features that will eventually become vector features, and used in verification and identification [152].



### **2.15.3 Identification**

In the identification phase, the captured palm vein image is used in identifying the database palm vein images. The matching processing here is one too many before the identification is done.

### **2.15.4 Decision**

Features matching is the key procedure for the decision stage. This stage involves using a specific algorithm in calculating the similarities between the captured image that are used to query the stored templates in the database. The comparison will need to be done one by one. After which the decision will be taken based on the similarity computed.

In the case of authentication, the similarity must not be less than the selected threshold otherwise the authorization will not be denied and declared the authorizer as an imposter. While an identification involves, the maximum similarity score calculated from the vein feature is used to identify the user [153]. Figure 2.16 shows the framework of Palm Vein Recognition. The below section describes stages of palm vein development

## **2.16 Stages of Palm vein and Recognition System Development**

5 main stages are involved in developing a palm vein recognition system [154]. These stages are as follows:

**STAGE1:** Acquisition of palm vein image

**STAGE2:** Palm vein Pre-processing

**STAGE3:** Feature extraction

**STAGE4:** Training and Classification

**STAGE5:** Recognition/Testing

### **2.16.1 STAGE 1: Palm Vein Image Capturing and Acquisition**

Palm vein individual is taken by a sensitive camera called near-infrared CCD and the captured images are stored in the database [155]. A wavelength CCD camera of about 850 is suggested because palm vein patterns cannot see in visible light. Therefore, an ordinary CCD camera cannot be used in image capturing. Data capturing is the first activity that is involved in the pre-processing of biometric features in the pattern

recognition process, then converts these features into the form that a computer can manipulate [147].

Palm vein images of individuals will be captured. This acquisition of the palm vein imaging is achieved using an infrared CCD-sensitive camera. Each individual may capture two images of both left and right hands because both have different image patterns.

### **2.16.2 STAGE 2: Palm vein pre-processing stage**

Palm vein images are prepared for pre-processing in this stage. The following activities involve in pre-processing stage:

#### **Scaling of Pictures**

The original captured sizes of the palm vein image may be resized from the original dimension of like 350×540 to 250×250 pixels any dimension, through the process of cropping.

#### **Captured Images organized into palm vein folder**

Individual images are resized to be grouped into two folders. The first folder is meant for training images while the other one is meant for system testing. Then training images folder contained four folders each with different resolutions of training images.

#### **Cropping**

There are many sizes in which the palm vein images could be cropped into, the following are some by not limited to: “10\*10, 15\*15, 20\*20, 25\*25, 30\*30, 35\*35, 40\*40, 45\*45, 50\*50, 55\*55, and 60\*60 pixels and these could be from the centre of the images. Then the varying resolution effects need to be tested on the performance of recognition.

#### **Conversion of Cropped Images to Gray Scale**

The cropped images of palm veins stored in the database are suitable for the palm vein recognition system by converting them into grayscale. Because two-dimension arrays analysis is required by most of the algorithms that are used for palm vein recognition.

### **2.16.3 STAGE 3: Feature Extraction**

The classification process is done by using cropped palm vein image information. The features extraction like minutiae, delta points, principal lines, and wrinkles by using PCA algorithm and the recognition is enhanced in this process [156].

### **2.16.4 STAGE 4: Training and Classification Stage**

Eigenspace is ordered here by computing Eigen palms (eigenvectors). Eigen palm space is projected by cantered training image vectors. Euclidean distance, used in form of a threshold to determine the testing image, the class, and the training of PCA and ANN.

### **2.16.5 STAGE 5: Palm vein Testing/Recognitions Stage**

The individual different training images were used in testing and recognition and different image resolutions to determine performances under a different image. The next section describes appearance-based architecture.

## **2.17 Appearance Based Architecture**

The following review the appearance approach that will be considered in this research work. The non-linear Algorithms will be considered. Non-linear is believed to have been used in addressing the problem faced by a linear appearance approach.

### **2.17.1 Linear Analysis**

In the linear analysis method, manifolds use in science and important. Linear principal manifolds are explained in the linear analysis. The complex structure properties are informed of important properties of the simpler space which is explained by manifolds [157]. The average image of all the people in the database is computed. Palm can be described as a subspace of the Palm's vein [155], [158].

The palm vein image is changed to the average image by subtracting them from each other.

The following 3 statistical techniques that can be found in the linear analysis are:

1. Principal Component Analysis (PCA)
2. Independent Component Analysis (ICA)
3. Linear Discriminant Analysis (LDA) and others.

The 3 palm recognition techniques stated above which each technique contained a database that contained trained images. A trained and test database test stored different images of the same person. One image for one person is contained by the test database. The basis vector of some statistical properties was generated by each technique. The high dimensional basis vector will first be calculated after which the projection of the training database of palm vein into the basis vector. Then feature vector is formed. The matching is now performed using distance measures.

### **2.17.2 Nonlinear Analysis**

The number of nonlinear principal manifolds is explained by non-linear analysis. The nonlinear analysis has a more complicated structure than the linear subspace. A spatially sampled image representation is referred to as non-linear analysis. The inner nonlinearity nature is differentiated by inner nonlinearity in the data or parameter. nonlinearity due to the choice of parameters [159].

1. Kernel Principal Component Analysis (KPCA)
2. Kernel Independent Component Analysis (KICA)
3. Kernel Linear Discriminant Analysis (KLDA) and others.

### **2.17.3 Kernel Principal Component Analysis (KPCA)**

The structure of high-dimensional features and complicated spatial used by PCA and Kernel PCA is non-linear. Linear dimensionality reduction is only allowed by standard PCA. But standard PCA will not be useful where data has more complicated structures and not in good clarity in a linear subspace. Standard PCA allows us to generalize to nonlinear dimensionality reduction through kernel PCA [160], [161].

The second-order statistics of the image sets do not address higher-order statistical dependencies like the relationships among three or more pixels [162]. KPCA is a nonlinear extension of PCA. The main idea is to incorporate PCA into non-linear to give a KPCA. The non-linear method is used to map input into feature space and by adopting a polynomial kernel, the principal component will be calculated with the space of higher-order correlations of input pixels[26]. This produces a good performance. KPCA is a development of the PCA method. A dimensional reduction is performed by using a non-linear kernel function. The usage of the non-linear kernel function involves the

transformation of image space to feature space and feature space makes the manifold of data to be simple [163].

The use of kernel function reliant makes features space data separable rather than reliant on the original input space. The introduction of kernel functions into the performance of nonlinear PCA was researched by Scholkopf et al [160]. The methodology applies a non-linear mapping to the input  $(\psi(x): R^N \rightarrow R^L)$  and the linear PCA is solved in the feature subspace. The kernel functions are used to make implicitly by the mapping  $\psi(x)$  [164].

Conclusively, the non-linear function known as kernel function is preferably more efficient than the linear function. The utmost that it integrates nominal and ordinal variables and that it can switch and realise nonlinear associations among variables.

# Chapter III

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## 3. Research Model and Methodology

The methodology and research approach for this research work are discussed in this chapter. It also states and justifies the reasons for choosing the research method to answer the questions and hypothesis [171]. The chapter discusses areas like the research approach, data collection methods, the research purpose, the research strategies, data analysis are also covered in this chapter. The first phase of this research methodology involves integrative research where different concepts and theories are integrated and this helps in the development of the research model. Research comparative analysis and an empirical tool (**i.e. survey**) are involved in the second aspect of the methodology. The research also employs a Design Fiction approach to provide a framework for the design and introduce new technology to a targeted audience. A clearer idea is dissipated to the audience through participation in a design experiment.

### 3.1 A Design Fiction, E-Commerce Simulation and Survey Approach

Design Fiction is a method of design, and also a way of research and is a means of anticipating, planning, and also giving a clear description of an idea to participant in a given research. A deductive approach is used in this research (i.e. survey) to gather primary research data that involves the development and proof of a hypothesis. This research has developed several hypotheses (section 3.5) requiring empirical examination [171], [172].

According to Bryman in [172], an empirical approach has a way of contributing immensely to the research background. A survey is a quantitative method for data collection from respondents needed in which facts, opinions, and attitudes are captured. This has three components: questionnaires, structured interviews, and observations. Large data collection is possible in this method from a known total population and this method is economical [42], [51], [173]. This research work adopted a survey method to exploit the benefits such as easy data collection, economical, and relatively quick. In this method, the researcher can gather large data to support the few pieces of literature available in the field area. This research study will use a self-administered anonymous survey developed

in this research. The survey will be manually administered to catch the targeted audience, although, more recently, a web-based administered survey is gaining popularity [113]. In this case, a manual approach is preferred because it is being used to collect data from a wide-ranging demographic with potential problems of connectivity and the nature of the research which is targeting a generally distrusting audience that may invalidate the data. Personal supervision and interactivity between the researchers and the participant may increase the validity of the results which will be analysed with SPSS and double-checked with MS Excel to have benefits of both tools [174].

The survey questionnaire consists of 200 questions across 16 sections that are close-ended. The first section consists of structured questions that examine participants' previous E-Commerce experience etc.

### **3.2 Descriptive Research Type**

Surveys and fact-finding inquiries refer to descriptive research, and this is used to describe a situation that is happening [151]. Descriptive research is used in analysing the market, demographics, and consumers' attitudes. Descriptive research is used to answer questions like “what, who, when, how, and where” [175]. The research or aspect of activities that involve Information technology, marketing, commerce, and Technology acceptance scenarios can be tested using this research [175].

### **3.3 Research Approach**

The justification in the chosen quantitative approach is based on advantages such as; economical, saving time, covering a large range of data, etc. A quantitative approach helps to describe the trends in a population. It also gives a clear relationship direction between variables (independent and dependent) [113]. Quantitative and qualitative data can be generated from a large research sample by the researcher using this approach [172]. A questionnaire design with a quantitative analysis was used in generating the variables used in model formulation.

The quantitative research approach was initially used to study natural happening systems. Numerical methods (mathematical modeling), laboratory experiments survey methods and formal methods (econometrics) are examples of quantitative methods [52], [176], [177].

Sachdeva [175] stated that qualitative research is based on data gathering that explains details of situations, and interactions in providing depth and detailed description of events by the people. Although, quantitative research is used for theory testing the researcher must keep distance to avoid bias with the result [25]. Research shows that participants are the source of data in quantitative while participants are not in the qualitative approach [178].

### **3.3.1 Analysis Methods**

The hypotheses will be tested using the data analytic tool in Microsoft Excel and co-tested with SPSS analytic tool. The data used for the analysis mainly derived from the fieldwork carried out in Nigeria. The descriptive analysis was used to measure the central tendency, mean frequency, standard deviation, variance, etc. as shown in table 6.1 and an inferential statistics test is adopted to measure various tests to determine strength, directions, and the relationship between variables. The effect size is also used to determine the extent of relationships variables [179].

## **3.4 Data Collection Methods**

Data is said known as basic fact [175] which includes observation experience of result from an experiment, or a phenomenon that has variables which could be used for measurement. Primary and secondary are two methods of data collection. Primary data are obtained from the participants' experiences and observations from experiments or fieldwork [179]. The researcher generates primary data from questionnaires and interviews. Therefore, the primary data of this research is mainly generated from the fieldwork carried out in Nigeria. Again, secondary data are generated from personal experience or personal observation from the fact and findings from book journals which needs to be adequately referenced [180].

### **3.4.1 Secondary Data Source**

Secondary data sources are data collected from the web, electronic databases, and print resources.

#### **Print resources**

Print resources are hard copies that are majorly found inside the library. They are printed in visions, and they come in the form of, magazines, and journals. They provide recent information and give an update periodically.



## **Electronic Databases**

This can be referred to as an information repository where things are kept and accessed electronically. The use of computers and the internet are very important in this data source. Many of these databases are accessible to the researcher free of charge due to schools' and libraries' bulk subscriptions. Examples are; company profiles, magazines, government data, newsletters, business reports, directories journal articles, and reviews [25].

### **3.4.2 Primary Data source**

Primary data will mainly be collected from the targeted audience as fieldwork and pilot study.

#### **Pilot Study**

This will be done with Nigerian citizens at the University of Sussex. The essence of this is to determine their experiences in adopting new technology, how they build trust in removing fears, and their willingness to continue when getting back to Nigeria [176].

#### **Field Work/ Main Study**

This will be carried out in Nigeria by targeting groups of audiences. Primarily more than half of the country's economy is run by the middle class that consists of entrepreneurs, artisans, farmers, miners, and those who involve in manual labour. This is to determine, their previous experiences, challenges, and their willingness to accept the new technology in E-Commerce.

## **3.5 Study Settings**

The selected cases illustrate the development potential of E-Commerce under the above-outlined conditions in Nigeria. The study will target a demographic to include professionals considered across different sectors such as civil servants, students, and office workers, but also those engaged in manual labour. For manual labour, the study notes that environmental working conditions are said to be a particular factor affecting the effectiveness of the Fingerprint identification system in an E-Commerce transaction, which will be examined. These cases will be analysed from a comparative perspective at the end of the section. Each factor (e.g., fear of risk, perceived advantage, security, Usability, perceived fear, and trust) is discussed and justified.

A model is presented with the associated hypothesis. A set of independent and dependent variables are used to formulate a conceptual model for E-Commerce adoption in Nigeria. Section 3.5.1 to 3.5.5 discuss all the hypotheses in detail.

### **3.5.1 Fear of Risk**

#### **Background**

Nkotagu clarifies that fear of risk is common in E-Commerce because of its virtual operations [98]. The risk level appears to be diminishing when there is trust, see Section 3.5.4, between every individual that participated in E-Commerce transactions. Kim and Prabhaka research on the link between the fear of risks and trust in a transaction as major determinants in the adoption of e-commerce [19]. They emphasised that both perceived risk and trust have not been treated to a large extent in the context of E-Commerce. The high-risk level of E-Commerce systems leads to greater fear in carrying out E-Commerce transactions, and when citizens do not trust a system, it then becomes a problem to genuinely patronise such a system. Also, a further study was conducted by Broillet et al on online transaction activities regarding decision-making concerning the impact of fear of risk and its comparison to the trust in the adoption of online transactions [181].

This research revealed that perceived risks of E-Commerce are one of the major determinants of adoption behaviour. If the level of perceived risk is more than the level of trust, there will be a distrust behaviour of the system by the trustor [19]. Experience in conventional trade methods (Physical transactions) shows that the risk is lower while online transactions are perceived to have high risk. Risk discernment seems to effect directly the attitude E-Consumers in the adoption of E-Commerce [181].

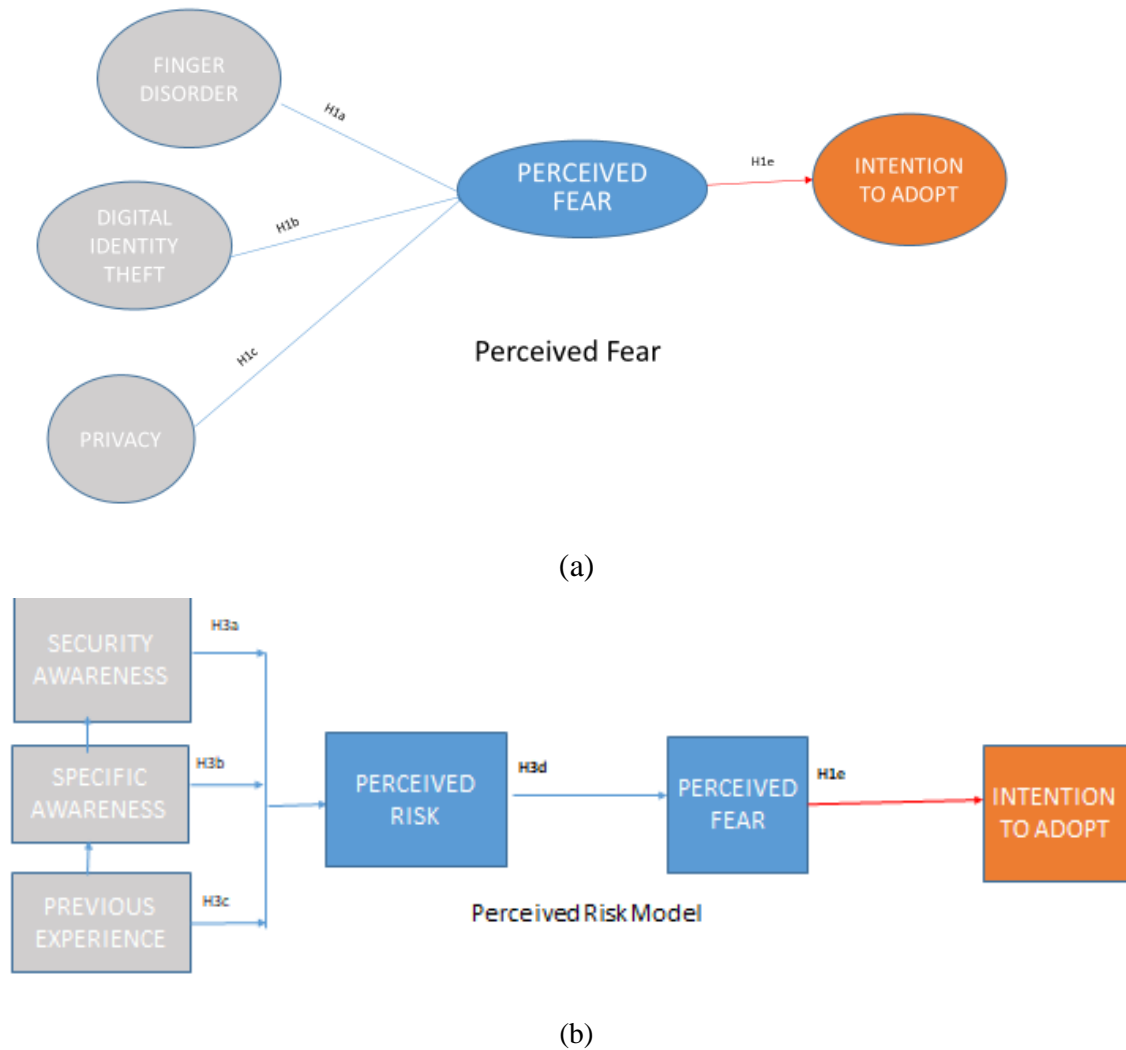
#### **Summary**

Customers may face financial and privacy risks when disclosing personal information on online transaction activities and this may affect their decision to use E-Commerce transactions as their fear of risk is elevated and thus trust in E-Commerce is reduced leading to lower adoption of E-Commerce. In light of this, CPVA becomes imperative.

#### **Model**

Figure 3.1 proposes a Perceived Risk and Fear model of E-Commerce adoption. Perceived risk is caused by three independent variables (factors), which eventually lead

to Perceived Fear for the citizens to engage in E-Commerce adoption. Perceived fear is further influenced by three other factors.



**Figure 3.1 (a) the Perceived Fear Model and (b) and other factors affecting Perceived Risk and Fear Model**

### Hypothesis

Based on the model in Figure 3.1, the decision to transact online or not to do so is influenced by fear of risk and leads to the following hypothesis.

#### Perceived fear model

H1a: A citizen's **fingerprint disorder** leads to a **perceived fear** of making E-Commerce transactions.

H1b: **Digital identity theft** leads to a **perceived fear** of making E-Commerce transactions.

H1c: A citizen's breach in **privacy** (Independent Variable (IV)) increases their **perceived fear** (Dependent Variable (DV)) of making E-Commerce transactions.

H1e: Decreasing a citizens' **perceived fear** (IV) increases their **intention to adopt** (DV) E-Commerce.

#### Perceived risk model

H3a: A citizens' **security-specific awareness** of E-Commerce influences their **perceived risk** (DV) of making E-Commerce transactions.

H3b: A citizens' **specific awareness** of E-Commerce influences their **perceived risk** (DV) of making E-Commerce transactions.

H3c: A citizens' bad **Previous experience** (Independent IV) in E-Commerce transactions increases their perceived **risk** (DV) of making E-Commerce transactions.

H3d: A citizen's increased **perceived risk** (IV) increases their **perceived fear** (DV) of making E-Commerce transactions.

### 3.5.2 Security

#### Background

Security is a way of protecting and preventing the details of an individual customer who carries out transactions from fraud that may occur within an organisation, and also fraud due to identity theft [182]. Customers may not be willing to transact online due to fear of stealing individual financial information. Security technology and architecture are some of the most researchable topics in the E-Commerce field. Also, there are issues of security and privacy challenges in integrating the Internet of Things (IoT) with E-commerce [183].

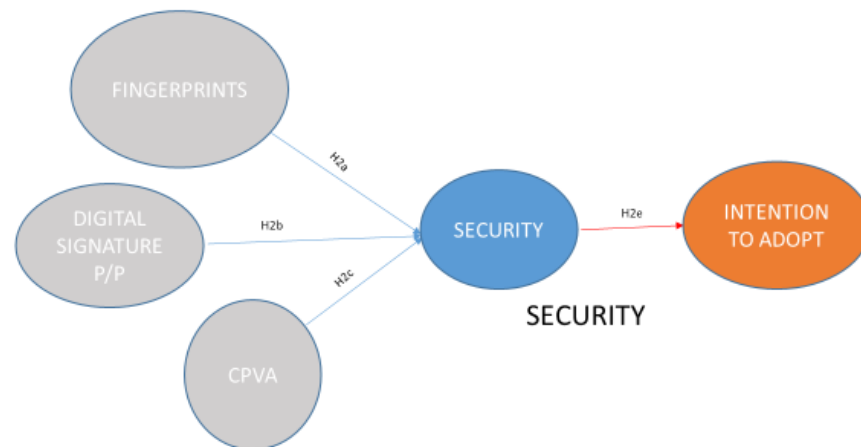
Digital Identities are being stolen daily through the use of vulnerable authentication methods, e.g. IoT devices are often hacked due to poor security methods [184]. The area of concern in security technology is the architecture and network. Studies reveal that further improvements are required in the electronic security architectures to increase E-Commerce trust through personal authentication [20], [185]. Other research has shown that security affects E-Commerce adoption [55].

#### Summary

Different methods of authentication using digital signatures have proved abortive or continue to be failing. Therefore, more needs to be done to have a secure and reliable authentication technique for E-Commerce, such as CPVA, that can command greater security leading to an increase in intention to adopt E-Commerce transactions.

## Model

Figure 3.2 proposes a security model to determine how security influences intention to adopt E-Commerce transactions. The security model has Fingerprint, Digital Signature, and CPVA as independent variables with associated hypotheses.



**Figure 3.2 Security Model**

## Hypothesis

Based on the model in Figure 3.2, the decision to transact online or not to do so is influenced by security concerns and leads to the following hypothesis.

### Perceived Security

H2a: The **Fingerprint** (IV) security authentication method leads to a citizen's greater sense of **security** in E-Commerce transactions.

H2b: The **Digital Signature** (IV) security authentication method leads to a citizen's greater sense of **security** in E-Commerce transactions.

H2c: The **CPVA** (IV) security authentication methods lead to a citizen's greater sense of **security** in E-Commerce transactions.

H2e: Greater **security** (IV) leads to a greater **intention to adopt E-Commerce** (DV).

### 3.5.3 Perceived Advantage

#### Background

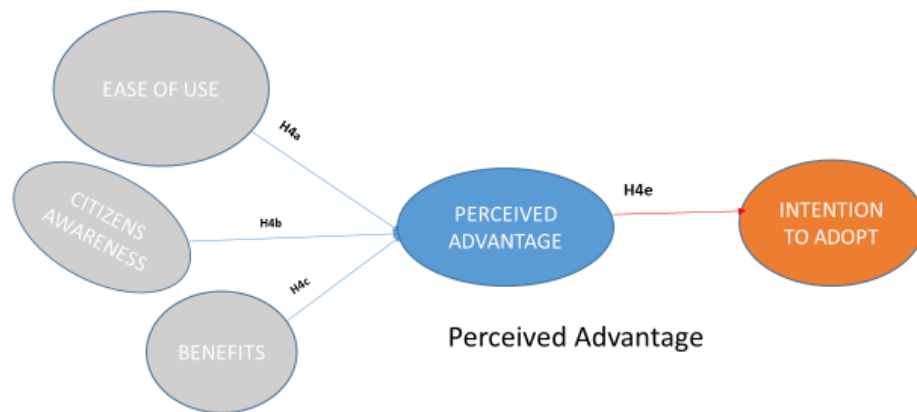
Perceived Advantage is said to affect the Technology Acceptance Model (TAM) of E-Commerce [55]. Many customers are worried when participating in an online payment system when using a credit card. Although, many systems have been built to guide against the pertinent ATM problems of fraudulent activities [186]. Meanwhile, many E-Commerce systems perform satisfactorily in the area of customer protection. Transactions are now simplified to a click of a mouse and this has helped in eradicating form filling. Payment of bills and other items online creates contingencies in the Electronic Payment System (EPS) [51]. Timing has been greatly minimised in using EPS than when using an existing payment method.

#### Summary

But there are many impediments associated with EPS and citizens have witnessed these in E-Commerce which reduced customers' Perceived Advantage.

#### Model

Figure 3.3 proposes a Perceived Advantage model to determine how ease of use, citizens' awareness, and perceived benefits could influence intention to adopt E-Commerce transactions.



**Figure 3.3 Perceived Advantage Model**

#### Hypothesis

Based on the model in Figure 3.3, the decision to transact online or not to do so is influenced by Perceived Advantage concerns and leads to the following hypothesis.

### Perceived Advantage

H4a: **Ease of use** (IV) of E-Commerce technology leads to a greater **perceived advantage** (DV) in using E-Commerce transactions.

H4b: **Citizens' awareness** (IVs) of E-Commerce technology leads to a greater **perceived advantage** (DV) in using E-Commerce transactions.

H4c: **Benefits** (IV) of E-Commerce technology leads to a greater **perceived advantage** (DV) in using E-Commerce transactions.

H4e: If a citizen **perceives an advantage** (IV) to using E-Commerce transactions this will increase their **intention to adopt E-Commerce** (DV).

### **3.5.4 Trust**

#### **Background**

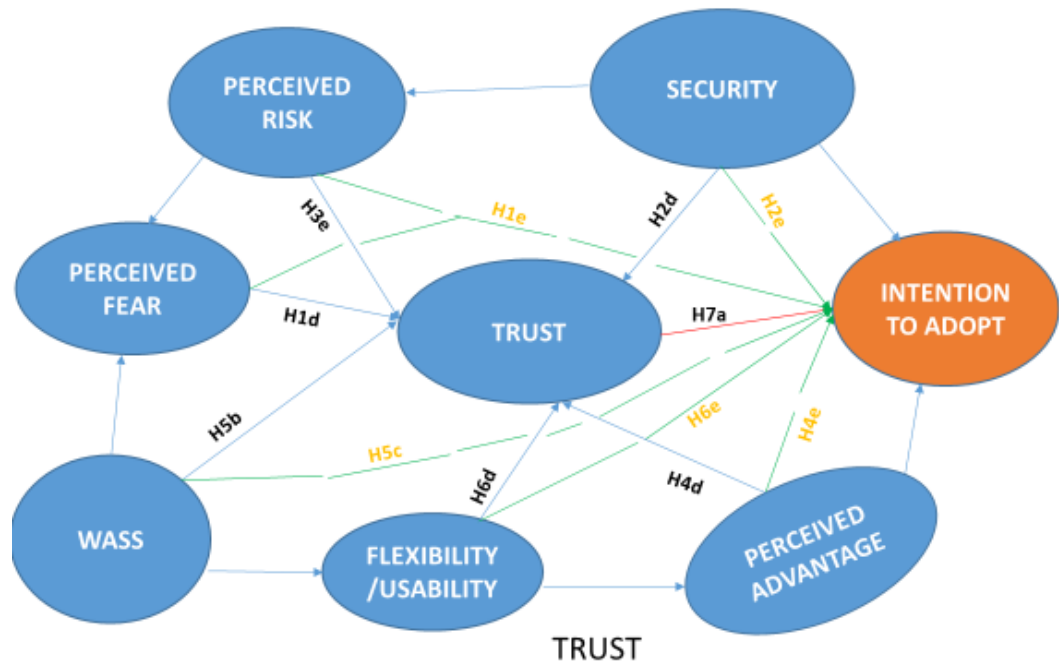
Trust is important in any transaction, more importantly in an online transaction. Customer confidence is very important in E-Commerce where the personal identification information is involved. Customers must be confident in the E-Commerce system if personal financial information would be released for a transaction. In order not to be used against their interest. E-Commerce vendors such as banks and credit card companies must have a perfect system so that customers will believe in them so that their information will not be misused [20]. Research shows that EPS requires trust and user confidence, this will be one of the most successful contributing factors to E-Commerce success in developing countries [79]. A survey conducted by Abrazhevich found that systems that are not secure and reliable will not be used by customers. Other findings establish that the influencer of intention to adopt E-Commerce transactions is credible EPS [20], [55], [79].

#### **Summary**

Therefore, high levels of consumer trust may lead to a high degree of purchase and increase the intentions of consumers to patronize E-Commerce.

#### **Model**

Figure 3.4 illustrates the trust model of the dependent variables and proposes a Perceived Advantage model to determine how these intermediate/dependent variables could influence intention to adopt E-Commerce transactions.



**Figure 3.4 Trust Model of Dependent Variables**

### **Hypothesis**

Based on the model in Figure 3.4, the decision to transact online or not to do so is greatly influenced by Perceived Trust and leads to the following hypothesis.

#### *Perceived Trust*

H1d: Decreasing a citizens' **perceived fear** (IV) increases their **trust** (DV) in E-Commerce Transactions.

H3e: Decreasing a citizens' **perceived risk** (IV) increases their **trust** (DV) in E-Commerce Transactions.

H2d: An increase in E-Commerce **security** (IV) increases **trust** (DV) of making E-Commerce transactions by the citizen.

H4d: A greater **Perceived Advantage** of E-Commerce by the citizens lead to greater **trust** of E-Commerce Transactions.

H5b: The adequate use of **Web Assurance Seal Service (WASS)** (IV) increases citizens' **trust** (DV) in E-Commerce transactions by the citizen.

H6d: A greater **flexibility/usability** (IV) of an E-Commerce system leads to greater **trust** (DV) in E-Commerce transactions by the citizen.

H7a: Greater **trust** (IV) in E-Commerce transactions increases the **intention to adopt** (DV) E-Commerce by the citizens.



### **3.5.5 Web Assurance Seals Services**

#### **Background**

Web Assurance Seals Services (WASS) are methods to mitigate the risk perceived on any organisation's or vendor's credibility especially those that may involve in a virtual transition [2], [32]. The risks are mitigated and this can increase the intention to adopt online transactions [116]. For instance, consumer trust and confidence can be enhanced by Web assurance services and this may increase consumers' trust to release their information on credit card numbers during an online transaction. In other words, perceived security risk might be reduced.

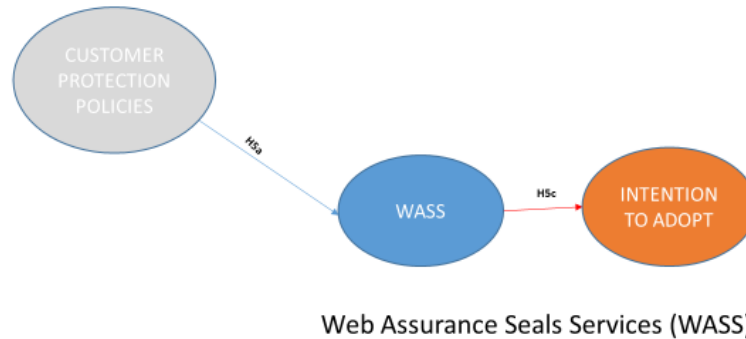
Purchasing perceived risk can be reduced with the involvement of third-party assurance seals [187]. Web Assurance Seal has been developed to reduce customers' concerns about security data privacy. The following are the Web Trust Web Assurance Seal that can be used on the internet: VeriSign, Trustee, and BBB Online [55]. E-Commerce assurance seals services are known as Web assurance services (WASSs) offered by a third party and agents that are certified (e.g., unions, accountants, computer companies, banks consumers, and for the Internet E-Retail sites. It is an indication that the site that has this sign on its website meets the required standards. In E-Commerce, the use of seal approval will increase the trust and the confidence of the user on a system [188]. This is due to the risk assessment that involves some payment features in giving personal and payment information [43]. A virtual transaction that involves a payment will be better using WASS. Hoffman et al have substantiated that consumer perceived risk can be reduced when the WASSs are seen on the vendors' website [32]. It is also used as a strategy where the vendor integrity is ascertained to customers, personal information is believed to be saved in such websites. Nikitkov and Bay discovered that online presence will increase the perceived risk of customers [98].

#### **Summary**

The perceived risk might be abridged by growing website trust and credibility using web assurance seals. Contrarily, WASS has not covered Africa and some other developing countries. The rate of the WASS logo that can be found on the Africans' website is very minimal [2], [189].

## Model

Figure 3.5 proposes a WASS model to determine how a Customer's Protection Policies could increase citizens' confidence in the E-Commerce system and influences intention to adopt E-Commerce transactions.



**Figure 3.5 Web Assurance Seal Service Model**

## Hypothesis

Based on the model in Figure 3.5, the decision to transact online or not to do so is greatly influenced by Perceived Trust and leads to the following hypothesis.

### Web Assurance Seal Service (WASS)

H5a: An increase in **protection policy** (IV) increases the use of **Web Assurance Seal Service (WASS)** (DV) in E-Commerce transactions.

H5c: The use of **Web Assurance Seal Service (WASS)** (IV) leads to greater **Intention to adopt** (DV) E-Commerce transactions.

## 3.5.6 Flexible Procedures/Usability

### Background

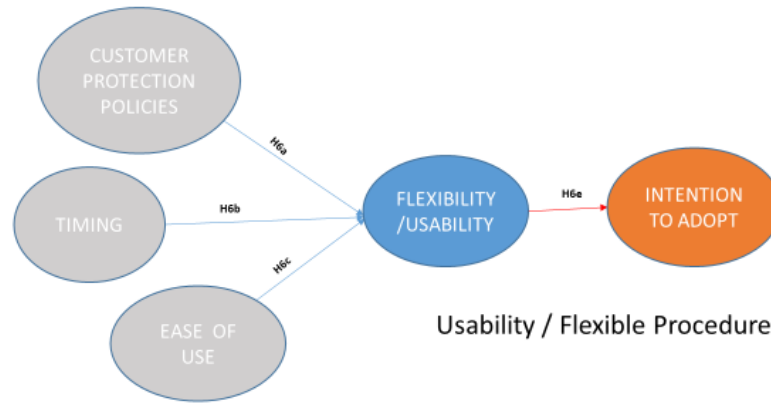
Transactions online ought not be a sophisticated complex job. It should be interactive and done in a user-friendly method. This transaction should be characterised by ease of use, flexibility, and simplified procedures. If payment and other services that are included in the entire E-Commerce process take much time and are complicated, this will discourage customers in E-Commerce participation. Adoption of an easy and few click approach for payments by E-Commerce operators will help customers in their authentication process.

### Summary

If customers' use of E-Commerce transactions is more convenient and they feel secure in their online transactions, there will be more adoption of E-Commerce [189].

## Model

Figure 3.6 illustrates the flexibility/usability model and proposes Customer Protection Policies, Transaction Timing and Ease of use could influence intention to adopt E-Commerce transactions.



**Figure 3.6 Usability Model**

## Hypothesis

Based on the model in Figure 3.6, the decision to transact online or not to do so is greatly influenced by Usability/Flexibility and leads to the following hypothesis.

### Usability/Flexibility Hypothesis

H6a: An increase in **protection policy** (IV) leads to greater **flexibility/usability** (DV) of E-Commerce transactions.

H6b: A decrease in **transaction timing** (IV) leads to greater **flexibility/usability** (DV) of E-Commerce transactions.

H6c: An **ease of use** (IV) of the E-Commerce platform leads to greater **flexibility/usability** (DV) of E-Commerce transactions.

H6e: A greater **flexibility/usability** (IV) lead to greater **Intention to adopt** (DV) E-Commerce transactions by the citizens.

In light of the above requirements (3.1 to 3.6), the following Figures 3.7 and 3.8 illustrate the research model block diagram and the research entity relation respectively.



The Research Model Block Diagram

**Figure 3.7 Research Model**

### 3.5.7 Performance Metrics Variables

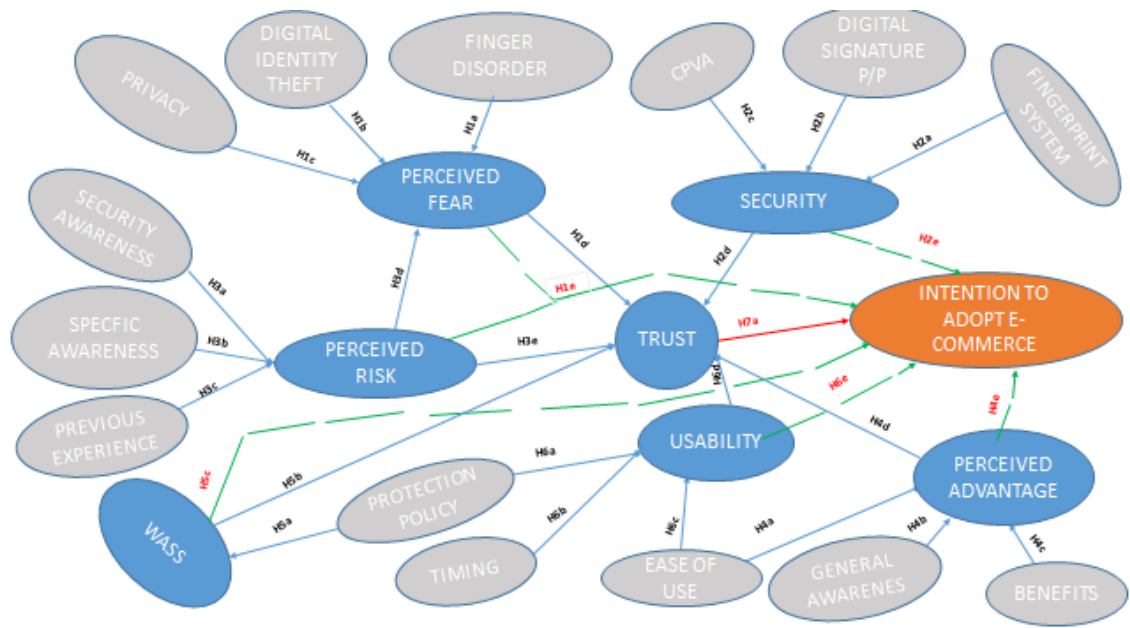
The performance metrics variables, described above are divided into 3 types as illustrated in Table 3.1:

**Table 3.1 Independent, Intermediate and Dependent Variables**

Independent Variables	Intermediate/Dependent Variables	Dependent Variable
a. Fingerprint Disorder b. Digital Signature c. CPVA d. Digital Identity Theft e. Privacy f. Security Awareness g. Specific Awareness h. Previous Experience i. Protection Policy j. Timing k. Ease of use l. General Awareness m. Benefits	a. Security b. Perceived Risk c. Perceived Fear d. WebAssuranceSealService (WASS) e. PerceivedAdvantage f. Flexibility/Usability g. Trust	a. Intention to adopt E-Commerce

### 3.6 Research Hypothesis Summary

The hypothesised relationships based on the models of dependent and independent variables described above are summarised in the research entity relation diagram in Figure 3.8.



**Figure 3.8 Research Entity Relation Diagram**

Table 6.17 in Chapter 6 relates all the hypothesis numbers with their independent and dependent variables to the resulting significance and effect sizes.

### 3.7 Chapter Summary

Chapter 3 focused mainly on the methodology and research technique used in this study. The survey method is quantitative in which the questionnaire (see appendix B) was used. The chapter also focused on model and hypothesis formulations. In general, the research design and other research concepts were discussed in this chapter. Therefore, the next chapter goes into experimental and architectural designs.

# Chapter IV

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## 4. Experimental Design

This chapter describes the experimental method that is designed to investigate the formulated hypothesis in chapter 3.

### 4.1 Design of Experiment

The experiment is designed to investigate the hypothesis formulated in chapter 3. The components of the experiential work described include:

- Description of an E-Commerce website scenario
- An illustration of security scenarios that include Digital Signature, Fingerprint Identification, and CPVA is a Design Fiction
- The sampling methodology
- The sample size determination
- The experiment methodology
- Design of the experimental sequence
- Design of the quantitative structure questions (items) to be tested in the pilot and the main study

This experiment involved taking an individual participant through scenarios that will explain the concept of the 3 security technologies chosen to investigate in this research work (Digital Signature, Fingerprint Identification, and CPVA).

The design of the experiment conducted in this research work focuses on reliability, proof of validity, and replicability. Issues, outlined in section 4.5.2 Experimental Factors, have to be addressed to carefully reduce the risk of error in measurement and ensure the validity of the independent variable. Also, it is very good and necessary to ensure documentation of the method is detailed. Archiving a level of statistical power and sensitivity is also important.

When experimenting, the scientific method has the following basic steps:

- Ask a testable question
- Collect your data based on the study design

- Get your result from the result analysis
- Publish your result with the research communities
- Replicate and store your result in a safe place

A key method implemented in the experimental design in this research work is the use of a Design Fiction to instruct experiment participants on the concepts of security in E-Commerce transactions [190], [191]. Other visionary forecasting methods that could have proved interesting include Science Fiction Prototyping and Imagination Workshop approach [192], [193], [194]. However, a Design Fiction approach has been chosen because a design fiction describes technology closer to existing technology capability, i.e., more believable as technologies that exist are included in the design fiction.

#### **4.1.1 Experiment methodology**

Design Fiction Prototyping started as one of the tools to help the engineering aspect of technologies with the sensitivity of what is happening in the society. Design fiction can describe a future technology that is realistic and close to the current environment. A developer can develop an informed and thoughtful understanding of how future technology is to work or behave. The methods presented in this research are about promoting innovative thinking that can lead to business innovation, product, technology, and with people in the nearest future [194]. Design fiction has the potential to play a strategic role in creative thinking and innovation promotion, by making visions of the future from people of different areas of business and societies. A design fiction methodology is designed to exercise ideas for business, a tool to design scenarios, technology innovations explanations for customer's consideration [193].

A research model was formulated in the previous chapter that has a set of dependent variables and independent variables. This experiment is designed to test how the independent variables (intermediate variables are also really independent variables with the dependent variable) discussed in chapter 3 influence the intention of citizens of Nigeria to adopt online transactions in E-Commerce (i.e., the dependent variable being 'intention to adopt' E-Commerce transaction). The independent variables are factors that determine the intention of E-Commerce adoption in Nigeria. One of the key issues of concern is security, which contributes significantly to the adoption. Also, the experiment is meant to show the relationship between other intermediate variables, which can also be

considered as dependent variables with other factors, see Figure 3.8, which describes the relationship between variables under investigation.

The following are the experiment's key aims and objectives. The research questions and the research model developed in this research work are the main aim and objectives of this work.

Investigating how the factors discussed in chapter 3 affect the intention of Nigerian citizens in E-Commerce adoption. For example, security is one main concern:

- Security Awareness leads to perceived risk and this leads to perceived fear. The perceived fear leads to the intention to adopt. That is, awareness of a lack of security (Security Awareness factor) features in an E-Commerce application leads to a Perceived Risk of using that E-Commerce application, which further leads to a Perceived Fear of losing identity information, or financial details, etc. which then reduces a citizen's Intention to Adopt E-commerce as a method of implementing online financial transactions. Therefore, the causes of huge fear and distrust for Nigerian citizens to adopt E-Commerce are targeted by this experiment.

Investigating those factors, which alleviates fears from the citizens. This experiment also targeted those dependent or independent variables.

- How a non-secure E-Commerce platform leads to a decrease in Trust (trust can be an independent, intermediate, or dependent variable depending on which hypothesis it is used in).
- How highly secure Authentication Techniques, e.g., CPVA, can lead to an increase in Trust.

#### **4.1.2 Experimental Factors**

In choosing the type of experiment suitable to investigate the research questions and the formulated hypothesis, many factors need to be considered. Below are the discussion topics when designing an experimental design. The following list illustrates issues that should be considered when experimenting.

- What number of factors does the design have, and are they fixed or random?
  - 14 Independent variables



- 8 Intermediate variables
  - 1 dependent variable
- What kind of control is required?
  - Gender is controlled to avoid gender bias in this research and also, avoid being served as a confounding variable.
- What kind of manipulation exists?
- What background variables are available?
- How many units of an experiment can be generalizable, do they have enough power?
- Then what is the sample size?
- Are interactions between factors Important?
  - Independent
  - Intermediate
  - Dependent
- Do delay effects have an influence on substantive factors on outcomes?
- Do response shifts affect self-report measures?
- What is proxy pre-test usage?
- Do variables have lurking?
  - Lurking variables are important explanatory variables that might well escape attention in a routine statistical analysis [195]
- Should conditions be blind to the researcher, client/patient, or even the analyst of the data?
- Do feasibility of subsequent application of different conditions to the same units?
- What is the number of control and noise factors that should be used?

### **4.1.3 Experimental Tasks**

The experimental task describes details of the activities or scenarios that will occur to test the hypothesis, research questions, and research model as discussed in chapter 3. In this research, the following are the experimental tasks that will be adopted.

## **Design Fiction Documentary**

Design Fiction is used to produce a documentary to educate the participants on the knowledge that need to know concerning the security architectures considered in this research. This will ease the determination of Technology Acceptance (AT) by the participants. In giving the research explained to the participants, the documentary method is more appropriate to give correct, concise, reliable, and constant information.

## **Shopping Experimental Task**

The simulated E-Commerce platform will be used by the participants to experience the shopping activities with the 3 authenticating techniques that this research work is addressing. This will enable the participants to be able to practically identify each authenticating technique and its identities as taught in the Design Fiction Documentary (DFD).

## **Survey (Questionnaire)**

A survey will be conducted as the third experimental task and a questionnaire will be used to get the research feedback from the participants. The questionnaire is very good to get the correct and unbiased response from the participants. An open-ended question that consists of 16 aspects was designed to cover every area of the research and to test the participant's understanding. A questionnaire of 200 questions item designed that consist of 16 sections which cut across all identifiable barriers, previous experience, and present level security and expectations from the proposed CPVA system. This questionnaire covers the following aspects:

- Demographic Data
- Previous Experience in Computer and Internet Usage
- Information about the Previous E-Commerce Experience
- Information about E-Commerce Awareness
- Statement about the Expected Benefits from using E-Commerce
- Statements about the simplicity of using e-commerce (Ease of Use)
- Statements about the E-Readiness and the quality aspects of E-Commerce systems
- The importance of providing the following necessary information in E-Commerce
- The importance of Web of Assurance Seal Services (WASS) and other e-commerce policies

- The importance of applying the following features in e-commerce schemes
- Statements about the reliability aspects in e-commerce (Trust)
- This part deals with complete user perception after the Design Fiction Documentary and Shopping in the E-Commerce environment
- User perception on e-commerce security
- This portion pacts with the potential for users to adopt E-Commerce.
- User Appraisal for New CPVA Authenticating Method in the Shopping Experiment
- Intention to Adopt E-Commerce Systems.

#### **4.1.4 Survey Administration**

The survey was used to collect data from participants administered manually and this task can only be done after the participant had already completed the first two tasks (Design Fiction Documentary (DFD) and Ecommerce Shopping Simulation Website). Each of these participants that completed the questionnaire will be given a token amount of money for the time spent. Therefore, the survey will be administered in the following ways:

##### **Data Collection**

The questionnaire that will be used to survey this research work will be manually distributed to the participants after completing the shopping experimental task to avoid the following problem or to achieve the following advantage.

- This will allow the fieldwork to cover a targeted audience and the impediments because the availability of the view computer system will not affect the research work.
- Manually distributed questionnaires will not let the participants be bored or tired on the computer because of the volume of the questionnaire.
- Manually distributed questionnaires will also save time because two or more participants could be given a questionnaire at the same time. While with the electronic distribution, participants will be delayed due to network problems in many areas where the experiment was carried out. This may result in the participants' time being wasted and many of them might withdraw their participation.

## **Data Entry**

Although manual data collection and manually transferring into digital Excel is prone to error the following methods have been considered to minimise the error reduction during the pilot studies and the main fieldwork in Nigeria. The two main operations performed on data entry are discussed in the following section.

### *Anonymization*

Data anonymization will be exploited with the use of an ID in which each participant's questionnaire will be uniquely identified for easy traceability. Although, each participant's data will be unidentifiable to conform to the ethics rules. Also, this will reduce data mismatch and data replication will be avoided.

### *Data Verification*

There will be a different person to verify the manually inputted data with the use of unique IDs to identify that the participant's response is adequately recorded.

## **4.1.5 Pilot Studies**

The experiment makes use of a few participants to test the strength of survey questions within Nigerian students that are in the University of Sussex. The results generated from the pilot studies were used to update the methodology, experimental, and questionnaire design. Before embarking on the main stage of fieldwork, the pilot study must be carried out. A pilot stage will ensure that:

- All the important points are included
- They are in the correct order
- Ambiguity is removed
- All sections are correct and in the right order
- Non-important cases are omitted

### **The First Pilot Study**

The first pilot study was done in the UK where Nigerian scholars in the University of Sussex were used to test the workability of the experimental scenarios. A total number of 40 students were used but only 34 were able to complete all the experimental tasks including the survey. All the completed participants' data were entered and computed. Many adjustments like time, an incentive to the participant, and the experimental

procedure. These changes were made to the experimental tasks based on the conduct and output of the pilot study conducted in the UK.

### **The Second Pilot Study**

The second pilot was conducted in Nigeria. This becomes important so that there will be a proper understanding of the background knowledge of the participants on computers, the Internet, and E-Commerce in general. It helped the researcher to know the weakness and strengths of the participants. 15 participants were used as a sample because of the short time between the second pilot study and the main fieldwork. In this sample 10 participants completed the tasks while the other 5 participants withdrew at one point or the other. The data of completed ones were recorded and computed to effect final changes to the experimental tasks. Changes were made like experimental timing and the rate of the tasks, increment to the incentive given to participants. This second pilot study helps in identifying and adjusting some pertinent factors that may likely affect the conduct of the main fieldwork.

## **4.2 Sampling Size**

There are factors considered in the chosen sampling size, the fieldwork was done across the middle class where citizens whose mode of work might also involve manual means. More than 85% of work in Nigeria is done by manual methods. Business, Good deliveries, farming, marketing, etc. are done using hands which involve fingertip usage and this probably leads to finger damage. Therefore, using the Fingerprint Identification system might be difficult for these sets of people which are attributed to fears in adopting E-Commerce. The sampling will cut across these categories of workers including students.

The study design affects the sample size in the research. Also, the sample size for the study increment leads to a power proportionate increment. In other words, the following had been put into consideration before arriving at the sample size [194]. Due to costs of fieldwork and engaging participants in the field, and given the nature of the research not being extremely critical the parameters for the sample size calculation are chosen (using one of many online sample size calculators) with a Confidence Level of 95%, where the CL springs the probability with which an estimated interval will comprise the true value of the parameter. Also, a Confidence Interval (CI) of about 10% is chosen where a CI is a kind of estimate calculated from the experimental data [196]. Further, given the

participant demographic is considering a wide range of occupations (discussed next) the experimental population can be taken as the population of Nigeria, 180 million (although this does not affect the sample size). This leads to a sample size of 96.

However, the sample size was over 200, but after withdrawals, etc. the final sample was 191 leading to a confidence interval of about 7%. The number of males may be equal or a bit different from the number of females to control the gender. For example, the Confidence Level of 95% in this research sampling shows that the researcher is confident that 181 samplings out of 191 estimates will fall between the upper and lower values specified by the confidence interval (7%). Table 4.1 shows the purpose, where the experiments were conducted by the researcher, and sampling descriptions.

**Table 4.1 Experiment Samples Description**

<b>Experiment Purpose</b>	<b>Participant/ where</b>	<b>Method/ Means</b>	<b>Sample</b>	<b>No of Completion</b>	<b>Purpose of the study</b>
1 <sup>st</sup> Pilot study	Sussex students (Nigerian citizen)	Experiment & survey (manually distributed)	40	34	To test and validate the experiment
2 <sup>nd</sup> Pilot study	Nigeria (Citizen)	Experiment & survey (manually distributed)	15	10	To understand the participants
Fieldwork	Nigeria (6 cities across 4 geographical areas)	Experiment & survey (manually distributed)	200	191	To gather the main primary data for this research work

#### **4.2.1 Participants Sampling**

This research is targeting professionals of the middle class who are believed to be the driver of the economy due to their daily involvement. These people are artisans, mechanics, farmers, miners, factory workers, businesspersons, etc. Although, many categories like entrepreneurs, civil servants, and students also practice farming as their second job or engage in other labour works like carrying a load, packing, and others which may even damage the fingertips. The research established that many students were denied by the Fingerprint attendance system due to a fingertip or any other reason. Therefore, the problem of Identity Theft that was reduced by the introduction of the Fingerprint Identification System was substituted by the Problem of High False Rate (HFR). Since

the experimental Strategy is by Design Fiction and Within Subject Design, therefore the previous experience may just be an added advantage but not a determining factor.

#### **4.2.2 Research Population**

Every participant must be a citizen of Nigeria since the research is to establish the intention of Nigerian citizens to adopt E-Commerce if more security and trust are built into Nigerian E-Commerce platforms. The sample population will be taken from 4 regions of the countries in schools, workshop places, bank premises, government offices, farming settlements. The research population will consist of males and females between the age ranges **of 18-60**. Random selections were used to select the subject in the experiment.

#### **4.2.3 Research Sampling Method**

In this research, simple random sampling was used in which, an equal chance is given to every individual in the target audience to be part of the sample. The major benefit completely is unbiased so that larger populates will be represented which is important in the presentations of the research results. The following are the advantage of using Probability sampling.

1. Randomly selected subjects or participants by the researcher has a higher representation of the whole population than nonprobability sampling.
2. The result extrapolation is good and useful in the chosen method.
3. Hypothesis testing is possible with Probability sampling.

The randomization principle is what probability sampling is based on. In this case, every entity has the means to be chosen as part of the sample. The idea and belief in this method signify that anyone chosen will have a good representation and the result drawn will be in the interest of the whole population be reliable. While non-probability sampling relies on the assumption that will be heavily characterized by the whole population.

### **4.3 Design of Experimental Task**

The experiment uses a within-subject design because it is economical to run and the method has high statistical power also.

### **Within-subject Design**

In this method of experimental design, the same group attends more than one experiment and can be established under all the settings. In Within Subject Design, individual differences are controlled and kept constant [197]. It achieves more statistical power and reduces the error of variance with a subject difference. Efficient in the way of subjects and lane.

### **Between Subject Design**

Each group of subjects is only under only one condition. Between subject designs of many experimental conditions, require the number of subjects multiply by that condition. Whereas the similar experiment conducted as a within-subject design needs only the number of subjects [197].

The problem of Fractional Factorial Design is that, if there is no group, there is a possibility of internal validity i.e. carryover effect can become a confounding variable. Using between Designs can reduce the carryover effect. More and higher statistical power can be achieved through Within-subjects designs.

#### **4.3.1 Design of questionnaire survey**

The items were piloted tested with 40 subjects by the Nigerian students at the University of Sussex to test the strengths and validation of the questionnaire. Then, the questionnaires were administered as fieldwork in 4 regional locations with 6 places in Nigeria.

#### **4.3.2 Design of Demographic questionnaire**

The questionnaire design is done to capture demographic data in section 1: this involves 8 structured questions. The structure adopted includes gender, age range, income level, Level of Education, Nationality, and Occupation.

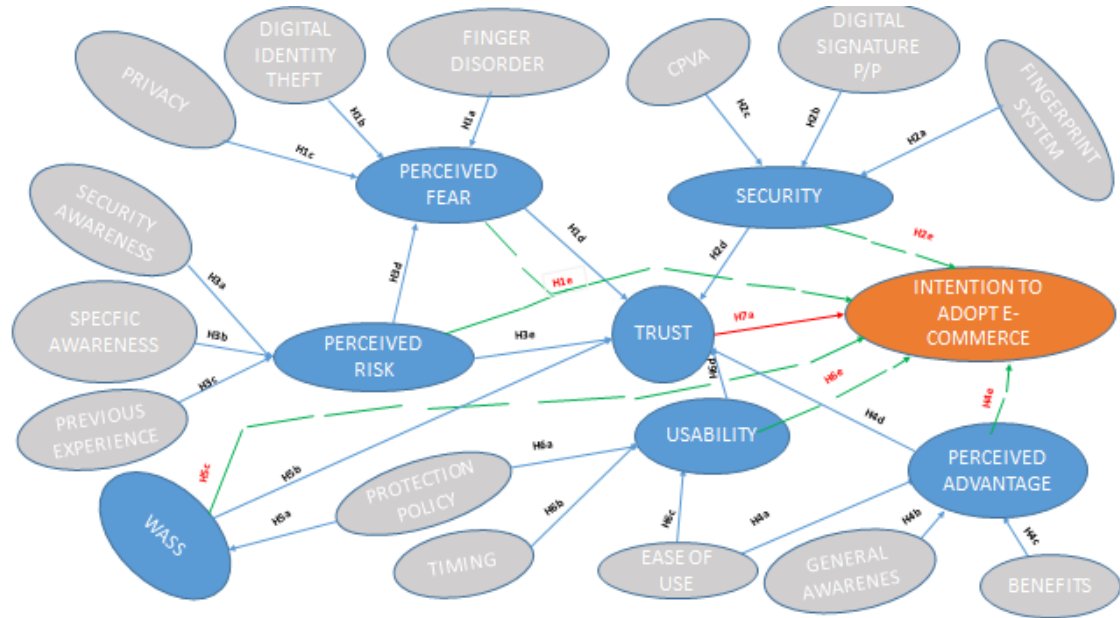
#### **4.3.3 Design of another post questionnaire**

The second section questionnaire of about 200 in 16 sections was designed to measure both dependent and independent variables used in this study. The structured question constructed in the second phase were from the secondary investigation from textbooks, journals, and findings from the publications. This generated questionnaire was developed from the theoretical framework.



#### 4.3.4 Research Independent Variables

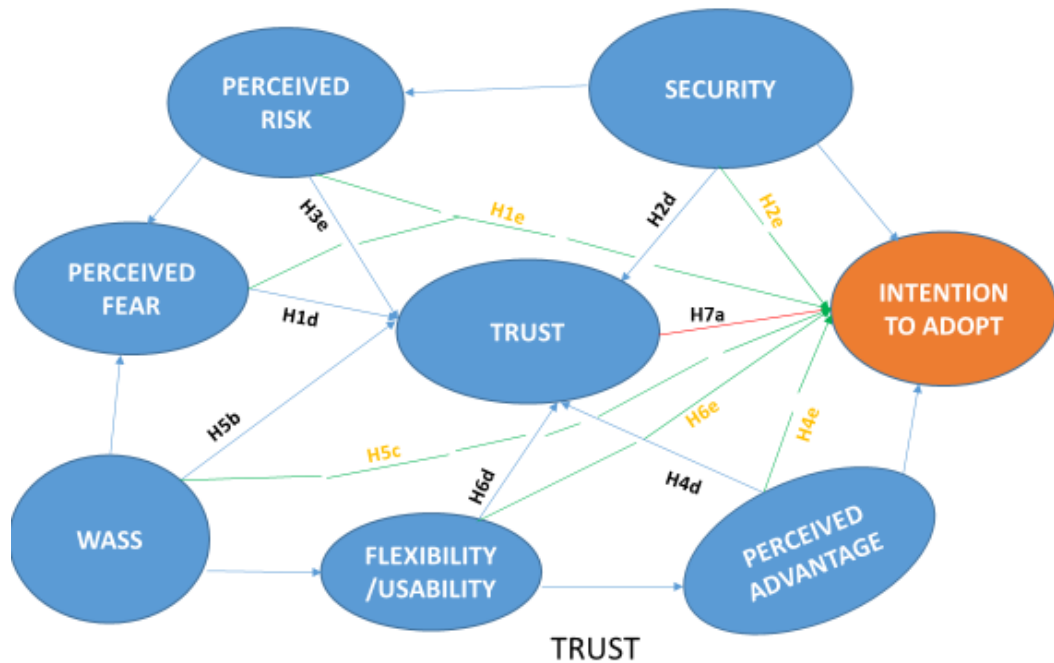
Independent variables are subjected to experimenter changes to test their dependent variables. It is the main reason for the experimental outcome. Observing from the model developed in the preceding chapter, there are fourteen independent variables in the research model illustrated in Figure 4.1



**Figure 4.1 Entity Relation Diagram – E-Commerce Adoption Model**

#### 4.3.5 Research Dependent Variables

The dependent variable is a kind of variable that relies on an independent variable. In the experiment, subject the independent variable to changes, the dependent variable is observed and recorded. When you take data in an experiment, the dependent variables are the ones to be measured. There are 8 dependent variables in this research, however, 7 can also be considered as intermediate variables, discussed above. Figure 4.2 illustrates the trust model of the dependent variable relationship as shown below.



**Figure 4.2 Trust Model of Dependent Variable Relationship**

## 4.4 Chapter Summary

This chapter presented the experimental design. In this experiment, the following are put into consideration: experimental methodology choice, sampling and sample size, experimental belief that the research sample will accurately represent the total population, and the result drawn will be accurate, structured with quantitative measurements.

The population for this research study includes farmers, traders, industry workers mining workers, and all of those who are involved in the manual labour that would have been potential adopters of E-Commerce.

Design of experimental includes available interface technologies integration to simulate the experimental conditions, a Design Fiction is used in building an explanatory procedure of this research work [197]. Then follow by Citizen Usability appraisal by carrying out shopping experimental task by using the Within Subject method with the participants.

# Chapter V

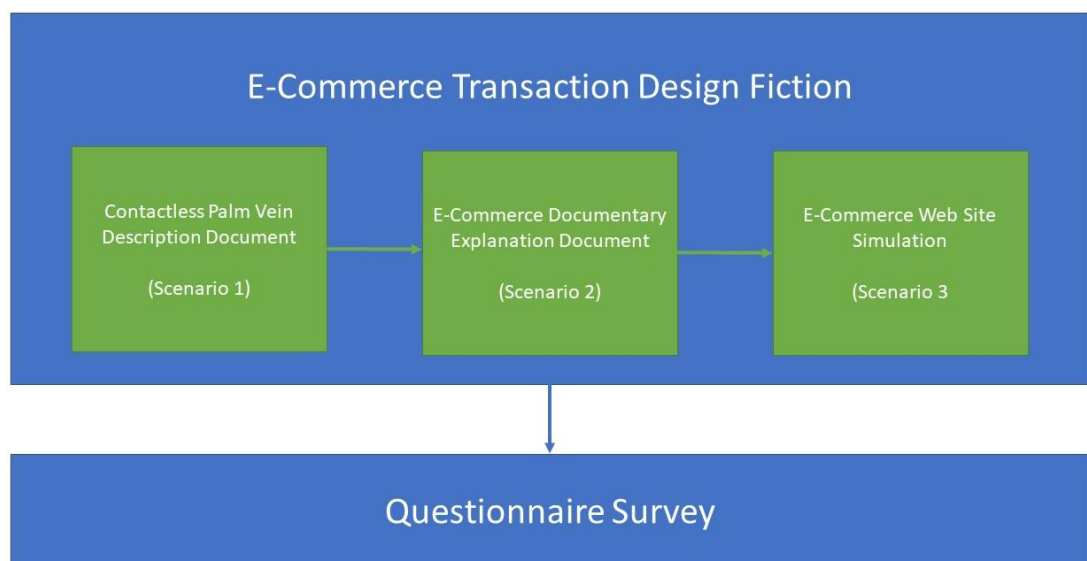
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## 5. Experimental Implementation

This chapter presents the experimental procedure conducted for both the pilot study and main fieldwork. The methods discussed in the previous chapter will be executed in the experimental procedure. In particular, the experiment implements a Design Fiction that is composed of three components:

- A description of Contactless Palm Vein Authentication methods in the context of other security methods such as Digital Signature and Finger Print Identification.
- An E-Commerce Documentary Explanation that describes how E-Commerce application utilizes authentication methods for online transactions.
- An E-Commerce website that simulates authentication methods including CPVA, Digital Signature, and Finger Print Identification methods with various tasks for the participants to complete.

Completion of the Design Fiction is then followed by the questionnaire to measure and test the hypothesis. Figure 5.1 illustrates the Design Fiction process followed by the questionnaire.



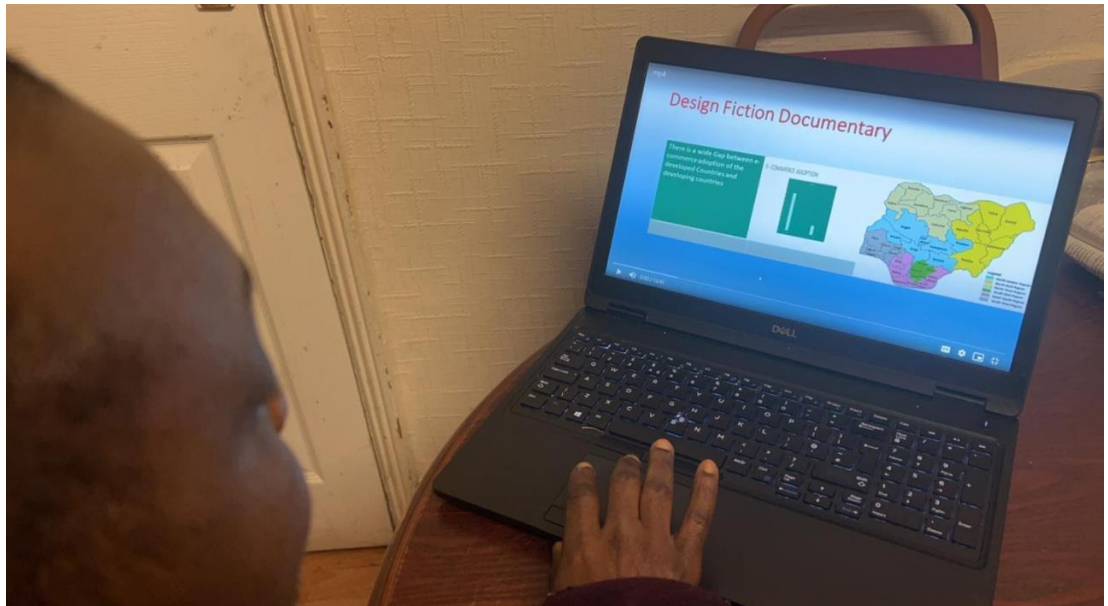
**Figure 5.1: Design Fiction and Questionnaire**

## **5.1 Experimental Task Execution**

An information sheet is provided to experimental participants and this document briefly introduces the purpose and objectives of this research work. It also conveyed the approval of this research by the science and technology cross-schools research ethics committee (C-REC). It emphatically states the procedure and sections that have to be taken by the participant. The consent form informed the participants that their participation is voluntary and any participant can withdraw at any particular time without giving any reason. The length of the experiment and the volume of the questionnaire are stated by the information sheet.

The experiment began by serving the participant with information and consent forms that have to be read and confirmed to be understood by the participants before continuing. Participants are also allowed to ask any question that is not clear to them. Participants have to sign the consent form and are given access to computers that are preloaded with the experimental tools. Experimental tools are the Design Fiction, which contains a documentary explanation (scenario 2), and an E-Commerce platform that simulates an online transaction environment (scenario 3) with CPVA, FPS, DS as security methods for comparison. CPVA characteristics are also described (scenario 1) in the context of other authentication methods.

Participants start and follow a defined procedure one step after the other. The first step to complete, after the information sheet and consent form, is to 1) observe the CPVA scenario, followed by 2) the Design Fiction Documentary, this is then followed by 3) engaging with the simulated E-Commerce solution experience, and finally 4) the participant completes the questionnaire. The below case scenario is used to show the order in which the participants must follow.



**Figure 5.2 Design Fiction Documentary [259]**

## **5.2 Experimental Tasks Using Within Subject Design**

Experimental tasks (Scenario 1, 2, and 3) are completed using a within-subjects experimental design simply because many useful data can be collected by using fewer participants. This makes the experimental design cheaper to run. To summarise, in this research work, 3 experimental tasks will be completed by all participants to test the efficacy of Contactless Palm Vein Authentication (CPVA) as a security authentication technique that increases intention to adopt E-Commerce transactions within the framework of the Technology Acceptance Model (TAM). These experimental tasks will employ the Within Subject Design method (WSD). WSD is known to have the benefits of higher statistical power, time, and is also more economical.

## **5.3 Use Case Scenarios**

There are 3 use case scenarios (i.e., CPVA description, E-Commerce Documentary Explanation, and E-Commerce Web Site) in this research work that is used to achieve the aim and objectives outlined in Chapter 1, and answer the research questions and hypothesis formulated in the research methodology, detailed in Chapter 3 and 4.

### **5.3.1 Scenario 1: CPVA Use Case**

The first use case scenario describes the architectural design of Contactless Palm Vein Authentication (CPVA) with the comparison of 3 algorithms used to achieve CPVA.

The nonlinear form CPVA algorithm was used to find the performance objectivity of each.

The 3 Algorithms are:

1. Kernel Principal Component Analysis (KPCA).
2. Kernel Independent Component Analysis (KICA).
3. Kernel Linear Discriminant Analysis (KLDA) [198].

Each of the above algorithms is computed to determine and evaluate the developed system using Training Time (TT), Recognition Accuracy (RA), False Acceptance Rate (FAR), False Rejection Rate (FRR), Recognition time (RT), and Equal Error Rate (EER). The main characteristics of these CPVA algorithms are described in the Design Fiction to the experimental participants to educate them on the efficacy of CPVA. The main characteristics of algorithms are described in the Design Fiction to the experimental participants to educate them on the efficacy of CPVA

Key CPVA Characteristics are:

- Non-Replication
- Liveliness
- High Accuracy
- Contactless [9] etc.

### **CPVA Framework**

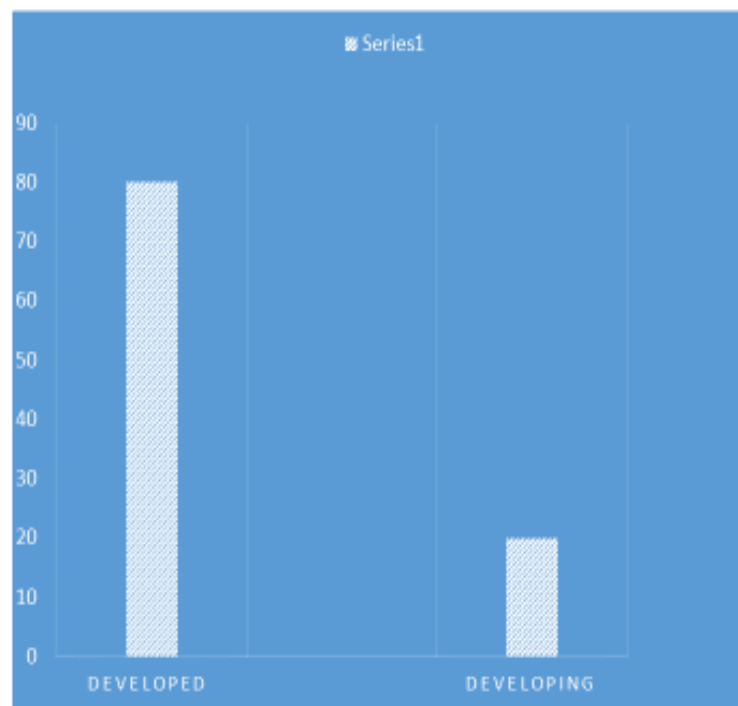
A typical CPVA framework is illustrated in Figure 5.2 which shows the key stages of vein image acquisition, feature extraction. The system framework architecture of CPVA was extensively explained in Chapter 2.

### **5.3.2 Scenario 2: E-Commerce Documentary Explanation Use Case**

The Design Fiction also contains an E-Commerce Documentary Explanation Scenario for explanatory purposes. The research model (Chapter 3) formulated to address the research questions and hypothesis of factors touching E-Commerce adoption in developing countries identifies Security as a major barrier that has to be well explained to the participants in lay person's terms. This will assist the individual that will participate in the survey to be familiar with the security problem, individual experiences, and the proposed solution.

This Design Fiction starts with an E-Commerce introduction, its concepts, and how its total adoption benefited the developed world. After that, the E-Commerce situation in developing countries (a case study of Nigeria), comparison of E-Commerce in terms of adoption and benefits are also explained. The Documentary continues by talking about the identified barriers affecting E-Commerce adoption in developing countries and highlights security as a major barrier.

The Design Fiction's Documentary Explanation scenario (DFD) continues with various figures to illustrate the topic of research. For example, Figure 5.3 shows the wide breach between the Developed and Developing Countries [199] and is used as one of the slide components on the DFD, which is also accompanied by a voice-over in English. English is a second language in Nigeria but is well understood by all participants.



**Figure 5.3 DFD slide showing the Wide Gap between Develop and Developing Countries [200]**

The DFD explanation continues by giving security tips on how the secure E-Commerce platform should be and the use of Digital Signature as an authenticating method in the daily financial offline and E-Commerce transactions. This now led to the vulnerability of the use of Digital Signature (PIN and PASSWORD) for authentication [202]. Digital Signature vulnerabilities lead to Identity Theft (shown in Figures 5.6 and 5.7, more slides used in DFD) which prevents citizens to adopt E-Commerce in developing countries. More so, different E-Commerce adoption on yearly basis is shown

in Figure 5.8. The identity theft rate analysis was also shown to the participants. Then how this identity theft leads to E-Commerce rejection is explained. Figure 5.4 shows E-Commerce security tips, again formatted as slides in the DFD. Note, the main formats used for the DFD were PowerPoint, videos, and text with voice-over composed into a multimedia presentation while Figure 5.5 shows a digital signature sample.



**Figure 5.4 Showing Security Tips for E-Commerce Website in the DFD [201]**



**Figure 5.5 Digital Signature Authenticating Techniques in DFD**



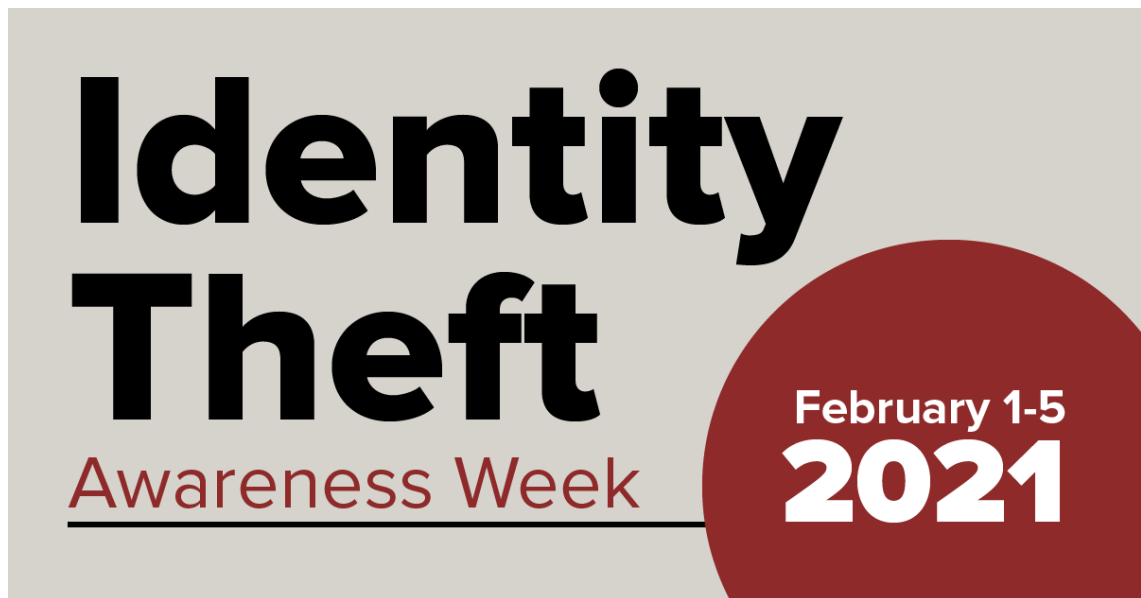


Figure 5.6 Showing the Identity Theft in DFD [203]

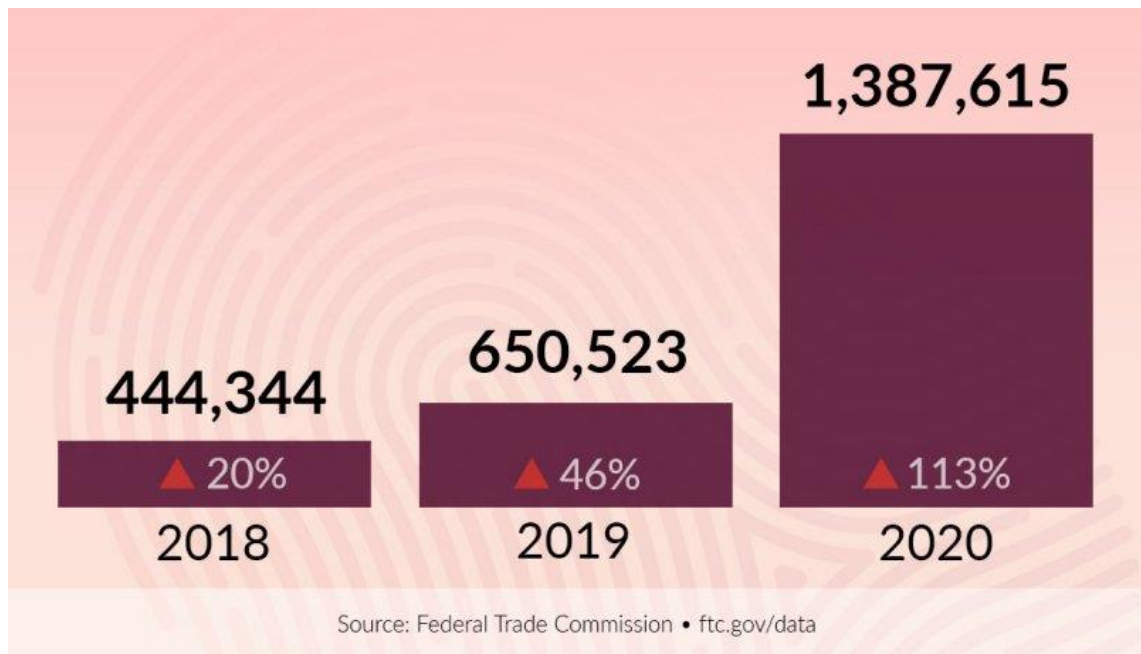
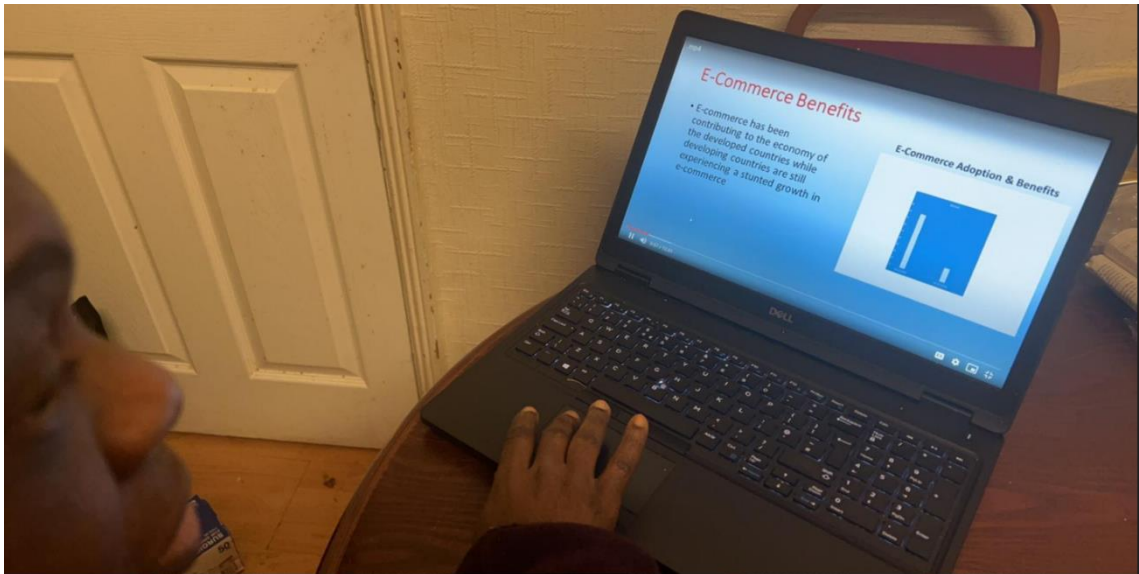


Figure 5.7 Showing the Rate of Identity Theft in DFD [204]



**Figure 5.8 Showing the Rate of E-Commerce Adoption between Developed and Developing Countries in DFD [205]**

The third aspect of this Design Fiction Documentary (DFD) explains Biometric Authentication and its' techniques (as shown in Figure 5.9) as a substitute for Digital Signature to prevent fraud in developing countries' E-Commerce. This examines different techniques of Biometric Authentication and discussed the Fingerprint Identification System (FIS) (as shown in Figure 5.10) for E-Commerce authentication. The introduction of FIS into E-Commerce for authentication in developing countries prevents fraud but is not effective as it often gives a High False Rejection Rate (HFRR), because of the fingertip damage as shown in Figure 5.11. Fingertip damage is common in developing countries, due to manual labour engaged (95% of the tasks) engaged with by the citizens. In light of this, the majority of citizens are declared as impostors during authentication. An example is seen in the use of FIS in the Joint Admission and Matriculation Board (JAMB) exam in Universities. Also, in the Electioneering process of the Independent Electoral Commission (INEC) where many registered voters were rejected due to Fingertip Damage. Many of these are witnessed in the daily financial activities (i.e. banks). Figure 5.12 illustrates biometrics authenticating devices that can be used for security authentication as explained in the DFD.

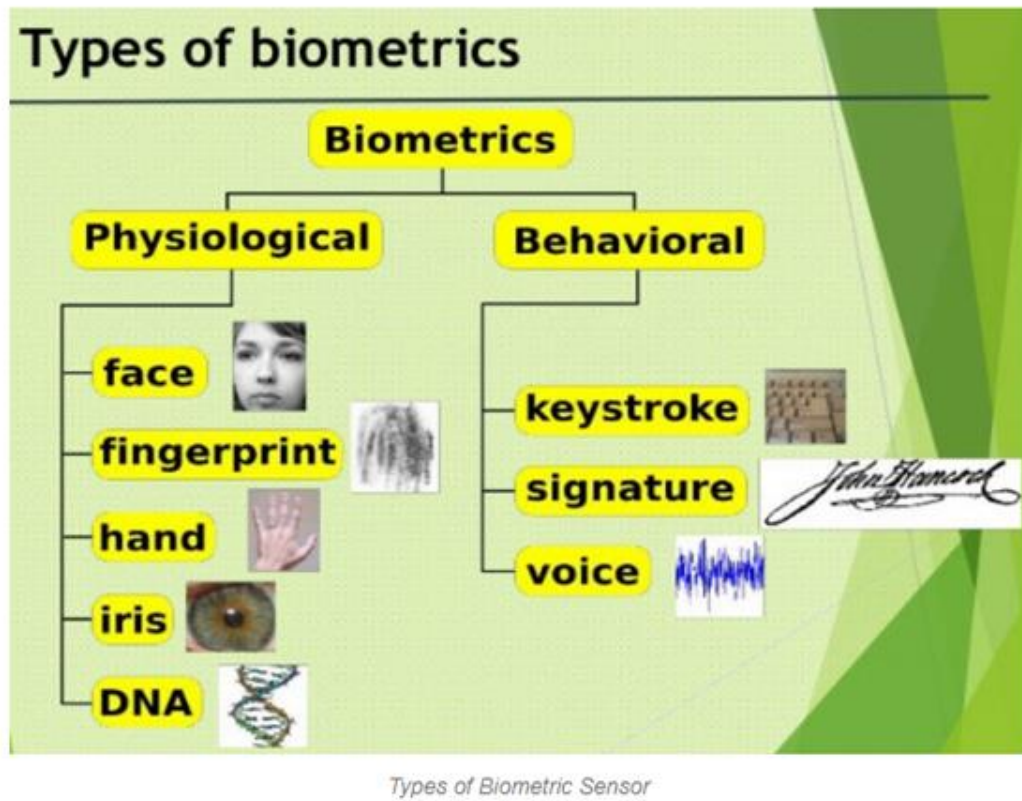


Figure 5.9 Showing Various Biometric Techniques in DFD [206]

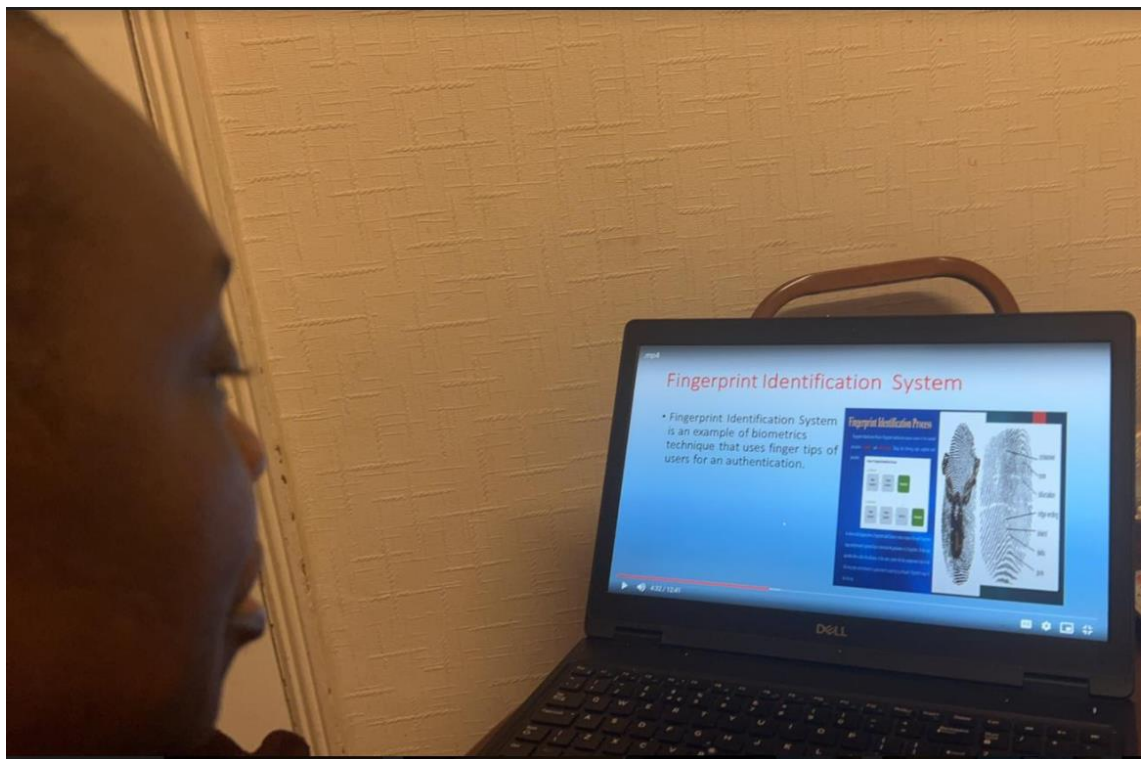
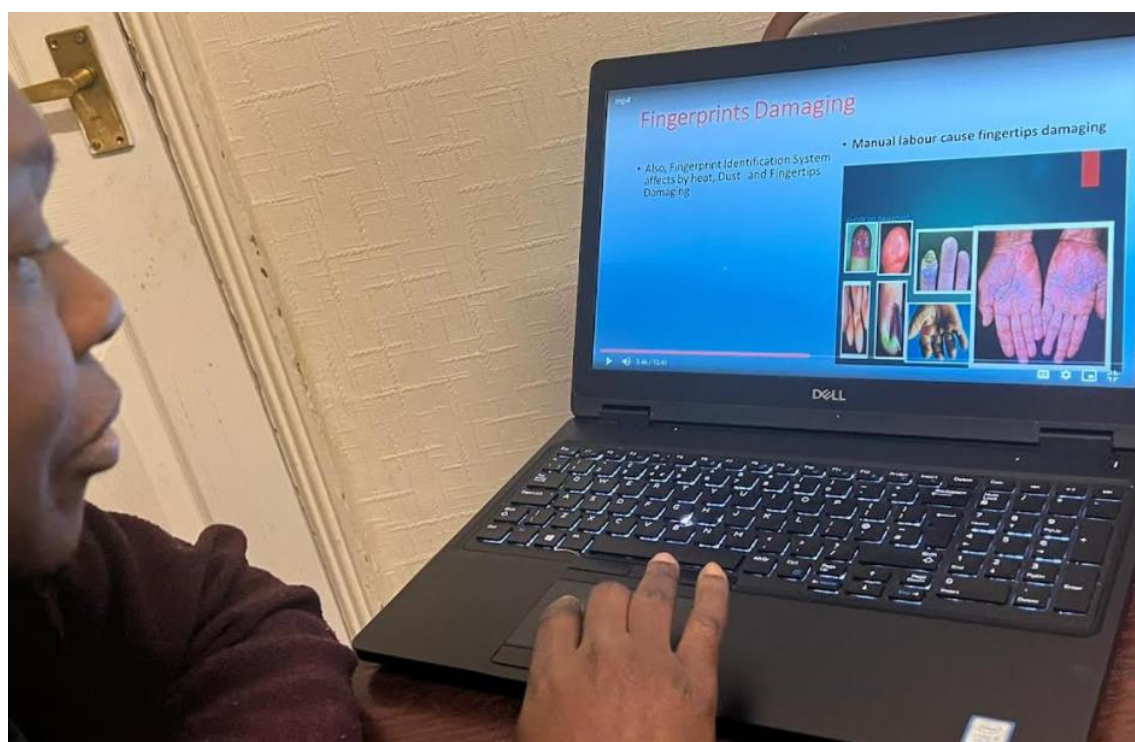


Figure 5.10a Showing Fingerprint Tips Identification in DFD

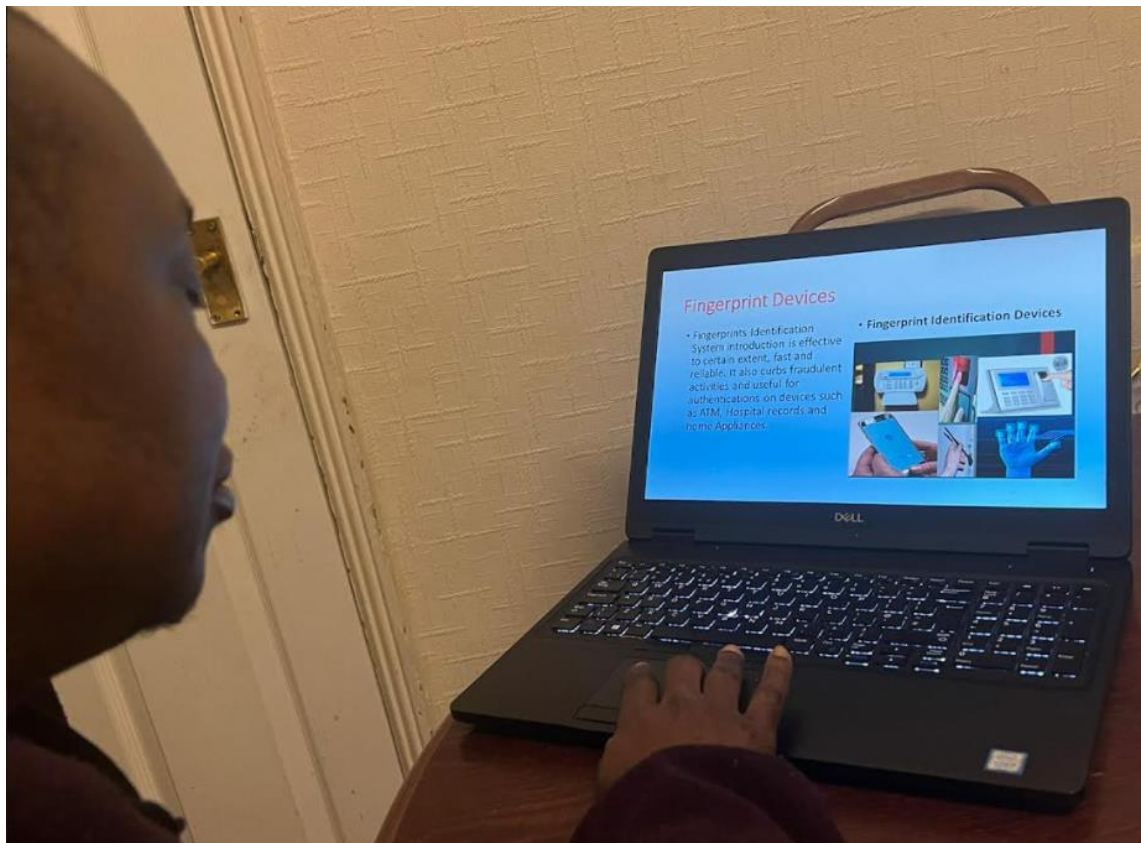


**Figure 5.10b Showing Fingerprint Tips Identification [207]**



**Figure 5.11 Showing the Fingertips Damaging in DFD [208]**





**Figure 5.12 Showing the Finger Devices in DFD [209]**

The last aspect of the DFD explains the proposed authenticating method in E-Commerce. Contactless Palm Vein Authentication (CPVA) is proposed to increase E-Commerce security in developing countries. This will override the current ineffectiveness of the Fingerprint Identifications System. The CPVA inner vein of the palm will be utilised for registration and authentication and this cannot be affected by the damage to the outer layer of the palm as a result of manual labour. How this is to be achieved is explained to the participants, CPVA benefits, its security strengths, and its application examples are also given in the documentary. Figure 5.13 shows Contactless Palm Vein Authentication Techniques while Figure 5.14 shows how CPVA Works, Figure 5.15 indicates a comparison between the biometrics Authentication Techniques, and Figure 5.16 illustrates the application of CPVA as all discussed in the DFD.

# PALM VEIN TECHNOLOGY

YOUR HAND IS THE KEY



P.PAVANA  
IIIrd CSE  
12AT1A0526

## Palm Vein Biometric ID

### Key Advantages

#### High Authentication Accuracy

- FAR: 0.00008%
- FRR: 0.01%



#### Non-Traceable and Non-Shareable Authentication Method

- Delivering unmatched security and privacy that is virtually impossible to forge

#### Non-Intrusive Interface

- Contactless solution that leaves no biometric fingerprints following authentication
- High level of user acceptance

#### Applicable to All Users with Virtual No Enrollment Failure

- Works regardless of ethnicity, age, and other demographical statistics
- Highly applicable to all users due to minimal impact from external factors (abrasions, dry skin, chemical damage, wearing skin lotion, etc.)

FUJITSU

M2SYS

Figure 5.13 Showing Contactless Palm Vein Authentication Techniques in DFD[210], [211]

## HOW CONTACTLESS PALM VEIN WORKS

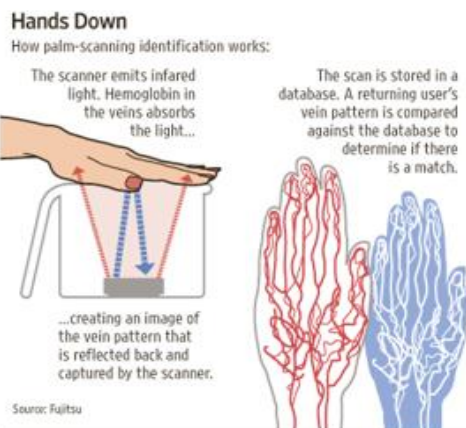
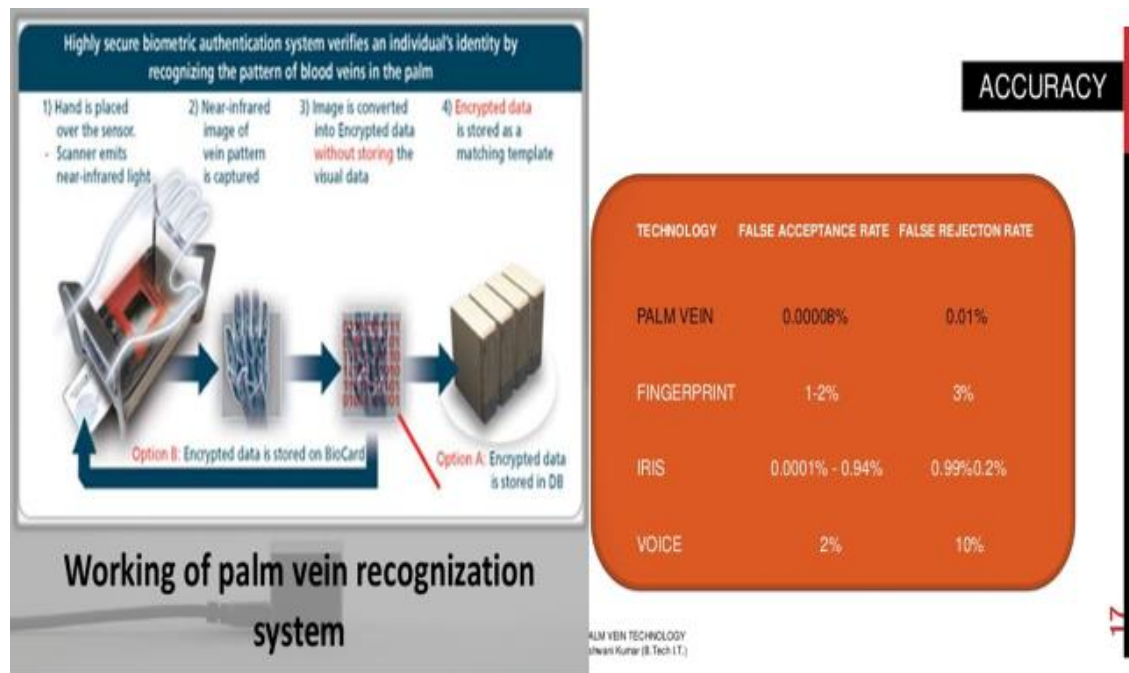
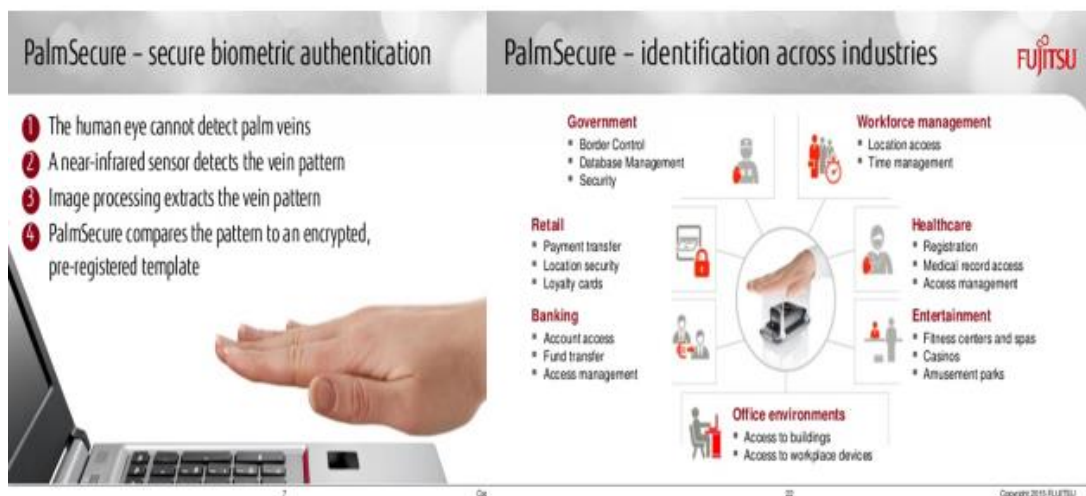


Figure 5.14 Showing how CPVA Works in DFD [15 ], [212], [213]



**Figure 5.15 Showing Comparison between Authentication Techniques in DFD [15], [115],**

## Using CPVA to Authenticate e-commerce transaction



**Figure 5.16 Showing Application of CPVA in DFD [214]**

As mentioned above, the DFD is made with animation packages, e.g. Adobe Acrobat Auditioning, and other recording devices. Design Fiction is a research method that is used to present the trend for future Technology Acceptance to the participants to create Technology Acceptance Awareness with the participants. The research has shown that Design Fiction has been yielding a good result in Technology Acceptance. The Design Fiction Documentary explained above takes 10 minutes for the participants.

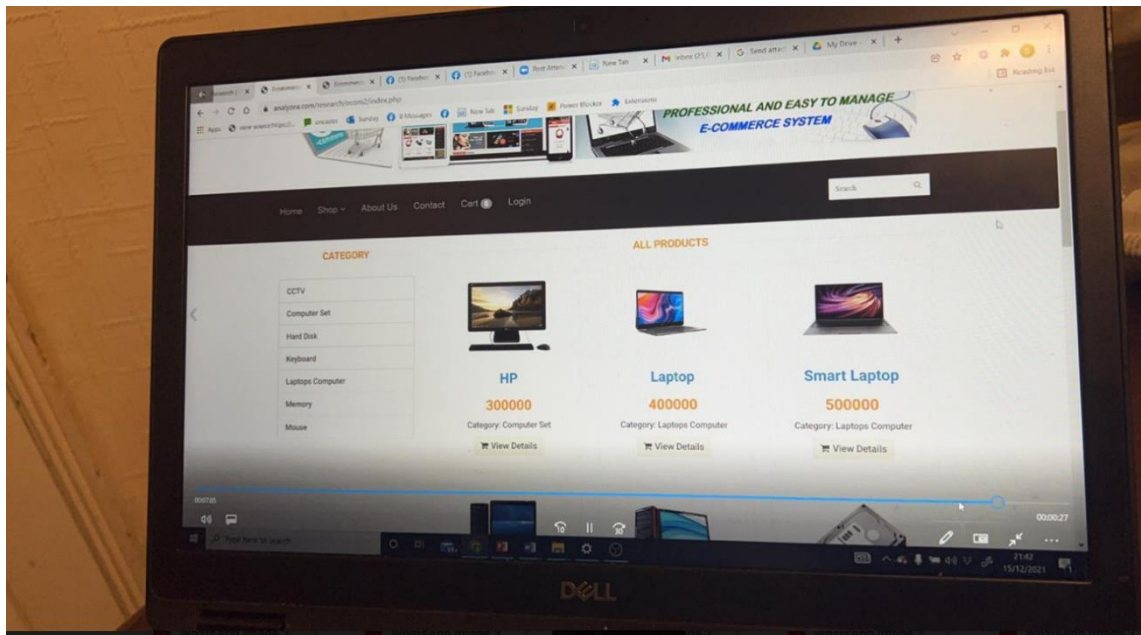
### **5.3.3 Scenario 3: Shopping Automation Use Case**

The last component of the Design Fiction is the E-Commerce shopping platform simulation that is developed to give the participants an idea of how authentication methods are implemented as described in the CPVA description and the DFD. Authentication is required in almost every area of life: Homes, Automobiles, Data protection (i.e. hospitals, exams, Banks, and Voting). Figure 5.17 shows the interphase of the simulated E-Commerce shopping platform. Citizens will not have adequate trust in online transactions if E-Commerce platforms are not adequately secured. This E-Commerce platform simulation is built for participants to register and undergo a shopping experience. The site stimulates the use of the 3 authenticating methods for their payment. This will allow the participants to have adequate practical knowledge of these 3 authenticating methods as opposed to theoretical knowledge delivered in the CPVA description (scenario 1) and the DFD (scenario 2).

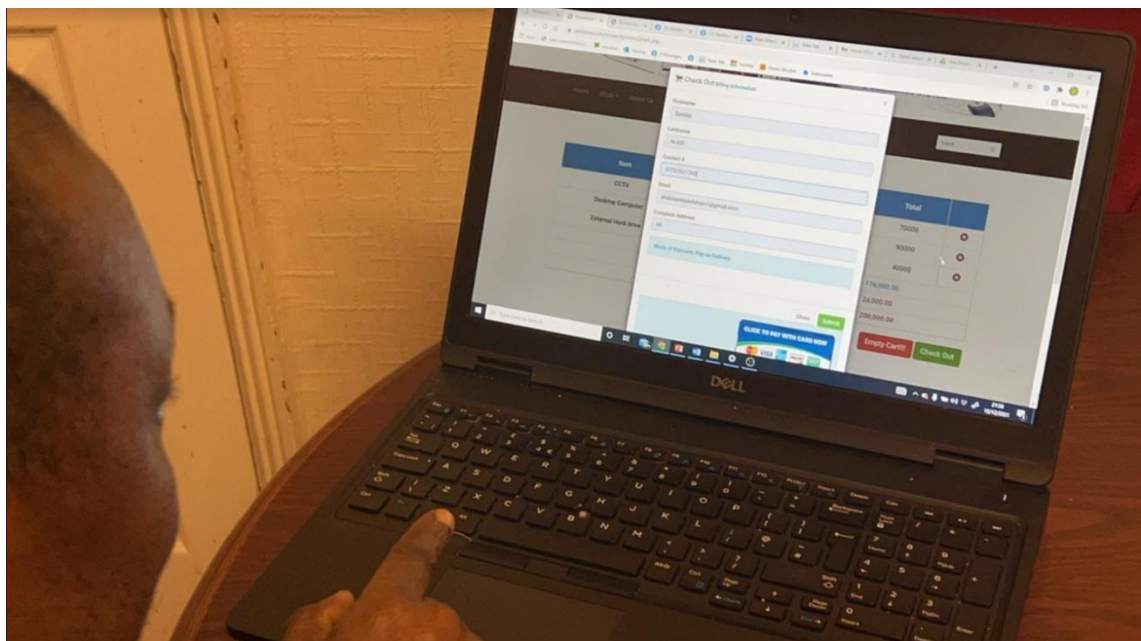
Based on this, the participants will have usability experiences to give adequate feedback in the survey that will be very useful and relevant for the Technological Acceptance Model and this research model. This E-Commerce platform simulation follows a normal E-Commerce website design that will take the data of buyers by registering before proceeding for shopping, which is good for security reasons. Nevertheless, you can check the various products with their prices without registration. After adding the products to your basket and checkout, then you can proceed to the payment after your satisfaction.

The transaction completion by payment for the purchase of the goods by the participants can be authenticated using the 3 authenticating methods described in this research work as illustrated in Figure 5.18 shows Digital Signature Authenticating Payment in E-Shopping Application Payment Section, Figure 5.19 indicates Fingerprint Authentication Payment in E-Shopping and Figure 5.20 shows CPVA Authenticating Payment in E-Shopping Application. This will give the participants the right motive thinking in their survey feedback. Again, the participants' usability experience is very important in giving feedback on Technology Acceptance. The third case scenario experiment will be conducted using Within Subject Design (WSD). The 200-structure questionnaire is used to test the willingness of the participants to use the authenticating techniques offer in the E-Commerce shopping application and hence a measure of their intention to adopt E-Commerce will also be tested.

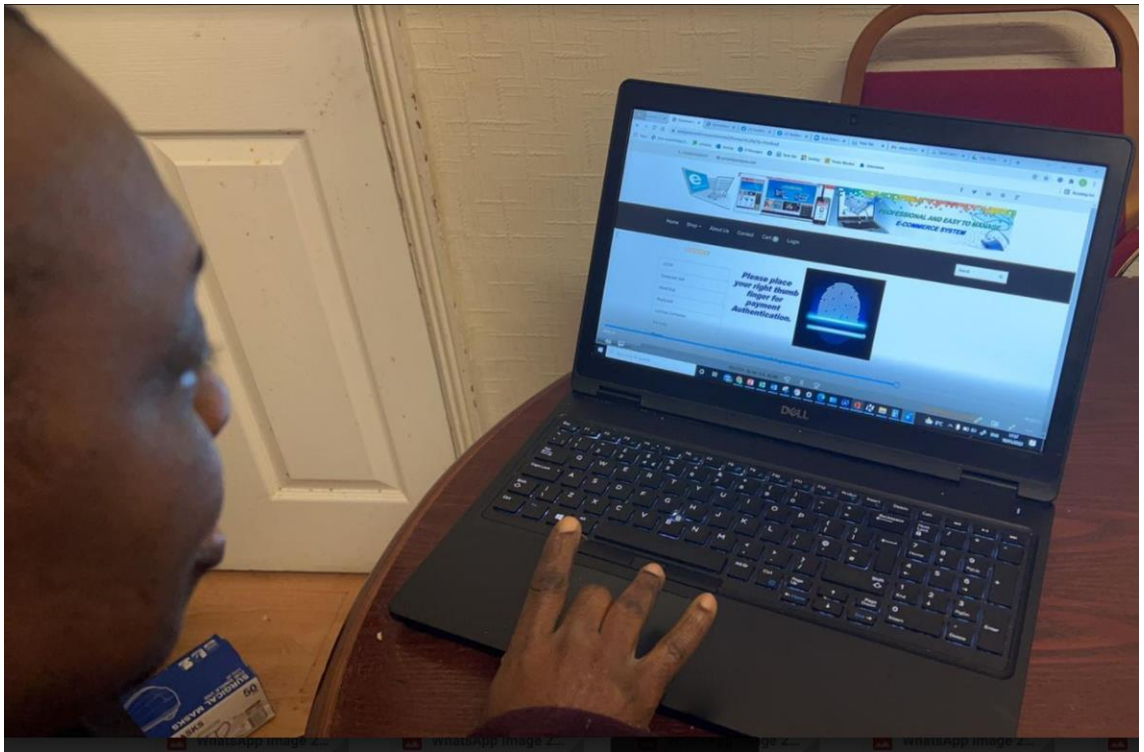




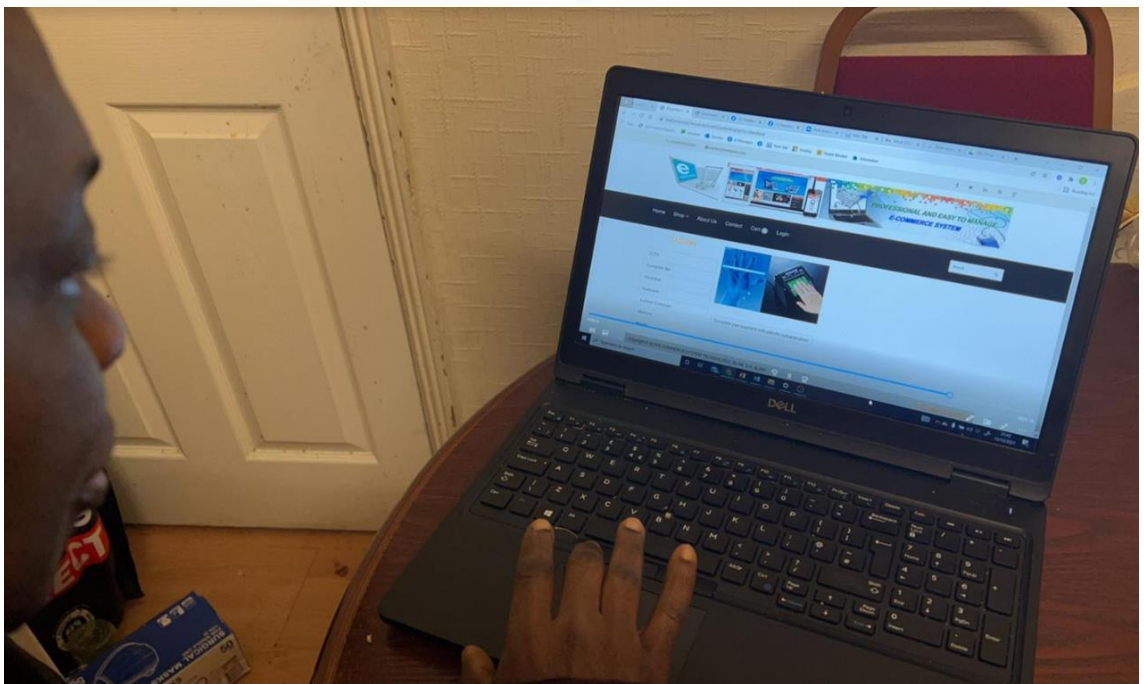
**Figure 5.17 the Interface of the E-Shopping Application**



**Figure 5.18 Digital Signature Authenticating Payment in E-Shopping Application Payment Section [215].**



**Figure 5.19 Fingerprint Authentication Payment in E-Shopping [216]**



**Figure 5.20 CPVA Authenticating Payment in E-Shopping Application**

## **5.7 Pilot Studies Results**

The first pilot study was carried out using sampling from citizens of developing countries in the UK mostly in the University of Sussex and the neighbouring

communities, the result was gathered and analysed to validate the experimental design and to see the direction of the respondent. Almost 40 participants were tested but 34 participants completed all the experimental tasks including the survey. Two third of the participants were citizens of Nigeria and others are citizens from other areas of developing countries. However, findings from the pilot study were used to validate the experimental design. Again, further reliability and clarity checks were done to the questionnaire to remove any ambiguity.

Also, the second pilot study was carried out in Nigeria, where few samples were considered to view the understanding and to know what could likely impede the commencement of the main fieldwork. A sampling of 15 participants was chosen. Invariably 10 participants completed their tasks while others withdrew. From the pilot study and the result analysed, I observed that more time was needed to be allocated to each of the experimental tasks and the DFD needed to be played according to an individual capacity. Therefore, I discovered that an individualistic approach to experimental equipment is very important for the coherency in the experimental performance [197].

The results of both pilot studies gave us an insight into the experimental strategical approach and helped in minimizing problems encountered during the main fieldwork.

## **5.8 Chapter Summary**

The experimental procedures were discussed in which 3 case scenarios were discussed. The CPVA description and DFD were used to educate the participants about the authentication techniques, their advantages, and their weakness. Again, the other experimental task involves using a simulated E-Commerce shopping website for the participants' e-transaction experiences and their various payment authentication techniques. Besides, the chapter also comprises a survey in the form of a questionnaire to get their responses from the experiment, which was done using Within Subject Design.

# Chapter VI

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## 6. Data Analysis

The previous chapter discussed the experimental procedure where the experimental setup and caring-out instructions are stated. Two experimental scenarios were used to measure the participants' observations on the security and the adoption of developing countries' E-Commerce and Nigeria as a case study. A questionnaire is used as a survey in getting the participant's response. In order words, data analysis will be discussed in this chapter and experimental data were collected from the participant who took part in the experiment.

The following operations have been applied to the data derived from participants for this research work.

**Data Cleansing:** this research work includes correcting omission, incorrect recording, and wrong data types entry.

**Outliers Detection and Treatment:** Outliers are data whose values are far away from other data values. The following were used to examine the outliers in this research work: mean, standard deviations, minimum and maximum values. Also, inter-item variance, covariance, and correlation were used to see the dispersed nature of the data. No outlier was found, maybe because the Likert scale that has the range of 1-Not at all to 5- Greatly were used and the Likert type is categorical. Therefore, it does not require any outlier treatment.

### 6.1 Research Variables

There are two kinds of variables that are measured in this research: Independent and Dependent variables [217]. An Independent variable is subjected to changes due to manipulations that occur in an experiment. The effect of this manipulation will be observed on the dependent variable [198]. In this research, a questionnaire is used to acquire the participant's response arranged in the following categories:

- Demographic data
- Citizens' experience on Computers and the Internet.
- Citizens' Previous experience in E-Commerce etc.

## 6.2 Data Analysis Type

The Data Analysis in this research is mostly based on Likert Scale data from scale 1 to 5. The first test that will be carried out is based on Descriptive Statistics where Central Tendency will be measured. Table 6.1 and 6.2 present the Descriptive Statistical Tests and Inferential Statistical Tests respectively. Inferential statistics are used to generalise the data about the larger population.

### A. Descriptive Statistical Tests

**Table 6.1 Descriptive Statistical Test**

Data Items Type	Central Tendency	Variability
Likert Type Scale	Median, Mode	Frequency, Standard deviation
Likert Scale	Mean	Variance

### B. Inferential Statistical Tests

**Table 6.2 Inferential Statistical Tests**

Statistics Type	Test Type	Test Function
ANOVA	T-Test, f	T measures the Strengths and the Directions of Dependent and independent variables.
Correlation	Z-Test, Chi-square, P-value	The dependent and independent variable's relationship can be measured.

### 6.2.1 Descriptive Statistics

In this research work, basic data features are described using descriptive statistics. Samples and the measures in the study are given in summary. It also gives graphics analysis and this serves as the basis of the analysis of quantitative data.

Descriptive statistics are describing what data does and what data is. That is, descriptive statistics describe what is going on in the data. It summarizes quantitative data in a presentable format. Central Tendency discussed further below is also used to describe what is going on in descriptive statistics.

## 6.3 Central Tendency

Central tendency measures a set of data by identifying the central position in the data using a single value. This can still be referred to as a measure of central location. They

are a part of summary statistics. The main examples of central tendency are: mean, median, and mode [218].

Although, each of these measures of central tendency is appropriate to use in one form another. For instance, data collected in this research, the use of mean will be appropriate to summarise the data behaviours rather than either the median or mode [219]. Below the measure of central tendency that may likely be used in this research work are described.

### **Mean**

The arithmetic mean can be referred to as the average of a set of data. Mean is commonly used in summarising the outcome of quantitative data. The mean can be referred to as the total sum of data outcomes in a distribution (of values) and divided by the number of outcomes. The mean (or average) is the most popular measure of central tendency. In probability and statistics, the population mean (of a probability distribution or random variable) is a measure (central tendency) of that distribution [219].

There are different ways to calculate the mean of a set of data. Although all the methods yield the same results for either arithmetic mean or geometric mean method. For example, the average mean of the participant's response collected during the fieldwork is calculated. Below shows a formula for the population and sample mean.

$$\text{Population mean formula } \mu = \sum \frac{x}{N} \text{ or Sample mean } \bar{x} = \frac{\sum x}{n} \quad [220] \text{-----eqn 1}$$

Where x is the value of each questionnaire item and N is the total number of values.

Summary of the mean generated in this research work is displayed in table 6.15

### **Median**

This is referred to as the middle number in a set of numbers or a group of numbers. This measure of central tendency will be applied to the Likert type of research data. Most of the data collected in this research have a middle number [219].

### **Mode**

In a set of data, the highest outcome data is known as a model [221]. Mode is the number with the highest frequency in the distribution. This can be seen in table 7.1

### 6.3.1 Demographic Data

Demographic data are a set of participants' (anonymised) identifiable data collected during the research work. The demographic data was collected using a questionnaire from the participants and this data include gender, age group, income level, marital status, occupations, and educational level. This data is presented using a frequency table 6.3 to table 6.10.

### 6.3.2 Frequency

In a set of data, the number of occurrences of a particular data in that distribution is known as frequency [219]. A simple Frequency Distribution table may be used to present the data in a summarized way. The percentage of other statistical tools like mean difference, correlation, and others.

#### Statistics

The following Table 6.3 described the summarised demographic data collected from the participants and this comprises of the following: Age, Income, Education, Nationality, Occupation, and Marital Status. Thus, the table simply shows data for all 191 participants is present, i.e., no data missing.

**Table 6.3 Participants' Demographical Data**

	<b>Gender</b>	<b>Age Group</b>	<b>Income Level</b>	<b>Education Level</b>	<b>Nationality</b>	<b>Occupation</b>	<b>Marital Status</b>
Valid	191	191	191	191	191	191	191
Missing	0	0	0	0	0	0	0

#### Frequency Table

The following tables summarised the fieldwork demographic data from participants' frequency distribution of individual values or ranges of values for a variable.

#### Gender

The Gender of the participants that participated in this research are presented in table 6.4 and this is based on the random sampling where every citizen is given an equal chance.

**Table 6.4 Participants' Gender Data**

	<b>Frequency</b>	<b>Percent</b>	<b>Valid Percent</b>	<b>Cumulative</b>
F	89	46.6	46.6	46.6
M	102	53.4	53.4	100



Total	91	100	100	
-------	----	-----	-----	--

### Age Group

The Age Group presented below in table 6.5 is collected from the participants and this group is perceived to be the most relevant in E-Commerce transactions.

**Table 6.5 The Participants' Age Group**

	Frequency	Percent	Valid Percent	Cumulative Percent
18-23	32	16.8	16.8	16.8
24-29	35	18.3	18.3	35.1
30-35	44	23.0	23.0	58.1
36-39	40	20.9	20.9	79.1
42-47	28	14.7	14.7	93.7
48-53	7	3.7	3.7	97.4
54-60	5	2.6	2.6	100.0
Total	191	100	100	

### Income Level

The Income level presented in table 6.6 shows the average income of citizens. It cuts across every aspect of the income that is available in Nigeria.

**Table 6.6 Participants' Income Level**

	Frequency	Percent	Valid Percent	Cumulative Percent
200k+	1	.5	.5	.5
100-200k	22	11.5	11.5	12.0
50-100k	66	34.6	34.6	89.5
20-50k	53	27.7	27.7	39.8
20k	29	15.2	15.2	55.0
Non	20	10.5	10.5	100.0
Total	191	100.0	100.0	

### Educational Level

The Education level of the participants in the research is presented in table 6.7 and this shows the set of education that citizens engaged in i Nigeria.

**Table 6.7 Participants' Educational Level**

	Frequency	Percent	Valid Percent	Cumulative Percent
Bachelor	63	33.0	33.0	33.0
Diploma	67	35.1	35.1	68.1
High School	40	20.9	20.9	89.0
Master	21	11.0	11.0	100.0
Total	191	100.0	100.0	



### Nationality

The demographic data collected on the nationality were able to reflect the case study, which is Nigeria, and only a few that are non-Nigeria as shown in table 6.8.

**Table 6.8 Participants' Nationality**

	Frequency	Percent	Valid Percent	Cumulative Percent
Nigeria	188	98.4	98.4	98.4
Non-Nigeria	3	1.6	1.6	100.0
Total	191	100.0	100.0	

### Occupation

The citizens' occupation collected from the participant in this research is shown in table 6.9 which shows the various categories available in Nigeria.

**Table 6.9 Participants' Occupational Data**

	Frequency	Percent	Valid Percent	Cumulative Percent
Accountant	1	.5	.5	.5
Artisans	25	13.1	13.1	13.5
Business	64	33.5	33.5	47.1
Civil Servant	7	3.7	3.7	50.8
Cpt. Operator	1	.5	.5	51.3
Facility Mgt.	1	.5	.5	51.8
Farming	32	16.8	16.8	68.6
Industry	39	20.4	20.4	89.0
M. Worker	11	5.8	5.8	94.8
Pastor	1	.5	.5	95.3
Student	5	2.6	2.6	97.9
Teaching	4	2.1	2.1	100.0
Total	191	100.0	100.0	

### Marital Status

The participants' status collected during the fieldwork are stated in table 6.10 below:

**Table 6.10 Participants' Marital Status**

	Frequency	Percent	Valid Percent	Cumulative Percent
Married	117	61.3	61.3	61.3
Single	72	37.7	37.7	99.0
Widow	2	1.0	1.0	100.0
Total	191	100.0	100.0	

The next section discusses inferential statistical tools that are used in the data analysis of this research work. Each of these measures: strength, spread out of data, relationship, and the extent of the relationship.

## 6.4 Standard Deviation

The Standard Deviation refers to the way data is spread out. It also measures the dispersion in a given dataset by its mean. Standard deviation is known to be the square root of the variance [219]. For example, the spread of data in table 6.9 shows participant occupations that spread out from the Accountant, which is the least, to Business. In a given data set if the point is much away from the mean, it simply indicates that deviation is high within the data set; in order words, as the spread-out increases in the data, then the standard deviation also becomes higher. The dispersion signifies the measurement of how wide the data is; Standard Deviation can be calculated using the below formula,

$$s = \sqrt{\frac{\sum(x-\bar{x})^2}{n-1}} \quad [218] \text{ -----eqn. 2}$$

Where x is the value of each question given by the participant and n is the total number of values for all the questionnaire items to measure a particular factor.

The Standard Deviation derived from this research work is summarised and stated in table 6. 15.

### 6.4-1 Range

The range gives the rate of statistical dispersion when the central tendency is used or the degree to which spread occurs in the data. The range is mostly reported using a single number. The difference between the peak and the lowest distribution values gives us the range [219]. For example, the range of demographic data in table 6.8 between the Nationality of Nigeria and Non-Nigeria.

### 6.4.2 Variance

In the research, the variance is used to determine the relationship between individual numbers in a given data set. Given an added weight to the outlier in the research can be seen as a drawback when using a variance. Variance treats all deviations from the mean equally without minding their direction [222]. Variance is not easily interpreted in the research. It normally makes use of its square root which is the standard deviation in a given data set. The formula for population variance is written below:

$$\sigma^2 = \frac{\sum(x-\mu)^2}{N} \text{----- eqn.3}$$

Where ... N is the total number of participants, x is the value of each item of the questions in the questionnaire.

The summary of variance generated in this research work is stated in table 6.15.

### 6.4.3 Covariance

In the research, covariance is used to measure variables with different measurements of unit measure variables that did not have the same units of measurement. By using covariance, researchers will be able to know if the variable unit is increasing or decreasing. Although covariance does not have one standard formula therefore it is not easy to determine the level of togetherness movement in variables. Therefore, variance data cannot be compared with a different scale. The wide range of data that involves interprets to be difficult.

The covariance formula is stated below:

$$COV(X, Y) = \frac{\sum(X-u)\sum(Y-v)}{n-1} \text{-----eqn. 4}$$

In which, X and Y are random variables. For example, Covariance measures the total variation of two random variables from their expected values. Variables tend to move the relationship can be tandem or show an inverse when using covariance [223].

In a given set of data, large covariance signifies that variables have a strong relationship between them. The covariance generated in this research work can be found in the archive of this research.

## 6.5 Correlation

A correlation in the statistics can be referred to as a relationship definition between two variables. When correlation is applied in the research work, there will be a standardized interdependence measurement between two variables, and this will establish how closely these variables are. The essence of correlations in research is meant to determine variables that are connected in a given study. For example, an increase in ‘security’ is closely correlated to a decrease in perceived risk [223].

### 6.5.1 Correlation Type

The following are the type of correlations in the research:

## Positive Correlation

A relationship is said to be positive when an increase of one variable leads to the second variable's rise. Also, a decrease in the first variable will lead to the second variable's decrease. The occupations that have a greater increase in manual labour lead to an increment in fingertips damage. The occupation list can be found in table 6.9 above.

## Negative Correlation

A correlation is said to be negative if an increment in the first variable leads to a reduction in the second variable. It means the relationship between the two variables is in opposite direction. For example, an increase in identity theft will lead to a reduction in adopting E-Commerce. Another example of a negative correlation is that if the security level is increased, the crime rate will reduce.

## No Correlation

At times in the research or a given set of numbers, there may be no correlation between two variables. Any changes in one variable may not have any significant effect on the second variable. For example, an increase in the level of education may not have any effect on employment. The below formula is a simple formula to determine the correlation between two variables (x and y) in a relationship.

$$r_{xy} = \frac{\sum(x_1 - \bar{x})(y_1 - \bar{y})}{\sqrt{\sum(x_1 - \bar{x})^2 \sum(y_1 - \bar{y})^2}} \text{-----eqn. 5}$$

Where x and y are random variables.

### 6.5.1 Correlation Coefficient

Correlation Coefficient can be referred to as a way by which the relationship's strength and direction are represented numerically. Two variables that relate together have strength and direction of their relationship and it can be positive, negative, and no correlation. Correlation is said to be positive when one variable increment leads to the second variable's rise. Also, the decrease in the first variable will lead to the second variable's decrease. In other means, its correlation can be negative when an increment in the first variable leads to a reduction in the second variable. It means the relationship between the two variables is in opposite direction and there may be no correlation between two variables if any changes in one variable may not have any significant effect on the second variable.

The numerical representation of the correlation coefficient can be from positive to negative. A positive number greater or equal to one indicates a perfect relationship, while a positive number of 0.1 to 1.0 indicates a perfect positive correlation. The correlation measurement is determined by the correlation coefficient. The correlation values are -1 and +1. A perfect positive correlation is when the correlation coefficient value is 1. But in the opposite, the correlation coefficient is negative which indicates a negative correlation. If the correlation coefficient is smaller than one but still greater than zero, it specifies a less than perfect positive correlation. The higher the positive coefficient number of correlations the stronger the relationship between the two variables. The formula for the correlation coefficient is stated below:

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{(\sum x^2) - (\sum x)^2} \sqrt{n(\sum y^2) - (\sum y)^2}} \quad [224] \text{ -----eqn. 6}$$

The following are the significant differences between the correlation coefficient and covariance:

- Correlation value ranges between -1 to +1 while covariance values can be any.
- Between the two variables, correlation is more useful for determining the extent of the relationship than covariance.
- Covariance makes use of units while correlation doesn't have units.
- The mean or scale of the variable does not affect correlation.

## 6.6 Reliability and Validity Test

Reliability can be defined as the assurance of how reliable the test measurement is. Validity is very important when choosing a test. Validity refers to the characteristic that the test measures and how adequate the test measures the chosen characteristic in a given study. The following reliability test is used in this research work.

### Cronbach's Alpha

Cronbach's Alpha shows how reliable the test to use in a particular measurement is, In the research, high reliability indicates the acceptance and satisfaction in the result or job while low reliability signifies low satisfaction. Therefore, Cronbach's alpha is employed in this study to see if the survey used in this study is reliable.

The formula for Cronbach's alpha is written below:

$$\alpha = \frac{N \cdot \bar{c}}{\sigma + (N-1) \cdot \bar{c}} \quad [225] \text{----- eqn. 7}$$

Where N is the number of items and  $\bar{c}$  is average covariance among the items.  $\sigma$  is average variance.

However, the Cronbach alpha reliability test for each variable in this research is stated in table 6.15 in which each factor Cronbach Alpha is determined with their respective question items, but the entire study Cronbach's Alpha is displayed below in table 6.11.

**Table 6.11 The Research Reliability Cronbach's Alpha**

Cronbach's Alpha	No of participants
.976	191

### Standard Error

In the given research, standard error signifies how reliable the mean is, and a very small and negligible standard error shows the accuracy of the sample mean and reflects the actual population mean. Although a standard error can be experienced by using a larger sample [225].

The indication of the reliability of the mean is known as the standard error. When the mean is accurate, the standard error will be negligible and it is an indication that the sample mean is a true representation of the actual population mean. If the sample size is large, the standard error will be smaller. Although, SE is not directly affected by sample size [226].

The formula for the Standard Error is stated below:

$$SE = \frac{\sigma}{\sqrt{n}} \text{-----eqn. 8}$$

Alternatively:

Chimneys Standard Error estimate of the mean is:

$$S = \sqrt{\frac{\sum(x-\bar{x})^2}{n-1}} \text{-----eqn. 9}$$

Where x is the value of each item and n is the total number of the values given by the participant.

### 6.6.1 Skewness

Skewness can be referred to as the description and the measurement of symmetry in given population distribution. Any dataset in given research that has a skewness equal to 0 will be symmetrical. The relative size of the two tails is mainly measured by skewness. The below formula denotes skewness [226].

$$\alpha_3 = \frac{\sum (X - \bar{X})^3}{ns^3} \text{-----eqn. 10}$$

$$Skewness = \frac{n}{(n-1)(n-2)} \sum \frac{(X_1 - \bar{X})^3}{s^3} = \frac{n}{s^3(n-1)(n-2)} (S_{above} - S_{below}) \text{Skewness generated}$$

X is the random variable,  $\mu$  is the mean,  $\sigma$  is the standard deviation.

- normal distribution and any other symmetric distribution with finite third moment has a skewness of 0.
- A half-normal distribution has a skewness of below 1
- An exponential distribution has a skewness of 2.
- A lognormal distribution can have a skewness of any positive value, depending on its parameters.

The data collected in this research work can be found in the archive for this research.

### 6.6.2 Kurtosis

Kurtosis can be referred to as a measurement of the two tails' combined size. This measurement signifies the measurement of the probability of the two tails [227]. This value may be compared to 3 which is the value of kurtosis of normal distribution. If the value of kurtosis in a given study is more than 3, meaning that the dataset has heavier kurtosis than the number distribution. But if the kurtosis is smaller than 3, meaning that the dataset has a lighter kurtosis than the number distribution. Therefore, if the distribution is normal, the kurtosis will be 0. The peak of the distribution can be measured by kurtosis [228].

Below is the formula for Kurtosis:

$$\alpha_4 = \frac{\sum (X - \bar{X})^4}{ns^4} \text{-----eqn. 11}$$

$$Kurtosis = \left( \frac{n(n+1)}{(n-1)(n-2)(n-3)} \sum \frac{(X_1 - \bar{X})^4}{s^4} \right) - \frac{3(n-1)^2}{(n-2)(n-3)} \quad [197] \text{ ----- eqn. 12}$$

The Kurtosis generated for the dataset in this research work can be found in the appendix.

Where  $X_1, \dots, X_n$  are independent random variables,  $\mu_4$  is the fourth central moment and  $\sigma$  is the standard deviation.

### 6.6.3 Average inter-item covariance

The below table is to show how each question item interrelated to another. A covariance matrix with all non-zero elements shows that all the individual random variables are interconnected [229]. Variables are correlated both directly and indirectly with internal other variables respectively.

This can be referred to as a measurement of how much the items vary together based on their average. A table is used to generate the items and the last number is the alpha in the dataset and this is internal consistency standard measurement [150].

Below is an example of a generated table of An Average inter-item covariance the last number that will be used as a standard measurement is 1.454 of EI8 and this is the standard measurement for this dataset as shown in table 6.12.

**Table 6.12 The Sample Result of the Inter-Item Covariance Matrix**

	E11	E12	E13	E14	E15	E16	E17	E18
E11	1.197	.788	.372	.237	.239	.265	.204	.357
E12	.788	1.493	.496	.282	.238	.571	.544	.499
E13	.372	.496	1.207	.693	.613	.524	.599	.462
E14	.237	.282	.693	1.319	.885	.687	.600	.528
E15	.239	.238	.613	.885	1.224	.805	.629	.485
E16	.265	.571	.524	.687	.805	1.585	.990	.900
E17	.204	.544	.599	.600	.629	.990	1.438	.987
E18	.357	.499	.462	.528	.485	.900	.987	1.454

An Average inter-item covariance for this research work is summarised in table 6.14.

### 6.6.4 Average inter-item correlation

Average inter-item correlation is a way of analysing internal consistency reliability. It is meant to check, for example, that an individual question (item) is consistent and gives an expected contribution with other questions in measuring the general variable and



construct meant to measure [150] belonging to a particular hypothesis. Items that are to measure the same idea are checked maybe they give the same result [230]. For example, 8 number question items are measuring a computer and Internet usage previous experience in the survey used in this research work. The test reading ability and test reading comprehension may be checked on the subject matter in the items survey questions.

An example of a table generating an Inter-Item Correlation Matrix is shown in table 6.13 below where the last number will be checked which +1 shows a perfect correlation between the intern-items.

**Table 6.13 Showing the Sample Result of Inter-Item Correlation Matrix for measuring computer and Internet usage previous experience**

	<b>E11</b>	<b>E12</b>	<b>E13</b>	<b>E14</b>	<b>E15</b>	<b>E16</b>	<b>E17</b>	<b>E18</b>
E11	1.000	.590	.310	.189	.198	.193	.155	.271
E12	.590	1.000	.370	.201	.176	.371	.371	.331
E13	.310	.370	1.000	.549	.504	.379	.455	.349
E14	.189	.201	.549	1.000	.696	.475	.436	.381
E15	.198	.176	.504	.696	1.000	.578	.474	.363
E16	.193	.371	.379	.475	.578	1.000	.656	.593
E17	.155	.371	.455	.436	.474	.656	1.000	.683
E18	.271	.339	.349	.363	.363	.593	.683	1.000

The Inter-Item Correlation Matrix number generated in this research work can be found in table 6.16.

Table 6.14 shows the sample results of summary item statistics that summarise, item means, item variance, inter-item covariance, and item-item correlation.

**Table 6.14 Showing the Sample Results of Summary Item Statistics**

	<b>Mean</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Range</b>	<b>Maximum/ Minimum</b>	<b>Variance</b>	<b>No of Items</b>
Item Means	3.189	2.812	3.455	.644	1.229	.033	8
Item Variance	1.365	1.197	1.585	.389	1.325	0.22	8
Inter-Item Covariance	.553	.204	.990	.786	4.860	0.53	8
Inter-Item Correlation	.404	.155	.696	.541	4.484	.025	8

## 6.7 Chi-square

In a given dataset, the relationship between two categorical variables can be determined by using a chi-square statistical method [231]. The chi-square informs researchers if there is a relationship between two variables using a single unit. Using chi-square in a given dataset, the researcher is comparing the expected values with the actual values collected. The choice of chi-square depends on the data collection method and the hypothesis tested. Meanwhile, each type of chi-square uses the same ideology. Appendix D shows the summary of the hypothesis test's result generated by the use of the Chi-square.

The Chi-square formula is stated below:

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E_i} \text{-----eqn. 13}$$

Or

$$\chi^2 = \sum_{i=1}^i \sum_{j=1}^j \frac{(A_{ij} - B_{ij})^2}{B_{ij}} \text{----- eqn. 14}$$

Where x is the value of the questionnaire (items).

Table 6.15 shows the summary of variables with their number of items, Cronbach Alpha, means a summary, standard deviations, and Variance generated in this research work.

**Table 6.15 Summarized Statistics Analysis of Results Table**

S/No	Variables	No of Item	Cronbach Alpha	Means	STD	Variance
1	E-CommerceUserEssentialInformation	8	.845	3.19	1.17	1.3689
2	E-CommerceAwawareness	18	.930	3.22	1.19	1.4161
3	E-CommerceBenefits	7	.828	3.84	0.98	0.9604
4	E-CommerceEaseOfUse	6	.770	3.63	1.00	1.00
5	E-CommerceReadiness&Quality	7	.768	3.37	1.48	2.1904
6	E-CommerceEsseantialFeature	7	.871	3.29	1.13	1.2769
7	E-CommerceReliabilityTrust	10	.859	3.20	1.08	1.1664
8	IntentionToAdoptE-Commerce	10	.870	3.96	0.97	0.9409
9	previous-CommerceExperience	26	.908	3.19	1.24	1.5376
10	UserAppraisaForE-Commerce	25	.887	3.53	1.16	1.3456
11	UserPerceptionOnCPVA	7	.872	3.91	0.90	0.8100

12	UserExperienceOnDesignFictionExperiment	10	.890	3.96	0.80	0.6400
13	UserPerceptionOnTheExperimentScenarios	34	.888	3.51	1.16	1.3456
14	UserPerceptionOnFingerPrint	7	.818	3.99	0.82	0.6724
15	UserPerceptionOnPinPassword	7	.835	3.88	1.01	1.0201
16	E-CommerceWebAssuranceSealServices	9	.888	3.33	1.08	1.1664
17	PreviousComputerExperience	10	.874	3.37	1.19	1.4161
18	UserAppraisalForCPVA	9	.840	3.96	0.90	0.8100
19	PerceivedTransactionTiming	3	.803	3.05	1.17	1.3689
20	IdentityTheft	3	.766	3.93	1.03	1.0609
21	FingerTipDamaging	4	.811	3.94	0.85	0.7225

Table 6.16 shows the summary of variables with their generated correlation, standard error, level of significance, and F value. These values represent the hypothesized results of this research work.

**Table 6.16 The Summarized Hypothesized Results Table**

S/No	Variables	Correlation	Standard Error	Level of Sig	F
1	E-CommereUserEssentalInformation	1.000	0.084	0.000	7.752
2	E-CommerceAwwareness	1.000	0.078	0.000	11.306
3	E-CommerceBenefits	1.000	0.071	0.000	17.910
4	E-CommerceEaseOfUse	1.000	0.072	0.000	10.378
5	E-CommerceReadiness&Quality	1.000	0.107	0.000	11.440
6	E-CommerceEsseantialFeature	1.000	0.081	0.001	4.049
7	E-CommerceReliabilityTrust	1.000	0.078	0.000	26.257
8	IntentionToAdoptE-Commerce	1.000	0.070	0.000	12.848
9	previous-CommerceExperience	1.000	0.077	0.000	30.256
10	UserAppraisalForE-Commerce	1.000	0.084	0.000	7.492
11	UserPerceptionOnCPVA	1.000	0.065	0.00	9.676
12	UserExperienceOnDesignFictionExperiment	1.000	0.064	0.000	3.415
13	UserPerceptionOnTheExperimentScenarios	1.000	0.084	0.000	18.568
14	UserPerceptionOnFingerPrint	1.000	0.060	0.000	4.620
15	UserPerceptionOnPinPassword	1.000	0.073	0.011	2.790
16	E-CommerceWebAssuranceSealServices	1.000	0.078	0.000	18.713
17	PreviousComputer&InternetExperience	1.000	0.090	0.000	46.137.

18	UserAppraisalForCPVA	1.000	0.065	0.000	7.978
19	perceived-CommerceTransactionTiming	1.000	0.085	0.000	14.464
20	IdentityTheft	1.000	0.070	0.009	4.801
21	FingerTipDamaging	1.000	0.060	0.000	12.697

## 6.9 Model Hypothesis Testing

The relationship of the variables will be shown by the result of the hypothesis. This is illustrated in tables 6.15 and 6.16. One of the ways to show this result is by the level of significance. Sampling is a way by which variability is observed. If the study sampling is large, there will be a significant difference in the statistical test except if there is no effect in the study and the value will be zero. If the analysis is done using the p-value, it is not better understanding like using effect size [232]. The stronger relationship is often denoted between two variables if the p-value is very low or negligible [233]. The significant P-value must have a value less than 5%. The table showing the hypothesis test summary of each item using Chi-square can be found in the appendix.

## 6.10 Effect Size

In the research study, statistical significance is important to prove the hypothesis. But the effect size is more important in any research study because the effect size informs the researcher how important the result is while significant [234].

### 6.10.1 Advantages of Effect Size

Effect size allows the researcher to have a deeper revelation of how useful the result is. In discussing the findings using the effect size, the researcher will be able to discuss them across and deeply. The study will cut across various scopes and disciplines. The following formula denotes the effect size in a given research. The Effect size is a measure of the strength of a phenomenon and the size of the different relationships quantitatively [148], [235].

$$\text{Effect Size} = \frac{M_1 - M_2}{\frac{S_1 + S_2}{2}} \quad [234]$$

$$\text{Pooled standard deviation } S = \frac{S_1 + S_2}{2} \quad \text{-----eqn. 15}$$

Where:

- $M_1$  = mean of group 1
- $M_2$  = mean of group 2 and
- $S_1$  = Standard Deviation of the first group
- $S_2$  = Standard Deviation of the second group [236].

Effect size assists to account for the effect of different sizes error which allows us to compare courses with different levels of diversity in scores and class sizes. It is statistically more robust to do the latter [234]. The following effects also are considered in this research.

$$Eta^2 = \frac{SS_{effect}}{SS_{total}} \quad [234] \text{ -----eqn. 16}$$

where: the  $_{effect}$  is the sum of squares for the effect you are studying, and the  $_{total}$  is the total sum of squares for *all* effects, errors, and interactions in the ANOVA study [234]. Therefore, a significant  $p$ -value tells us that an intervention works, whereas an effect size tells us how much it works.

It can be argued that emphasizing the size of the effect promotes a more scientific approach, as, unlike significance tests, the effect size is independent of sample size [234].

### 6.10.2 Standardized and Unstandardized Effect Sizes

The effect size can refer to a standardized measure of effect (such as  $r$ , Cohen's  $d$ , or the odds ratio), or to an unstandardized measure. Standardized effect size measures are typically used when: The Cohen's  $d = 0.2$  small,  $d = 0.5$  medium,  $d = 0.8$  large. These effect sizes evaluate the quantity of the variance in an experiment that is accounted for by the experiment's model. The effect size in this research work is shown in Table 6.15 below.

Pearson's correlation often denoted  $r$  and is widely used as an effect size when paired quantitative data are offered. Using correlation  $r$  as an effect size,  $r = .1$  weak,  $r = .5$  moderate,  $r = .7$  strong, and  $r = .9$  very strong. Therefore, the correlations are 1 in table 6.16 which shows a perfect and very strong relationship.

Another measure of effect size used for chi-squared tests is Cohen's  $w$ . This is defined as [237].

$$\varphi = \sqrt{\frac{\chi^2}{n}} \quad [238] \text{ ----- eqn. 17}$$

The Summary of the combination of the 3 measurement variables used to determine the effect size is shown in table 6.17.

**Table 6.17 The Summary of the effect size of Various Hypothesized Relationships**

<b>Variable1 Independent</b>	<b>Variable 2 Dependent</b>	<b>Hypothesis number</b>	<b>Signifi cance (p)</b>	<b>Effect Size Correlation (r)</b>	<b>Effect size Cohen (d)</b>	<b>Extent</b>
Finger Disorder	Perceived Fear	H1a	0.000	1.0	0.4	Strong
Identity Theft	Perceived Fear	H1b	0.009	1.0	0.4	Strong
Privacy	Perceived Fear	H1c	0.000	1.0	0.3	Strong
Fingerprint System	Security	H2a	0.000	1.0	0.8	Very Strong
Digital Signature	Security	H2b	0.011	1.0	0.7	Strong
CPVA	Security	H2c	0.000	1.0	0.7	Very Strong
Security Awareness	Perceived Risk	H3a	0.000	1.0	0.8	Very Strong
Specific Awareness	Perceived Risk	H3b	0.000	1.0	0.8	Very Strong
Previous Experience	Perceived Risk	H3c	0.000	1.0	0.6	strong
Perceived Fear	Perceived Risk	H3d	0.000	1.0	0.4	Strong
EaseOfUse	Perceived Advantage	H4a	0.000	1.0	0.3	Strong
General Awareness	Perceived Advantage	H4b	0.000	1.0	0.6	Strong
Perceived Benefits	Perceived Advantage	H4c	0.000	1.0	0.5	Strong
Protection Policy	WASS	H5a	0.000	1.0	0.3	Strong
Protection policy	Usability	H6a	0.000	1.0	0.1	Strong
Transaction Timing	Usability	H6b	0.000	1.0	0.4	Strong
Ease of use	Usability	H6c	0.000	1.0	0.1	Strong
Perceived Fear	Trust	H1d	0.000	1.0	0.4	Strong
Security	Trust	H2c	0.000	1.0	0.7	Very Strong
Perceived Risk	Trust	H3e	0.000	1.0	0.6	Strong

Perceived Advantage	Trust	H4d	0.001	1.0	0.6	Strong
WASS	Trust	H5b	0.000	1.0	0.6	Strong
Usability	Trust	H6d	0.000	1.0	0.4	Strong

## 6.11 Chapter Summary

The chapter describes the data analysis part of the thesis, the data preparation which involves data cleansing and outlier detection. The Likert scale and Likert-type data were mentioned. The types of analysis that involve descriptive statistics where mean, median, and mode were discussed. The variability that involves frequency and the standard deviation is applied to the dataset collected in the fieldwork. The reliability measurement like Cronbach Alpha and standard error was used.

Again, statistical test like ANOVA, T-Test and F-Test was applied on the Likert scale data. Then Correlation, Covariance, Skewness, and Chi-square were also applied for the dataset to test the hypothesis in the research work. Also, the Effect Size and Correlation were applied to the data to know the extent of the relationships between the models and variables.

# Chapter VII

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## 7. Discussions and Findings

Chapter 6 discussed data analysis, where the analysis was done on the data collected during the fieldwork in Nigeria, using different statistical tools discussed in Chapter 6. Data was collected to allow measurement of the citizen's perspective to E-Commerce transactions in the context of an extended Technological Acceptance Model that focused on investigating Nigerian citizens' 'intention to adopt' E-Commerce transactions. Many statistical tools were employed to achieve the aim and objectives of this research work. As explained in Chapter 6, data collected from the fieldwork and analysed were mostly based on Likert scales. The demographic aspect of the data was analysed and presented using a frequency distribution table. Also, statistical tools used in the previous chapter include: mean, standard deviation, variance, covariance, correlation, skewness, kurtosis, effect size, etc.

This chapter presents findings and a discussion on the data analysis in the previous chapter on the citizen's response through their data collected during the fieldwork in Nigeria. A brief explanation of the hypothesis will be presented as explained in Chapter 3 of the thesis. Then testing and assessment of the hypothesis will be discussed. Also, discussion and answering research questions will be discussed. The discussion on the demographic data will be presented. The Chapter will mainly focus on the result of data analysis from the descriptive statistics of the sample to the use of statistical inferential tools. A summary of the significant factors with their impact on the citizens' intention to adopt E-Commerce transactions is presented.

### 7.1 Demographic Data

This section presents the demographic that was collected from the participants in the pilot studies and fieldwork study titled Authentication Technology Method for E-Commerce Application in Developing Countries Using Contactless Palm Vein Authentication (A Case Study of Nigeria) [2]. Survey questions were designed to collect demographic data like Gender, Age group, Income, Education, Nationality, Occupation, and Marital status. The other sections of the survey consist of 16 sections that were used



to measure various aspects of E-Commerce in this research work. The data collected signify the demographic data of the participants that took part in various studies in this research.

The following table 7.1 provides an overview and summary of demographic data in this study.

**Table 7.1 Participants' Demographical Data**

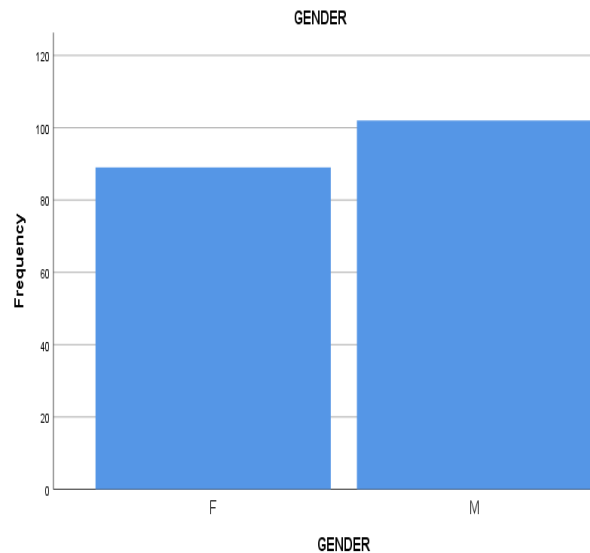
Demographics				Percentage
1	Gender	Female	89	46.6
		Male	102	53.4
2	Age Group	18-23	32	16.8
		24-29	35	18.3
		30-35	44	23.0
		36-41	40	20.9
		42-47	28	14.7
		48-53	7	3.7
		54-60	5	2.6
3	Income	NON	20	10.5
		20k	29	15.2
		20-50k	53	27.7
		50-100k	66	34.6
		100-200k	22	11.5
		200k+	01	0.5
4	Education	High School	40	20.9
		Diploma	67	35.1
		Bachelor	63	33.0
		Master	21	11.0
		PhD	0	0.0
5	Nationality	Nigeria	188	98.4
		Non-Nigeria	3	1.6
6	Occupation	Accountant	1	0.5
		Artisans	25	13.1
		Business	64	33.5
		Civil Service	7	3.7

		Comp. Operator	1	0.5
		Facility MGT	1	0.5
		Farming	32	16.8
		Industry	39	20.04
		Mining Worker	11	5.8
		Pastoring	1	0.5
		Student	5	2.6
		Teaching	4	2.1
7	Marital Status	Married	117	61.3
		Single	72	37.7
		Widow	02	1.0

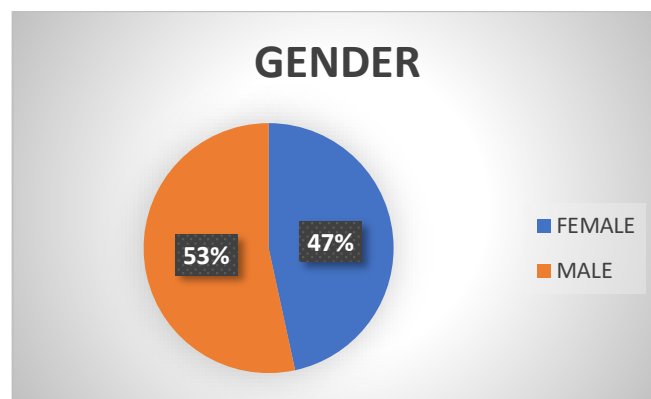
The following section discusses the participants' demographic data collected in this research work as summarised in table 7.1.

Table 7.1 above describes the data collected in this research work where 102 males took part in the study with 53.4% while 89 females of 46.6% equally took part in the study. Initially, equal gender sampling was aimed at the design of this study to control the gender in this research work. However, instead, the study chooses to use random sampling, where everybody has the same chance of being chosen as part of the sampling, thus eliminating bias. Stratified random sampling was used, which involves the use of pre-determined characteristics such as occupation, age group, income level, and other demographic features to choose a sample [239]. This random sampling method has advantages such as reliable and generalisable results [239].

Invariably, the indication in the data retrieved from the participant based on gender shows that male is more likely to participate in E-Commerce than their female counterpart. Also, females may be more prone to the physical transaction that has been in existence as a culture, where the benefits of bargaining and associative interaction take place [222]. Figures 7.1a and 7.1b show the participants' gender distribution that a considerable number of males are majorly interested in E-Commerce transactions which are slightly higher than their female counterparts.



**Figure 7.1a Participants' Gender Distribution using Bar Chart**



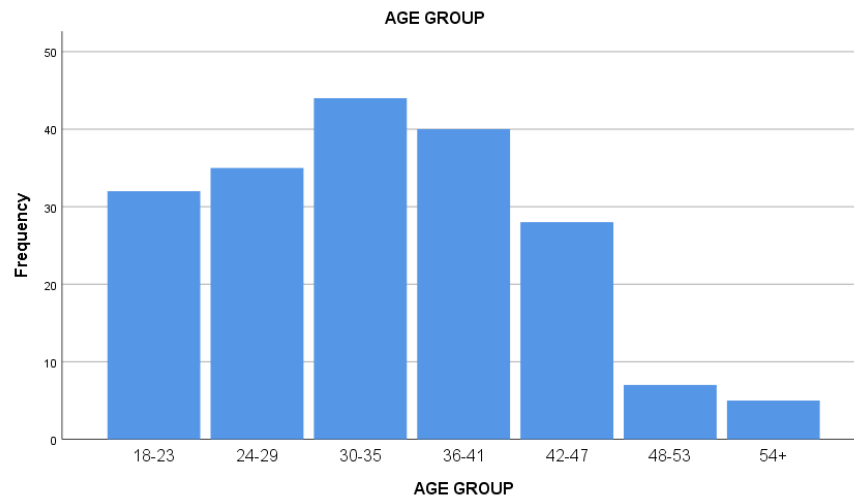
**Figure 7.1b Participants' Gender Distribution using Pie Chart**

### **7.1.2 Age Group Data**

The demographic data presented in table 7.1 represents a distribution of the active citizens in Nigeria that are in their working and active time. Age group 30-35 was the highest occurring age group having 44 numbers with 23.0%, probably because this age group refers to the most active youthful age where interest and quest for the use of technology are more. Moreover, the participation of this age indicates that they probably know the values and benefits that might arise due to the adoption of E-Commerce in Nigeria. Again, age group 36-40 was the second occurring age group with 40 participants having 20.9% of the total samples. This age group is another active age range, where citizens within this range are believed to have well established and also know the maximum benefits that may come from E-Commerce adoption. The next largest age group was 24-29 which has a total participant of 35 with 18.3% probably because this age

group is the first after youthful age after becoming an adult. This age group can refer to an inquisitive age group where information searching is very alarming [240]. Because it was believed that any knowledge gathering in this period will go a long way in assisting another age group. Moreover, many young farmers and artisans are from this age group range. All the above age groups are perceived to know the values and benefits associated with E-Commerce adoption in developing countries [241].

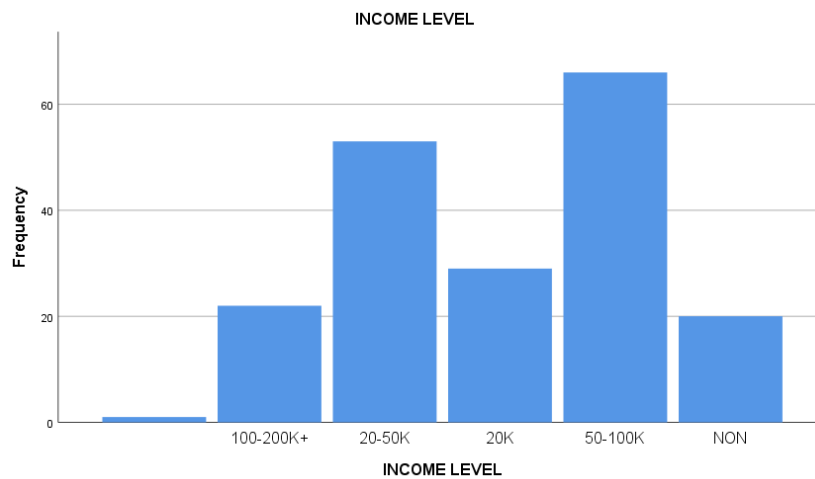
- However, from Table 7.1 above, age group 42-47 has a total participant of 28 with 14.7% and this shows the last age group with a vested interest in this research work [242]. Many industries workers and middlemen business owners are from this age group [150]. It can be probably noted that their participation indicates that the value and benefits of E-Commerce were also known by this age group. Age group 48-53 with 7 participants and 3.7% of the total sampling indicates the level of interest of this age group. The information agility for this group might be minimal and they may have a vested interest in their cultural heritage in terms of physical transactions than E-Commerce, which will be almost virtual in terms of dealing between customers and sellers. While the last age group which was 54-60 has only 5 participants with 2.6% of the total sampling. This Age group is towards the retiring age, retiring age, and above retiring age. In this age, a quest for new information is very minimal because people of this age group mainly value their cultural heritage, and they are probably cynical about E-Commerce transactions because they cannot afford to lose any of their lifetime earnings in the name of E-Commerce [189]. Figure 7.2 below indicates the trends of the above description about the age group as described above.



**Figure 7.2 Participants' Age Distribution**

### 7.1.3 Income Data

Table 7.1 above summarises the participant's data generated based on their income level. Moreover, the highest occurring participant is a group of 50 to 100 thousand Naira monthly with 66 participants and 34.6% of the sampling. Also, the next was 20 to 50 thousand Naira as monthly income with 53 participants and 27.7% of the total sample. While 29 participants were having 20 thousand Naira as their monthly income. This set of participants was referred to as low-income earners and their earnings might have implications on what they purchase with their money [29]. Again, the highest-earning group in this research study was 100 to 200k+ with 22 participants having 11.5%. Besides, 20 participants were not having any income either due to unemployment or other reasons. But definitely, this may have a heavy impact on their decision on the adaptability of E-Commerce. Moreover, though, income is a major determinant of whether a citizen will engage in a transaction or not, the virtual nature of E-Commerce may impose unnecessary fear on low-income citizens [189], [243]. Figure 7.3 illustrates the income level of the participants.

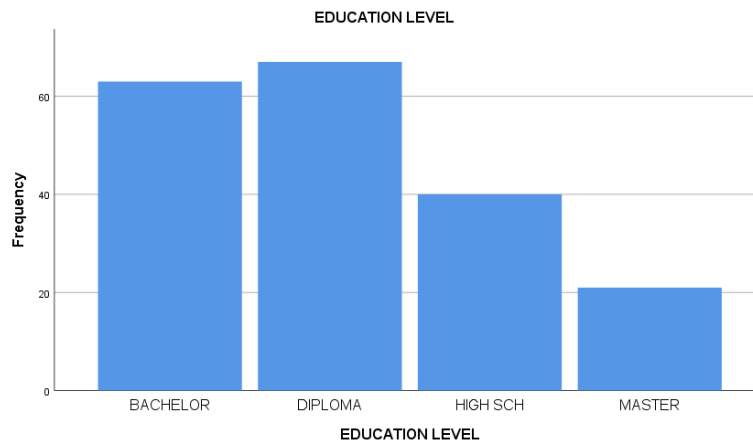


**Figure 7.3 Participants' Income Level**

#### **7.1.4 Educational Level**

The participants' level of Education as summarised in table 7.1 shows the summary of different levels of education that citizens can be acquired in Nigeria. The highest number of participants with 67 and 35.1% were having a Diploma level of education. This shows that the majority of citizens have a Diploma certificate in either formal education or informal education. Also, the next was the Bachelor's level of education with 63 participants and 33.0. This indicates that many Nigerian citizens acquired a Bachelor's degree despite the economic hardship and high unemployment status in the country. More so, 40 high school-level participants participated in the fieldwork. Although the high school level was the minimum qualification that took part in this research work so that every participant will understand and comprehend the aim and objectives of this study.

However, 21 Masters' levels of education took part in this research work. With 11% representation of the total sampling, this shows that the sampling distribution has every educational level representation apart from a Ph.D. that has no representation. This can be due to most places used for sampling collection are not academic places. It's maybe significant that people with Ph.D. educational level may not be found in the target of the occupation in this research work. Figure 7.4 represents the participant educational level in the sampling distribution in this research work.

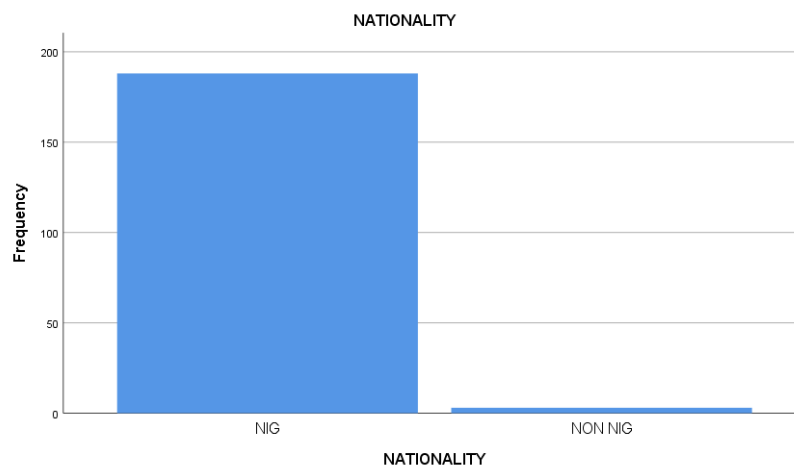


**Figure 7.4 Participants' Education Level**

### 7.1.5 Nationality

Table 7.1 shows the nationality of the participants that took part in this research work. There are 188 participants, i.e. 98.4% that are citizens of Nigeria with only 3 participants with 1.6% are from other developing countries. However, this is because the research fieldwork was carried out in Nigeria. However, the distribution is a true representation of developing countries [40]. As discussed in the literature review Chapter 2 this research results will scale to other developing countries because many developing countries have the same characteristics as explained in chapter 2.5.

Below Figure 7.5 shows the sampling distribution of nationality of the participants that took part in the fieldwork of this research work in Nigeria.



**Figure 7.5 Participants' Nationality**

### 7.1.6 Occupation

Table 7.1 described the sampling distribution occupation of the participants in this research work. The highest occurring participants were from Businesses with 64 participants and 33.5% of the total sampling. This may be because the business group consists of other sectors like Agri-Business, etc. In businesses, carrying and delivery of goods and services are very essential and also payment security is also very vital [63]. Many citizens engaged in businesses that are related to their jobs, in which many of these are performed manually. Therefore, being the highest occurring participants indicates that this study is very important and has a great impact on their activities.

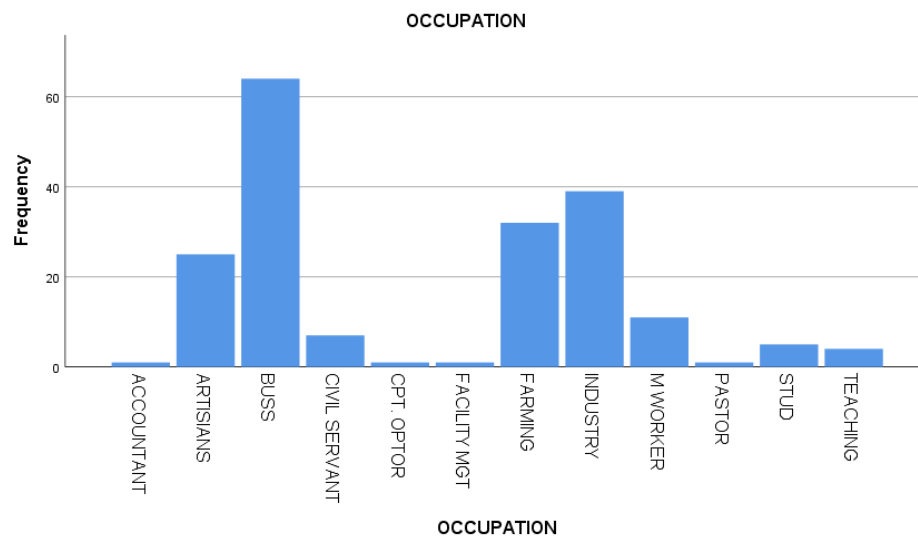
In addition, this study's fieldwork was able to witness 39 participants with 20.04% of the total sampling that are from industrial workers. Many industry workers will prefer another security feature to be used instead of their fingers just because of the nature of their job roles. Although, the study was carried out in the cities where the industrial workers were among the citizens that have an equal chance in the randomized sampling. Nevertheless, the impact, benefits, and values of this study are inimical to the industry workers [244].

Farming is a very important occupation in Nigeria [29] with 32 participants and with 16.8% of the total sampling. Although, Nigeria is an agrarian country with 70% on Agriculture. Though largely subsistence farming mainly involves the use of manual means to cultivate agricultural practices. Again, farming in Nigeria is a thing of necessity but not interesting because of the use of old methods. Though, 80% of families are surviving in Nigeria through small crofter, labourer, family, subsistence type farming [177]. Despite that the data were mainly collected in towns and cities of Nigeria, 32 actual farmers still participated in this research work. The provision of alternative security features to that of a fingerprint is very paramount to farmers because their fingertips damaging [38]. Also, artisans are another occupation that gains the attention of this study with 25 participants and 13.1% of the total sampling distribution. The fact that many artesians are mainly performing their job role through manual means signifies they knew that new alternative security authentication apart from fingerprint will benefit them immensely [197]. Also, mining was another occupation that may want an end to ineffective security authentication as a result of fingertips damaging. The fact is owing to the rigorous jobs taking place during the mining operations. Despite that the study was conducted in cities where miners may not be found, we were still opportune to get 11



participants which represent 5.8% of the total sampling. This is an indication that the study is very pertinent to the miners.

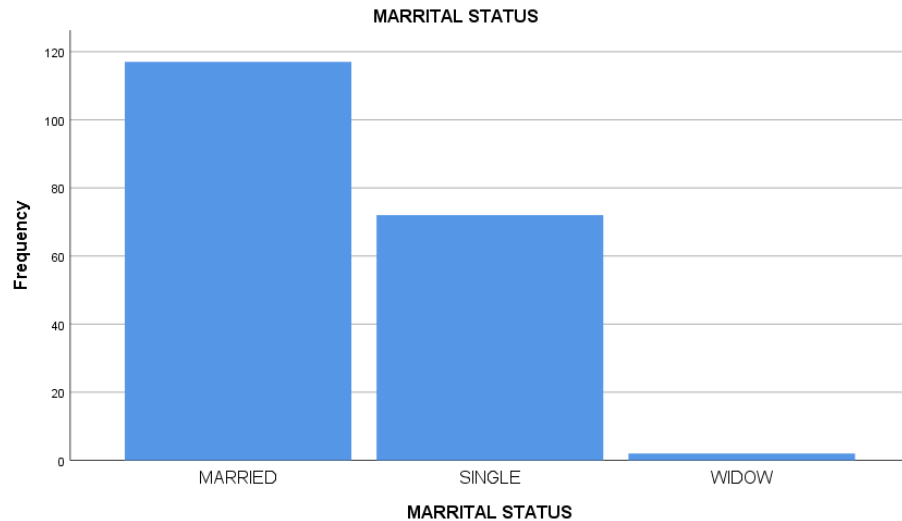
Also, 7 participants with 3.7% were civil servants who participated in the study. There are 5 students with 2.6% sampling representation that took part in the experimentation and 4 participants with 2.1% in teaching jobs. This indicates that the sampling distribution cut across various occupations in Nigeria [113]. The last set of occupations is Accountant, Facility manager, Computer operator, and Pastoral in which 1 participant each 0.5 % took part in the research work. Below Figure 7.6 shows the participants' occupations as collected in the fieldwork.



**Figure 7.6 Participants' Occupation Distribution**

### 7.1.7 Marital Status

In table 7.1, participant marital status was summarised, where 117 with 61.3% of participants were married. This is an indication is that married people are more concerned about security authentication probably because they engage more in transactions. Also, 72 participants participated in this research study with 37.7%. Invariably, it was also a significant effect on distribution sampling. Besides, there were two widow participants with a 1.0% representation in the sampling. The total distribution shows the complete status that can exist in the country. There was no Divorce and MS in the participant in the distribution sampling. Below Figure.7.7 shows the participant marital status in the research sampling distribution that was collected in the fieldwork.



**Figure 7.7 Participants' Marital Status**

## **7.2 Descriptive Statistics Discussion of Citizens' Data**

The data collected in the fieldwork will be discussed concerning CPVA as a premier security method. Data collected from participants in this research work was provided on a Likert scale and has been analysed to measure the efficacy of CPVA for authentication in E-Commerce in developing countries [2]. The Likert scale measurement of the participants' responses is discussed in this section for each of the models discussed in Chapter 3.

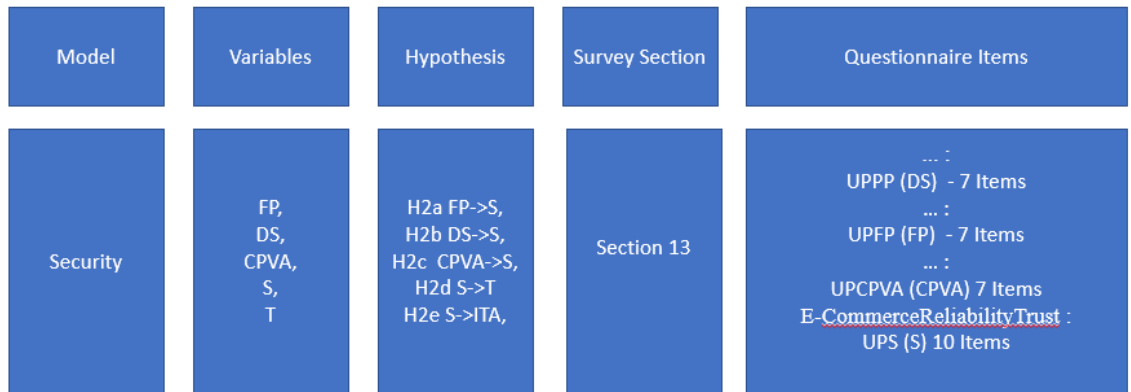
### **7.2.1 Explanation of Experimental Variables**

Recalling the research models designed in Chapter 3 and the overall research model entity-relationship diagram in Chapter 4, see Figure 4.6, there are 3 types of the variable present in the experimental study: Independent, Intermediate, and Dependent, where the Intermediate variables switch between Independent and Dependent depending on the specific model. This section synchronizes these research variables, hypotheses (associated research questions) that were discussed in chapter 3 with the questionnaire survey items.

#### **1. Dependent Variable Mapping**

Here those intermediate variables, which are also classed as dependent variables in this study as discussed in the research models, are Security, Trust, Perceived Risk, Perceived Fear, Perceived Advantage, Flexibility/Usability, and WASS [42]. The

mapping of variables in models to questionnaire items (see appendix) is illustrated in Figure 7.8 and table 7.2.



**Figure 7.8: Example mapping of the variables in the Security model through to Questionnaire items**

**Table 7.2 The Dependent Variables Synchronization**

Variables	Hypothesis	Model	Questionnaire Items
Security	<u>H2a, H2b, H2c, H2d and H2e.</u>	<u>Figures 3.2, 3.4 and 4.1</u>	E-CommerceReliabilityTrust (10)
Perceived Risk	H3a,H3b,33c,3e	Figure 3.1a, 3.4 and 4.1	UserExperienceOnDesignFictionExperience (10)
Perceived Fear	H1a,H1b,H1c, H1e	Figure 3.1b, 3.4 and 4.1	UserAppraisalForE-Commerce (25)
Perceived Advantage	H4a,H4b,H4c,H4e	Figure 3.3, 3.4 and 4.1	E-CommerceEssentialFeatures (7)
Flexibility/Usability	H6a,H5b,H6c,H6d,H6e	Figure 3.6, 3.4 and 4.1	UserPerceptionOnExperimentScenarios (34)
WASS	H5a,H5b,H5c	Figure 3.5, 3.4 and 4.1	E-CommerceWebAssuranceSealServices (9)
Trust	H1d,H3e,H2d,H4d, H5b,H6d,H7a	Figure 3.4 and 4.1	IntentionToAdoptE-Commerce (10)

## 2. Independent Variable Mapping

In this research, a set of independent variables were used that served as experimental variables. These are Fingerprint systems, Digital Signature, CPVA, Finger Disorder, Digital Identity Theft, Privacy, Security Awareness, Specific Awareness, Previous Experience, Protection Policy, Timing, ease of use, General Awareness, and Perceived

Benefits. Table 7.3 shows the synchronization of independent variables, refer to Questionnaire in Appendix.

**Table 7.3 The Independent Variable Synchronization**

Variables	Hypothesis	Model	Questionnaire Items
DigitalSignature	H2b	Figure 3.2	UserPerceptionOnPinAndPassword (7)
FingerprintSystem	H2a	Figure 3.2	UerPerceptionOnFingerPrint (7)
CPVA	H2c	Figure 3.2	UserPerceptionOnCPVA (7)
FingerDisorder	H1a	Figure 3.1b	FingerTipDamaging (4) UPFP1, UPFP4, UPFP5, UPFP6
IdentityTheft	H1b	Figure 3.1b	IdentityTheft (3), UPPP1, UPPP2, UPPP3
Privacy	H1c	Figure 3.1b	E-CommerceReliabilityTrust (10)
SecurityAwareness	H3a	Figure 3.1a	E-CommereUserEssentalInformation (8)
SpecificAwareness	H3b	Figure 3.1a	Previous-CommerceExperience (26)
GeneralAwarenes	H4b	Figure 3.1a	E-CommerceAwareness (18)
PreviousExperience	H3c	Figure 3.1a	PreviousComputer&InternetExperience (10)
ProtectionPolicy	H6a	Figure 3.5, 3.6	E-CommerceReadiness&Quality (7)
Timing	H6b	Figure 3.6,	PerceivedE-CommerceTransactionTiming (3) EI4, EI5, EI6
Ease of Use	H6c	Figure 3.6,	E-CommerceEaseOfUse (6)
PerceivedBenefits	H4c	Figure 3.3	E-CommerceBenefits (7)

## 7.2.2 Descriptive Weight Scale Measurement

The Likert Scale weight average that was used in this study has been measured to identify the central tendency of the scores from the participants. The formulae explained in Chapter 6 were used in Excel and repeated in SPSS to analyse the number and the 5-points Likert scale was used to represent the weight [42], [189]. The following describes the 5-point Likert scale as 1-Strongly disagree or Not at all, 2-Disagree or Fairly often, Very little, 3-Not sure or More or less, 4-Agree or Often or Very Much and 5-Strongly Agree or Very Often or Greatly. Also, 5 Likert scales were used to measure the degree of importance of the variable and their relationship. Table 7.4 summarises the average weight scale of these measuring variables, their respective result, and interpretation.

**Table 7.4 The Results Measurement Yardsticks and Interpretations**

Measurement Scale	Result	Review
1-1.79	Strongly disagree, Not at all Uninfluential	Very Uninfluential
1.80-2.59	Disagree, Fairly often, Very little	Uninfluential
2.60-3.39	Not sure, More or less, Medium	Neutral
3.40-4.19	Agree, Often, Very much,	Highly Important
4.20-5	Strongly agree, Very often, Very influential, Greatly	Very Important and Very Influential

Therefore, from the table above, the descriptive weight of the measurement variable can easily be stated and discussed. The below section identifies the key measurement variable with their descriptions.

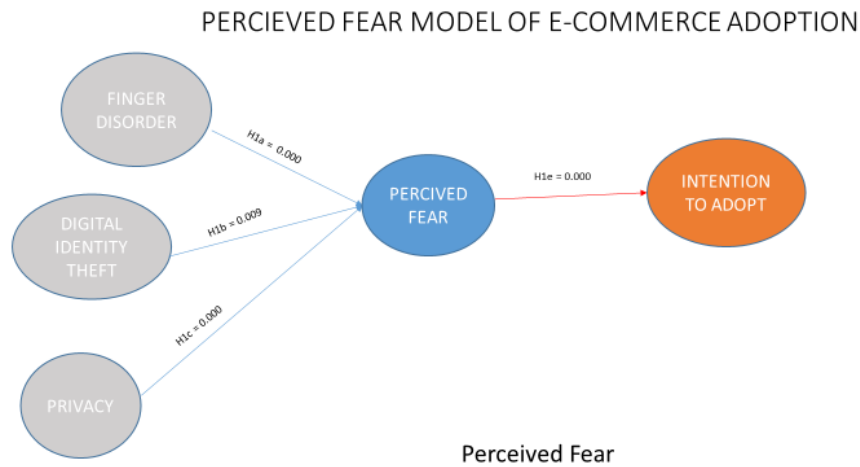
### 7.3 Statistical Analysis of the Study Hypotheses

The summary of the descriptive statistic was presented in the above chapter for both dependent and independent variables [243]. Also, the hypotheses generated in the chapter of this study and the data collected from the participants during the fieldwork in Nigeria will be used to hypothesized variables in this study. In this section, the result from the descriptive analysis will be summarised so that the relationship between the variables with E-Commerce adoption will be determined. The significant level of the relationship between these variables will also be determined.

The relationship between the research model that was discussed in chapter 3 of this thesis and the significant level be constructed for each relationship. The discussion in the section will also include the skewness, kurtosis, correlation, covariance, Item covariance, and effect size.

#### 7.3.1 Perceived Fear and Intention to Adopt E-Commerce Relationship

The perceived fear as discussed in Chapter 3 of this thesis, see Figure 3.1, and presented again in Figure 7.9 for convenience, is the fear that citizens have as a result of the untrusted authenticating system that resulted in the loss of money, properties, and even one's identity.



**Figure 7.9 The Results of the Perceived Fear Model**

Table 7.5 summarises the outcome of the measurement from the perceived fear model.

**Table 7.5 The Result Summary and Interpretations of Perceived Fear Model**

Variable	No of Items	Mean	SD	Variance	Std. Error	Level of sig.	Result Interpretation
Finger Disorder	4	3.94	0.85	0.7225	0.060	0.000	Sig., Agree & highly Important
Identity Theft	3	3.93	1.03	1.0609	0.070	0.009	Sig., Agree & highly Important
Privacy	10	3.20	1.08	1.1664	0.078	0.000	Sig. Neutral,
Perceived Fear	25	3.53	1.16	1.3456	0.084	0.000	Sig., Agree & highly Important

The following hypothesis will be answered based on the summary of the result in tables 6.15 and 6.16 in chapter 6.

1. H1a: A citizen's **fingerprint disorder** leads to a **perceived fear** of making E-Commerce transactions.

This hypothesis was tested with survey questions (4 items) with the participants after they engaged in the two experimental tasks set up in this research work. The survey consists of 4 structured questions with a reliability test of 0.811. These survey questions were used to test the participants' experiences concerning finger disorder in authentications. The survey was testing finger disorder existence and awareness by the participants. Also, the commonness of false rejection in user authentication in the

fingerprint identification process was tested. The impacts of fingertips damaging were also tested.

The result from the survey with a mean of 3.93 shows the respondents agreed on the above survey questions. Again, the standard deviation of 0.85 shows the wider nature of the data. This shows that the data is very spread from the mean. The standard error is very small which shows the internal consistency of the survey. Invariably, the significant level of 0.000 shows that there is a level of significance between finger disorder and perceived fear. The indication of this is that there is a strong relationship between finger disorder and perceived fear [156]. Therefore, based on the result of this study, the null hypothesis is rejected.

2. H1b: **Digital identity theft** leads to a **perceived fear** of making E-Commerce transactions.

Identity theft is known as stealing a person's identity either inform of PIN, Password, and other digital signatures that can be used for security authentication. As discussed in chapter 3, identity theft is capable of creating fear for the citizens in adopting E-Commerce in developing countries. PINs and Passwords of users are being stolen on daily basis and this has created a big fear in E-Commerce participation [158]. What the survey questions tested for include: how PIN/Password lead to Identity theft, whether an increase in Identity theft leads to an increase in online theft, and maybe an increase in an online theft leads to a decrease in trust of the citizen towards E-Commerce [243].

This hypothesis was tested using data collected from the participants during fieldwork and completing the two experimental tasks. The survey consists of 3 structure questions with the high-reliability feature of Cronbach Alpha of 0.766 which shows that the survey questions are accurate to test the hypothesis. Therefore, the mean from the survey's result is 3.93 which indicates that the participants agree that Identity theft leads to perceived fear in E-Commerce transactions [156]. More so, with higher standard deviation value of 1.03 indicates a greater spread in the data. The standard error of 0.070 tells us about the shape of the distribution, how close the individual data values are from the mean value. The small standard error signifies that the mean result from the survey is very accurate.

However, there is a significant level of 0.009 which shows that there is a relationship between Identity theft and perceived fear, and this indicates that the null hypothesis is rejected.

3. H1c: A citizen's breach in **privacy** (IV) increases their **perceived fear** (DV) of making E-Commerce transactions.

Privacy is said to be very important in any virtual transaction. The platform is also known to be reliable if the privacy of such is not compromised. The citizen's privacy is related to the confidentiality of their information [33]. As discussed in the methodology for E-Commerce in developing countries to witness total adoption, the privacy of such a system must be proven [245]. In the research, 10 survey questions (items) were used to measure the above hypothesis. The constructs measured include: to what extent does the internet a safe place, how safe is E-Commerce platforms in developing countries, also an extent to which city will be able to provide financial and personal information on the E-Commerce system, how user's data are shared and stored on the system, how the user has a control on their data, the government on citizen's data protection and impact of Personal Authenticating Technique on E-Commerce [246].

The survey questions (items) have a high-reliability result of Cronbach Alpha of 0.859 and this signifies that the questions were very accurate and good for this measurement. Also, from the survey result, the mean of 3.20 was generated and this indicates that the participants were neutral or not sure. Nevertheless, the standard deviation result of 1.08 shows that the data was highly spread about from the mean. The issue of privacy in any system is very important. Also, the standard error result of 0.078 tells that the mean result of this sample is accurate. This also indicates that the study sample mean is the true mean of the overall population.

Furthermore, in the study conducted a level of significance of 0.000 was generated. The issue of privacy cannot be overemphasized [246]. The result shows that there is a relationship between privacy and perceived fear [189] Therefore, the null hypothesis is hereby rejected.

4. H1d: Decreasing a citizens' **perceived fear** (IV) increases their **trust** (DV) in E-Commerce Transactions

This hypothesis was constructed from the relationship between 2 dependent variables. The details will be discussed in the Trust model section.



5. H1e: Decreasing a citizens' **perceived fear** (IV) increases their **intention to adopt** (DV) E-Commerce

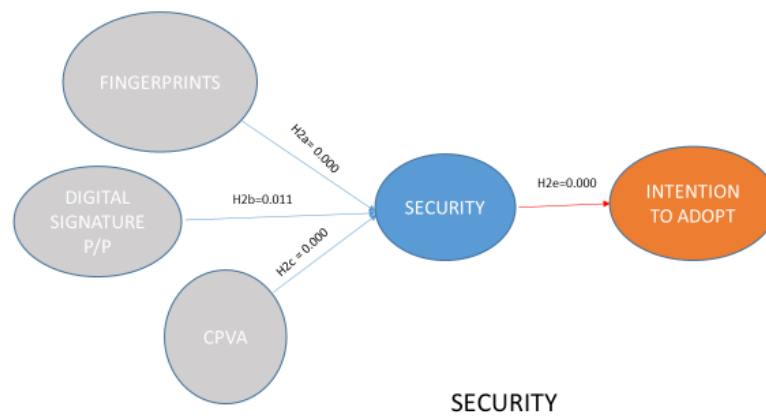
The above hypothesis was generated and discussed in chapter 3 with the research model. The relationship between perceived fear and intention to adopt E-Commerce is significant. Other independent factors and their hypotheses relating to the relationship with perceived fear are discussed above. Notwithstanding, the perceived fear relationship with intention to adopt E-Commerce was tested using a survey that consists of 25 structured questions. Perceived fear is said to be the bedrock of why citizens reject E-Commerce in developing countries [24]. The total rejection of E-Commerce was a result of fear that arises through identity theft, finger disorder, and porosity in privacy [174].

The Survey was used to test various aspects of E-Commerce and any issue that may momentarily lead to fear were discussed which includes: Fear of identity stealing, fear of charges of system usage, fear of use, fear of non-availability of protective policies, and fear of non-secure payment gateways. The well-structured 25 questions used have a Cronbach Alpha of 0.887 which signifies high reliability. The survey was very accurate and adequate for the measurement. The results produced from the survey are dependable and trustable for such Cronbach Alpha results. Also, the mean result of 3.53 was generated that indicates an agreement by the participants. Participants believed and agree that perceived fear leads to intention to adopt E-Commerce [51].

Moreover, the standard deviation of 1.16 shows that the data was highly spread from the mean and justifies close the individual data values are from the mean value. Also, the result from the survey produced the standard error of 0.084 which indicates that the mean result was accurate and the study sample mean is very close to the true mean of the overall population. Also, there is a significant level of 0.000 that establishes a relationship between perceived fear and intention to adopt E-Commerce.

### **7.3.2 Security and Intention to Adopt E-Commerce**

Security has been identified as the main barrier affecting the adoption of E-Commerce in developing countries [7]. There are several hypotheses discussed with security and its challenges in E-Commerce. There are several controversial issues regarding authenticating techniques in developing countries' E-Commerce [18].



**Figure 7.10 Showing the Result of the Security Model Relationships**

The relationship between security and intention to adopt E-Commerce was tested with hypotheses generated from other independent factors and the results were summarised in table 7.6 and also illustrated in Figure 7.10.

**Table 7.6 The Results Summary of the Security Relationship Model**

Variable	No of Items	Mean	SD	Variance	Std. Error	Level of sig.	Result Interpretation
FingerprintsSystem	7	3.99	0.82	0.6724	0.060	0.000	Sig., Agree & highly Important
Digital Signature	7	3.88	1.01	1.0201	0.073	0.011	Sig., Agree & highly Important
CPVA	7	3.91	0.90	0.8100	0.065	0.000	Sig., Agree & highly Important
Security	10	3.20	1.08	1.1664	0.078	0.000	Neutral, More or less

H2a: The Fingerprint (IV) security authentication method leads to a citizen's greater sense of **security** in E-Commerce transactions.

Fingerprint Identification System was introduced to the security authenticating system as part of the PAT to curb the security lapses created as a result of stolen identity. The hypothesis was tested using 2 experimental scenarios and a survey was used to get the response from Nigerian citizens. The survey consists of 7 Structured questions that tested the participants' experience on the use of both simulated and previous fingerprint Identification systems. Other aspects tested by the survey also include: Comparing the privacy of fingerprint system to that of digital signature, asking if authentication needs an improvement to have trust in E-Commerce, does false rejection rate increases the citizen's

perceived fear? And asking if fingerprint identification is enough to build user confidence and trust in E-Commerce.

The survey used was very reliable. Cronbach Alpha of 0.818 was used to measure the reliability of this relationship. The survey produced a mean result of 3.99, which indicates an agreement by the participants. It shows that the fingerprint identification system may not likely be enough to build a trustable E-Commerce system in developing countries. A standard deviation of 0.82 was also generated which signifies that the data is well spread out from the mean. The introduction of the fingerprint identification system into PAT to E-Commerce still assists substantially in Nigeria and other developing countries. However, more still need to be done in security authentication to produce a reliable E-Commerce system.

Also, a standard error of 0.06 was generated that indicates the high reliability of the mean. SE's result shows that the study sample mean is very close to the true mean of the overall population. Besides, a level of significance of 0.000 was realised and this indicates that there is a relationship between the fingerprint system and security in E-Commerce adoption of developing countries. Therefore, based on the null hypothesis is hereby rejected.

H2b: The **Digital Signature** (IV) security authentication method leads to a citizen's greater sense of **security** in E-Commerce transactions.

Digital Signature involves the use of PIN/Password to authenticate the E-Commerce transactions. The use of PIN/Password is known as one of the first security techniques in authenticating both physical and e-transactions [56]. The hypothesis was constructed and discussed with a model formulation in chapter 3. It has been identified that the use of digital signatures may likely be vulnerable due to identity theft. The relationship in the hypothesis was measured using a survey that consists of 7 structured questions. The area tested include: how PIN/Password lead to Identity thefts, how Identity theft leads to lead to online theft [35] How risky is the privacy when using PIN/Password, Does the stolen PIN/Password discourage? And citizen's privacy is more porous, there can be conniving between the operators when using PIN/Password.

The survey has a reliability result of 0.835 and this signifies that the results from the survey are reliable and confident. Also, the survey generated a mean of 3.88 which shows that the participants agree that the use of digital signatures may likely be vulnerable in

security authentication of E-Commerce in developing countries. Again, the standard deviation of 1.01 tells us how close the individual data values are to the mean value. It also indicates that the data is highly spread out and the use of digital signatures may likely have an impact on the E-Commerce adoption of developing countries.

Also, the survey produced a result of the standard error of 0.073 which shows that the sample mean is accurate and reliable. The study sample mean is very close to the true mean of the overall population. Moreover, there is a level of significance of 0.011 which tells that there is a relationship between digital signature (PIN/Password) and security, and with this, we reject the null hypothesis.

H2c: The **CPVA** (IV) security authentication methods lead to a citizen's greater sense of **security** in E-Commerce transactions.

In the methodology chapter of this thesis, the 3 authentication techniques considered were Digital Signature, Fingerprint Identification system, and Contactless Palm Vein Authentication (CPVA). The impact of the first 2 techniques was discussed and the study suggests that the first 2 authenticating techniques are not enough to have a reliable E-Commerce system in developing countries. In light of this, CPVA has been proposing to be used as a PAT that could bring more trust in E-Commerce. The formulated hypothesis was measured using two experimental scenarios (a design fiction and simulated E-Commerce platform) and a survey that consists of 7 structured questions. Those areas tested by the survey include: Asking about the design fiction simulation in the experiment, the reliability of CPVA as experience in a simulated CPVA shopping scenario, asking about the privacy of the CPVA in regarding the involvement of liveliness, also, participants were asked about false rejection in CPVA, will CPVA reduce the citizen's fear and lower the risk in using E-Commerce, does CPVA capable of increasing citizen's trust?

The result of the survey has a high-reliability result of Cronbach Alpha of 0.872 and this signifies that the results from the survey are accurate and reliable. Again, the mean result of 3.91 was generated which tells that the participants agree with survey and experimental scenario constructs. The mean result shows that CPVA may likely be capable of increasing citizens' trust in E-Commerce. If the citizen's risk can be lowered, definitely the perceived fear of the citizens is likely to be reduced and this may eventually lead to E-Commerce adoption. The standard deviation result of 0.90 indicates that the individual data value is highly spread out and how close they are to the mean.

More so, the result of a standard error of 0.065 shows that the study sample mean is reliable and very close to the true mean of the overall population. Besides, the level of significant result of 0.000 justifies that there is a relationship between CPVA and Security. With this, we reject the null hypothesis.

H2d: An increase in E-Commerce **security** (IV) increases **trust** (DV) of making E-Commerce transactions by the citizen.

This hypothesis signifies the relationship between two dependent variables and this will be discussed in detail in the Trust Model section.

H2e: Greater **security** (IV) leads to a greater **intention to adopt E-Commerce** (DV).

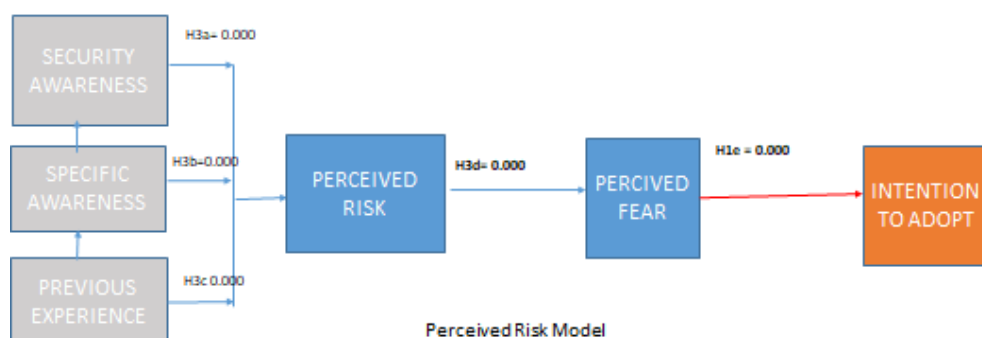
Security plays important role in businesses, especially in e-businesses and E-Commerce. The study has previously identified security as a major barrier in developing countries' E-Commerce. Building a highly trustable E-Commerce platform requires a high and sophisticated security mechanism. The hypothesis was developed and measured using a survey and 3 security techniques that are simulated in the experimental scenarios. The survey consists of 10 structure questions and tested the following: network and infrastructural safety, internet and E-Commerce safety, information privacy, data storage, data control, data protection policies, PAT impact and benefits, and effect of adequate protection on E-Commerce adoption.

The survey also has a high-reliability score of Cronbach Alpha of 0.859 and this signifies that the results from the survey are reliable and accurate. Again, the study sample means of 3.20 shows that the participants are neutral or at the medium in the survey respondents. But the standard deviation of 1.08 indicates that individual data is well spread out. The provision of adequate security techniques in E-Commerce will go a long way in enhancing and promoting E-Commerce adoption in developing countries.

Also, the standard error of 0.078 shows that the study sample mean is reliable and accurate and very close to the true mean of the overall population. The results from the survey also have a level of significance of 0.000 which indicates that there is a relationship between the Security and Intention to adopt E-Commerce in developing countries. With this level of a significant result, the null hypothesis is hereby rejected.

### 7.3.3 Awareness and Previous Experience Lead to Perceived Risk

Perceived Risk is common in developing countries' E-Commerce [247]. Many risks are associated with virtual transactions because the participants are operating through the platforms without physically meeting one another. Many independent variables have a relationship with perceived risk.



**Figure 7.11 Showing the Results of the Relationship in the Perceived Risk Model**

A set of hypotheses that will be discussed in the following section were formulated and tested using a survey questionnaire. The result of various relationships is associated with perceived risk. Below Table 7.7 summarises the results of these relationships and Figure 7.11.

### Table 7.7 Summarizing the Results of the Perceived Risk Relationship

Variable	No of Items	Mean	SD	Variance	Std. Error	Level of sig.	Result Interpretation
Security Awareness	8	3.19	1.17	1.3689	0.084	0.000	Neutral, More or less
Specific Awareness	26	3.19	1.24	1.5376	0.077	0.000	Neutral, More or less
Previous Experience	10	3.37	1.19	1.4161	0.090	0.000	Neutral, More or less
Perceived Risk	10	3.96	0.80	0.6400	0.064	0.000	Sig., Agree & highly Important
Perceived Fear	25	3.53	1.16	1.3456	0.084	0.000	Sig., Agree & highly Important

H3a: A citizens' **security-specific awareness** of E-Commerce influences their **perceived risk** (DV) of making E-Commerce transactions.

In any E-Commerce or virtual transaction, security awareness is very important [5]. This was discussed in chapter 3 of the thesis. The hypothesis was measured through a survey question and examined the security awareness perception of the participants that

took part in the fieldwork. Part of construct examined includes detailed steps on how to perform transactions electronically, help in the instruction of e-services, explanation on how the E-Commerce transactions being processed, about the updated date of the E-Commerce website, about us aspect of the E-Commerce website, about the existing users of the website and other security awareness related questions.

The Survey questions that consist of 8 structured items have high reliability of Cronbach Alpha of 0.845 which shows that the results from the survey are reliable. Again, the mean result of 3.19 shows the neutrality of the participant about security awareness. This indicates that many citizens' security awareness and how the perceived risks can be kept minimised whenever E-Commerce engagements are to be taken may not likely be enough. Then this may keep the risk high for the citizens who want to adopt E-Commerce. Invariably, the standard deviation result of 1.17 tells the extent to which the mean is widely spread out. Therefore, it signifies how individual data values are close to the mean value.

Also, the standard error of 0.084 signifies the accuracy and reliability of the mean value and the level of significance of 0.000 indicates that the relationship between security awareness and the perceived risk is significant and the null hypothesis is hereby rejected.

H3b: A citizens' **specific awareness** of E-Commerce influences their **perceived risk** (DV) of making E-Commerce transactions.

The survey used was reliable and it has a Cronbach Alpha of 0.908 which indicates that the survey was very accurate and adequate for the measurement. The mean of 3.19 shows the neutrality and more or less to the specific and general awareness that was examined. There are lots of benefits encompass with the adoption of E-Commerce if the citizens have adequate knowledge in the specific and general awareness of E-Commerce system. The standard deviation result of 1.24 signifies that the individual data are well spread out and the shape of the distribution is adequate.

Also, there is good reliability and accuracy about the mean value of this study sample distribution. The small and negligible standard error result value of 0.077 signifies that the sample mean is very close to the true mean of the overall population. Again, the mean value is reliable. Also, the level of significant result of 0.077 proves that there is a

relationship between specific/ general awareness and perceived risk. Therefore, the null hypothesis is hereby rejected.

H3c: A citizens' bad **Previous experience** (IV) in E-Commerce transactions increases their **perceived risk** (DV) of making E-Commerce transactions.

In the developing countries where many people that are educated are times IT illiterate. In other words, previous experience in computers and internet usage becomes very paramount. Since the computer system and the internet are the bedrock of E-Commerce. The hypothesis was formulated and discussed in chapter 3. Some of what is examined under this hypothesis include: the citizen's proficiency when using a computer, how often the participant uses the internet? The internet usage satisfaction was examined, how often do the citizens transact online, and how satisfied is the transaction? Was the previous experience encouraged to continue using E-Commerce? Previous online experience and the help concerning online transactions were examined and previous experience with gateways operators like banks, payment gateways, and others was tested.

The Survey used to measure consists of 10 items with Cronbach Alpha of 0.874, and this shows that the results from the survey are reliable and adequate for the measurement. Again, the mean value of 3.37 shows the neutrality of the citizens about the previous experience in computer and internet usage in developing countries. The standard deviation result of 1.19 shows that the individual data are well spread out and the individual data values are very close to this study sample mean value. Therefore, previous experience of the E-Commerce system is more or less from the study mean value but well spread out as confirmed by the standard deviation's result from the study.

Moreover, the standard error of 0.090 shows that the sample study means the value is accurate and reliable. The SE tells us how close the sample mean is to the true mean of the overall population. Besides, the level of significant result of 0.000 indicates that there is a relationship between the previous computer, and internet experience and the perceived risk, and the null hypothesis is rejected.

H3d: A citizens' increased **perceived risk** (IV) increases their **perceived fear** (DV) of making E-Commerce transactions.

The perceived risk as discussed in chapter 3 of this thesis identified that there are many risks associated with E-Commerce and virtual transactions. It is believed that the risk can be kept minimal if adequate knowledge and information are in place. The survey



was used to measure the hypothesis and it consists of 10 structured questions. The aspects measured include: Examine the application concept in general and the use of shopping application, the level of agreement with the experimental and the aesthetical nature of the E-Commerce system.

The survey has a good reliability result of Cronbach Alpha result of 0.890 which shows that the survey was very reliable and accurate for this measurement. Also, the mean result of 3.96 indicates that the participants agree in their response with all the constructs under the perceived risk. The risk in E-Commerce can be minimised or high depending on how it is being managed and available supports either technologically or inform of guidance policies. Furthermore, the standard deviation result of 0.80 tells that the individual data is spread out and individual data are close to a sample mean.

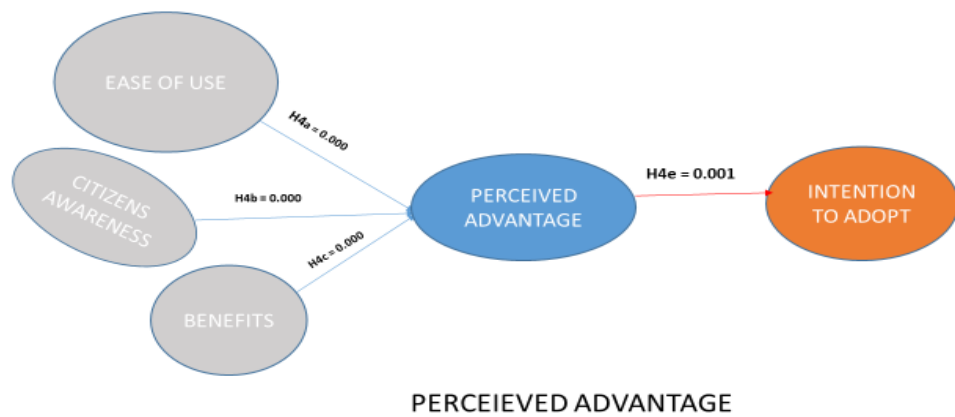
Besides, the above measurement has high reliability with a small value of the standard error of 0.064 which further proves that the mean value is reliable and accurate. This further signifies that the study samples mean the value is very close to the true mean value of the overall population. The level of significance of 0.000 tells that there is a relationship between perceived risk and perceived fear. The high the risk the more likely be the fear, therefore, based on the result, the null hypothesis rejected.

H3e: Decreasing a citizens' **perceived risk** (IV) increases their **trust** (DV) in E-Commerce Transactions.

The perceived fear relationship and intention to adopt E-Commerce were discussed above. However, the perceived fear relationship with the trust will be discussed in the trust model relationship that will be discussed in one of the below sections.

#### **7.3.4 Ease of use and the Perceived Advantage**

The ease of use was discussed in chapter 3 and this variable could contribute immensely to the adoption of E-Commerce if it is adequately put to use on the e-transaction platforms [248]. The simplicity of a system is very paramount to its acceptance by the citizens.



**Figure 7.12 Showing the Results of the Relationship of Perceived Advantage Model**

It is believed that ease of use and other independent factors lead to the perceived advantage. Below table 7.8 summarises other independent factors that are hypothesized with the perceived benefits.

**Table 7.8 Summarizing the Results of the Perceived Advantage**

Variable	No of Items	Mean	SD	Variance	Std. Error	Level of sig.	Result Interpretation
Ease of Use	6	3.63	1.00	1.0000	0.072	0.000	Sig., Agree & highly Important
General Awareness	18	3.22	1.19	1.4161	0.078	0.000	Neutral, More or less
Perceived Benefits	7	3.84	0.98	0.9604	0.071	0.000	Sig., Agree & highly Important
Perceived Advantage	7	3.29	1.13	1.2769	0.081	0.001	Neutral, More or less

**H4a: Ease of use (IV) of E-Commerce technology leads to a greater perceived advantage (DV) in using E-Commerce transactions.**

The perceived advantage can influence the adoption of the E-Commerce system in developing countries [47]. Many factors lead to perceived advantage which includes ease of use and others. The hypothesis was discussed and measured with a survey questionnaire that consists of 6 items. Then some aspects measured include: the extent to which the E-Commerce system is easy to use, E-Commerce concentration, and rejection, to what extent do the participants believe that E-Commerce aids economic developments? Test about the structured layout of the website was examined, the design and users'

graphic interface also examined, then how easy is the help and support available was also examined [249].

The survey used has a good reliability result, tested with Cronbach alpha with a value of 0.770 and this indicates that all the results computed from this survey are reliable. The high Cronbach Alpha value signifies that the mean value is accurate and reliable. Again, the mean result of 3.63 tells that, there is an agreement in participants with the ease of use and the perceived advantage. The system that proves to be simple in the design architectural form and the usage witness more patronisation by the users. Again, the standard deviation of 1.000 shows that the mean value is accurate and individual data is highly spread out.

Also, the standard error of 0.972 further signifies that the mean value is reliable and that the study sample mean is very close to the true mean of the overall population. The level of significant result of 0.000 shows that there is a relationship between ease of use and perceived advantage. The ease of use of a system has direct benefits that are advantageous. Therefore, based on the resulting level of a significant result, I hereby reject the null hypothesis.

**H4b: Citizen's awareness (IVs) of E-Commerce technology leads to a greater perceived advantage (DV) in using E-Commerce transactions.**

The citizen's awareness of E-Commerce is very important. There are many procedures, guidelines, support information that need to be known by the users to receive maximum benefits [18]. When citizens are aware of all that needs to know in the E-Commerce system, it is advantageous to users and virtual transaction procedures become better. The above hypothesis was measured using a survey that consists of 18 questions and the following aspects were addressed: E-Commerce platform advertisement, the effect of advertisement and the medium, email, radio, webpages, and workshops in E-Commerce were examined, the awareness campaign on E-Commerce activities, citizen's knowledge about E-Commerce fraud was tested and cybercrime knowledge was also tested.

The survey used to measure the above hypothesis has high reliability of 0.930 of Cronbach Alpha. This indicates that the results of the survey are reliable and accurate. The mean result of 3.22 tells that the participants are neutral in the general awareness of what they are supposed to know about the E-Commerce system. Furthermore, the

standard deviation result of 1.19 proves that the individual data are well spread out. SD value signifies how an individual value is very close to the sample mean. Citizens should be educated through an enabling policy where the E-Commerce benefit may likely be derived as a result of citizens being aware of necessary information and procedures.

The hypothesis further proofs with the standard error result of 0.078 which shows further that the mean value is reliable and accurate and how the study sample means are very close to the mean of the overall population. Besides, the level of significance of 0.000 was achieved which proves further that there is a relationship between citizen awareness and perceived advantage. Therefore, based on the level of the significant value we reject the null hypothesis.

H4c: **Benefits** (IV) of E-Commerce technology leads to a greater **perceived advantage** (DV) in using E-Commerce transactions.

The perceived benefits Are very important in E-Commerce. This can be described as one of the enabler adopters of E-Commerce. The hypothesis between perceived benefits and perceived advantage was measured using a survey that consists of 7 questions. The following aspects were asked to test in the survey: Quickness of the transaction, to what extent do you believe that E-Commerce will save time, money, and effort? It is believed that E-Commerce reduces the manual transaction procedure, the transaction ability was measured, the enhancement and adoption's ability were tested, cultural relationships and the increments in the purchasing power were also measured.

The survey used has high reliability of Cronbach Alpha of 0.828 which signifies that the survey's results are reliable and accurate. Again, the mean value result of 3.84 tells that the participants agree about the constructs in the above-discussed hypothesis. The standard deviation result of 0.98 proves that the individual data value is well spread out from the mean and individual data very close to the sample mean. The stand error result of 0.071 further testified to the authenticity and reliability of the mean value. SE also proves that the study means value result is dependable. And very close to the true value of the mean of the overall population. Besides, the level of significant result of 0.000 further proves that there is a relationship between perceived benefits and perceived advantage, and the null hypothesis is rejected.

H4d: H4d: A greater **Perceived Advantage** of E-Commerce by the citizens lead to greater **trust** of E-Commerce Transactions.

The relationship between perceived advantage and trust is the hypothesis of 2 dependent variables that will be discussed in the trust model.

H4e: If a citizen **perceives an advantage** (IV) to using E-Commerce transactions this will increase their **intention to adopt E-Commerce** (DV).

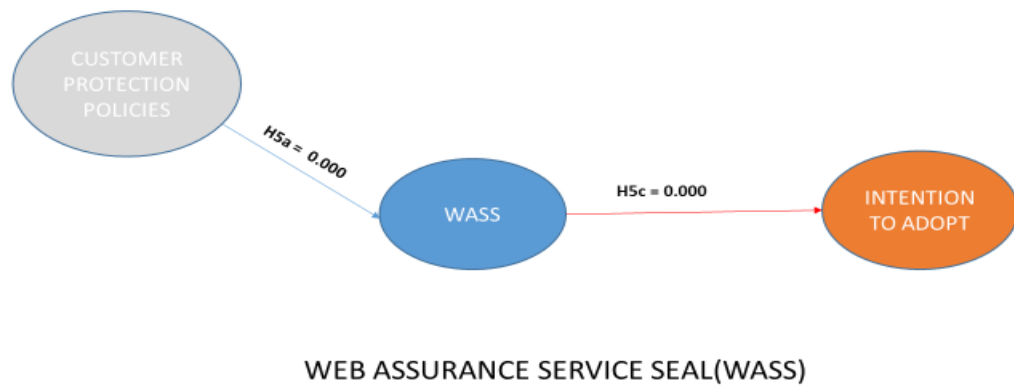
The perceived advantage as discussed above has a set of independent factors that are significant and have a relationship with perceived advantage. The above hypothesis was developed to ascertain the relationship to adopting E-Commerce in that particular model. The hypothesis was formulated to know and in chapter 3 of this thesis. This hypothesis was also measured using a survey that consists of 7 structured questions. That measured the following areas: the extent to which the citizens know how to track the status of a performed transaction, the history of the performed transaction, provision of the financial information, ability to rate, share the link, help support, electronic machine in the public area and the communication rate in the secure environment assessment were all tested in the survey.

The survey questions discussed above have a high-level Cronbach Alpha result of 0.871 shows that the survey result is accurate acceptable and reliable. Also, the mean result of 3.29 shows the neutrality of the respondents with the perceived advantage to adopt the E-Commerce system. E-Commerce is very advantageous but it may be very difficult to prove beyond more or less to the user that has not been witnessing such advantages. In another way, the standard deviation of 1.13 clearly shows that the data value is highly spread out and that the individual data is very close to the mean value.

Moreover, the standard error result of 0.081 indicates mean value accuracy and reliability. SE tells how close the sample mean is to the true mean of the overall population. There is also a level of significant result of 0.001 which shows that there is a relationship between perceived advantage and intention to adopt E-Commerce. Therefore, I reject the null hypothesis.

### **7.3.5 Protection Policy and Web Assurance Seal Service (WASS)**

A policy can be described as a rule guiding and operationality of a business or a system as discussed in the chapter of this thesis. The policy is meant to protect both the citizens and the systems to perform as expected and to follow the laid down regulations [246].



**Figure 7.13 Showing the Results of the Web Assurance Seal Service (WASS) Model**

Table 7.9 below summarises the result of protection policy and Web Assurance Seal Service (WASS) in the E-Commerce of developing countries.

**Table 7.9 Summarizing the Results of Web Assurance Seal Services (WASS)**

Variable	No of Items	Mean	SD	Variance	Std. Error	Level of sig.	Result Interpretation
Policy Protection	7	3.37	1.48	2.1904	0.107	0.000	Sig., Agree & highly Important
WASS	9	3.33	1.08	1.1664	0.078	0.000	Neutral, More or less

H5a: An increase in **protection policy** (IV) increases the use of **Web Assurance Seal Service (WASS)** (DV) in E-Commerce transactions.

In E-Commerce where every process is virtual, where the following processes like citing samples, ordering, payment, delivery, and in some cases returning or canceling the transactions are executed. There must be a strong policy that will protect the interest of both in such a transaction [65]. This hypothesis was used to examine areas like infrastructure sufficiency in Nigeria, Adequacy of E-Commerce Government policy, to what extent did Government and Organisations protect or not protect citizens satisfactorily, the rate of E-Commerce service in Nigeria, assessment of poster delivery, and impacts of a technical error in using such e-services.

The survey used in measuring the above hypothesis consists of 7 structured questions and has a reliability value of Cronbach Alpha of .537 which is on average. Notwithstanding, the mean result also shows the neutrality of the protection policy from the respondents. Probably, maybe much effort has not been witnessed in this aspect of E-

Commerce. But the standard deviation of 1.48 shows the extent to which individual data values are closed to the mean value. Though based on SD value individual data is well spread out.

Again, the standard error of 0.107 is a bit high and this shows how close the sample mean in the study is to the true mean of the overall population. In a nutshell, the result got are in; more or less, not sure or in the medium. Invariably, the result of 0.000 of the level of significance shows that there is a relationship between the protection policy and Web Assurance Seal Service (WASS). Therefore, the null hypothesis is rejected.

H5b: The adequate use of **Web Assurance Seal Service (WASS)** (IV) increases citizens' **trust** (DV) in E-Commerce transactions by the citizen.

The Web Assurance Seal Service (WASS) is very important in E-Commerce [250]. Trust is considered a critical enabler in reducing consumer concerns regarding E-Commerce transactions [19]. Another enabler that helps reduce consumers' concerns is Web Assurance Seal Services (WASS) [18]. Customers perceived fear is said to be low when web assurance seal services are cited on a particular E-Commerce site. The above hypothesis will be discussed in detail in the below section of the trust model.

H5c: The use of **Web Assurance Seal Service (WASS)** (IV) leads to greater **Intention to adopt** (DV) E-Commerce transactions.

Web Seal Assurance Services can be seen as an enabler of E-Commerce adoption [18]. WASS is said to have eased the tension of the consumers or the users of E-Commerce. The website's digital verification involves assessing a particular E-Commerce platform to ascertain the privacy and confidentiality of the customers. Many users of E-Commerce refused to give out their financial information because of identity theft and others form of online theft. A website with WASS verifiable signs is said to enjoy more patronage than those without. Therefore, I can say that WASS serves as an enabler of E-Commerce adoption in many circumstances [251]. The area tested with the survey includes information about the privacy policies, E-Commerce protection policies, awareness of human rights laws and regulations, about the consumer protection council of Nigeria, Central bank, independent body Nigerian Police Force, and the impact of Government policies in combatting the crime.

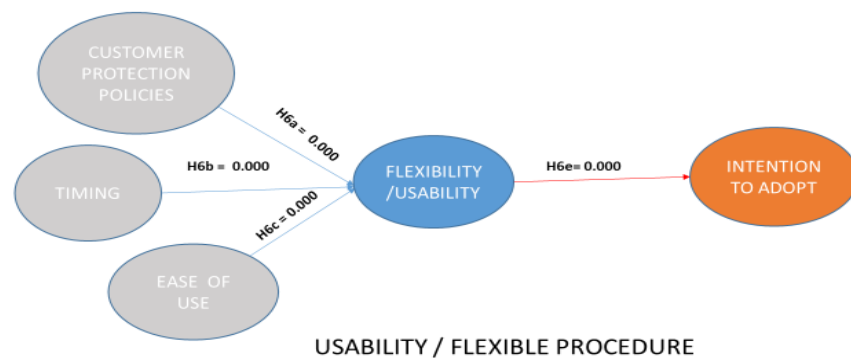
The above hypothesis was measured using a survey that consists of 9 structured questions that have a reliability value of Cronbach Alpha of 0.888. This value signifies

that the result of the survey is quite reasonable and reliable. The mean value of 3.33 shows the neutrality of the response of the participants. The citizens of Nigeria and other developing countries have not been enjoying the WASS in order words, their neutrality indicates that there is more to in this regard to the developing countries' E-Commerce. If this E-Commerce enabler (WASS) is to be benefited in developing countries' E-Commerce. Furthermore, the standard deviation of 1.08 shows that the data is well spread out and how close the individual data from the sample mean is.

Again, the result of the standard error of 0.078 proves the mean value reliability and also how close the sample mean is to the true mean of the overall population. Also, the level of significant result of 0.000 proves that there is a relationship between web assurance seal services and intention to adopt E-Commerce. Hence, I reject the null hypothesis.

### 7.3.6 Usability Relationships

The importance of evaluating the usability of E-Commerce websites is well recognized. What constitutes a good website has been traditionally explained by relating it to user and usability. In other words, a successful and preferable website generally refers to one with high usability, which is user-friendly and user-centered in an interface and functional aspects.



**Figure 7.14 Showing the Result of the Usability Model Relationships**

There is a set of hypotheses used to prove usability relationships. Table 7.10 below summarises the results of these relationships.

**Table 7.10 Summarizing the Results of the Usability Model**

Variable	No of Items	Mean	SD	Variance	Std. Error	Level of sig.	Result Interpretation



Protection Policy	7	3.37	1.48	2.1904	0.107	0.000	Neutral, More or less
Transaction Timing	3	3.05	1.17	1.3689	0.085	0.000	Neutral, More or less
Ease of use	6	3.63	1.00	1.0000	0.072	0.000	Sig., Agree & highly Important
Usability	34	3.51	1.16	1.3456	0.084	0.000	Sig., Agree & highly Important

H6a: An increase in **protection policy** (IV) leads to greater **flexibility/usability** (DV) of E-Commerce transactions.

The protection policies play much importance in customers' trust-building. Many policies protect both customers and vendors in carrying out safe e-transaction. As discussed above, the protection policy hypothesis was used to test the user perspective about the law and guidelines on E-Commerce transactions. It is believed that the protection policies assist users to have smooth usability. The policy protection has been discussed above but summarily, the survey has 7 questions, Cronbach Alpha of 0.537, and a mean of 3.37 which shows neutrality, and a standard deviation of 1.48 which signifies that an individual data is spread out.

The stand error of 0.107 is also on average and the level of significant result is 0.000 this indicates that there is a relationship between the protection policies and Usability and based on this, the null hypothesis is rejected.

H6b: A decrease in **transaction timing** (IV) leads to greater **flexibility/usability** (DV) of E-Commerce transactions.

Access time is very important in the design of any system. Customer values their precious time and at the same time, they would not want to make mistakes. The time that takes a transaction to execute and gives results is very important [20]. The hypothesis is designed for the transaction time in this research work to enable the researcher to determine how users are affected by the time it takes to complete their transactions. The survey was used to measure the above hypothesis consisting of 3 structured questions that measured the following: to what extent does the user knows the expected time to complete the E-Commerce transaction? To what extent did users know the expected time to spend when performing an E-Commerce transaction? And to what extent did users know the last update of the E-Commerce website?

The survey used has a reliability value of Cronbach Alpha of 0.766 which shows that the results from the survey are reliable and accurate. The result of the mean value of 3.05 shows the neutrality of the users with e-transaction time. It is said that the transaction time may be difficult to predict when performing an online transaction in developing countries due to network and other logistics problems. Invariably, the standard deviation result of 1.17 tells that the individual data are very close to the study sample mean value and the data is well spread-out.

Furthermore, the standard error result of 0.085 proves that the mean value of this study is reliable and how close the sample mean is to the true mean of the overall population. The level of significant result of 0.000 indicates that there is a significant relationship between the transaction time and Usability. Therefore, the null hypothesis is hereby rejected.

**H6c: An ease of use (IV) of E-Commerce platform lead to greater flexibility/usability (DV) of E-Commerce transactions.**

Ease of Use has been discussed in the above section but with usability, ease of use is very paramount to usability [247]. As discussed above this hypothesis was developed and measured using a survey that consists of the following results were generated: the Cronbach Alpha 0.770, which shows high reliability, and mean of 3.63 which indicates an agreement from the respondents, the standard deviation result 1.0 shows that the individual data is well spread out, the standard error of 0.072 shows the mean reliability and accuracy, the level of significant of 0.000 shows that the relationship between ease of use and usability and the null hypothesis is rejected.

**H6e: A greater flexibility/usability (IV) lead to greater Intention to adopt (DV) E-Commerce transactions by the citizens.**

The usability of a system is very important and can be described as one of the enablers of E-Commerce adoption [18]. Usability of E-Commerce in developing countries' hypothesis was measured with a survey that consists of 34 structured questions and the following areas were examined: the context of given scenarios of the experimental work was examined, the users' experience on the design fiction and authenticating technology was examined, the usage of the platform developed was tested with browsers, the user experience of simulated technologies of PIN/Password, fingerprint, and CPVA, the satisfactory performance of these authenticating technology was determined, user help

support and training concerning CPVA were examined and users general usage of the experimental scenarios was examined.

The survey used has a reliability value of Cronbach Alpha of 0.888 which shows that the survey's result is reliable. The mean value of 3.51 shows that the users of the experimental designed scenarios agreed with the respondents of the fieldwork. In other words, the flexibility of E-Commerce may likely increase the citizens' adoption. The result of the standard deviation of 1.16 indicates that the individual data is very close to the sample means and well spread out.

Again, the standard error result of 0.084 indicates the reliability and accuracy of the mean value and SE tells us how close the sample mean is to the true mean of the overall population. Also, the level of significant result of 0.000 signifies that there is a relationship between usability and intention to adopt E-Commerce. Therefore, users' experience and perception of E-Commerce usability may likely increase E-Commerce adoption in developing countries.

### 7.3.7 Trust Model in E-Commerce

Trust is very important in E-Commerce; every variable is either directly or indirectly leads to trust [19]. The trust model was developed that has several relationships and the trust leads to intention to adopt E-Commerce.

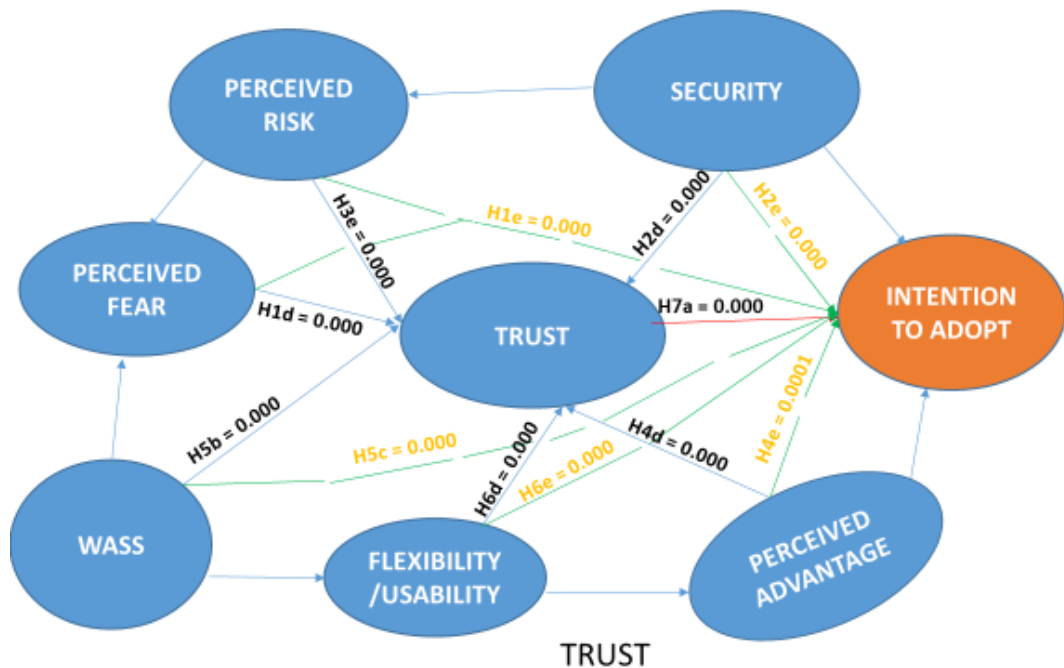


Figure 7.15 Showing the Results of the Trust Model

Table 7.11 summarised the result generated from the trust model and relationships.

**Table 7.11 Showing the Result of the Relationships of the Trust Model**

Variable	No of Items	Mean	SD	Variance	Std. Error	Level of sig.	Result Interpretation
Perceived Fear	25	3.53	1.16	1.3456	0.084	0.000	Sig., Agree & highly Important
Security	10	3.20	1.08	1.1664	0.078	0.000	Neutral, More or less
Perceived Risk	10	3.96	0.80	0.6400	0.064	0.000	Sig., Agree & highly Important
Perceived Advantage	7	3.29	1.13	1.2769	0.081	0.001	Neutral, More or less
WASS	9	3.33	1.08	1.1664	0.078	0.000	Neutral, More or less
Usability	34	3.51	1.16	1.3456	0.084	0.000	Sig., Agree & highly Important
Trust	10	3.96	0.97	0.9409	0.070	0.000	Sig., Agree & highly Important

H1d: Decreasing a citizens' **perceived fear** (IV) increases their **trust** (DV) in E-Commerce Transactions.

The perceived fear as discussed above is a potential fear that users perceived as a result of lapses that occurred in a system. An E-Commerce system encompasses virtual representation and this poses a threat to the user if the system is vulnerable. Therefore, as discussed above, the summary of the result will just be represented: 25 question items, Cronbach Alpha of 0.887, mean value of 3.53, SD of 1.16, SE of 0.084, and Level of Significant of 0.000. The results simply show that the survey results are reliable and there is an agreement in the respondents, the data is well spread out and there is a level of significance. Therefore, there is a relationship between perceived fear and trust. Based on this result, we reject the null hypothesis.

H3e: Decreasing a citizens' **perceived risk** (IV) increases their **trust** (DV) in E-Commerce Transactions.

Security is the most important factor in E-Commerce. For the user to be confident and trust a system, such a system must be highly secured [126]. The security has discussed above, has a relationship with the intention to adopt E-Commerce. Also, for the system

to enjoy total adoption, there must be adequate trust by the user. The summarised result of this hypothesis includes: the survey consists of 10 structured question items, Cronbach Alpha of 0.859, mean value of 3.20, SD of 1.08, SE of 0.078, and level of significance of 0.000. The Cronbach Alpha result shows that the survey result is reliable. The mean shows that the respondents are neutral in their responses. The SD result tells that the individual data are well spread out and the SE result indicates mean reliability. Besides, the level of significant result shows the significance and there is a relationship between Security and trust. The highly secure system may likely enjoy the trust of the users and witness more adoption.

H2d: An increase in E-Commerce **security** (IV) increases **trust** (DV) of making E-Commerce transactions by the citizen.

The perceived risk is said to have an established relationship with perceived fear which is directly linked to the intention to adopt E-Commerce [53]. If the perceived risk of users about a system is high this may lead to perceive fear and may have an impact on the trust because the trusted platform may likely affect intention to adopt E-Commerce. The Perceived risk relationship has been discussed above, but the results of this hypothesis are discussed below: 10 structured question items, with Cronbach Alpha of 0.890, the mean value of 3.96, SD of 0.80, SE of 0.064, and the level of significant result of 0.000. The survey results are accurate and reliable. Also, the mean value shows that there is an agreement from the respondents. Invariably, the perceived risk may likely be associated to trust. The SD shows that the individual data are spread out and close to the sample mean. The SE tells us that the mean value is reliable while the level of significance is significant. Furthermore, the relationship between perceived risk and trust is significant and therefore, the null hypothesis is hereby rejected.

H4d: A greater **Perceived Advantage** of E-Commerce by the citizens lead to greater **trust** of E-Commerce Transactions.

The perceived advantage can also be referred to as one of the enablers of E-Commerce adopters. Many benefits are associated with E-Commerce. This perceived benefit lead to perceived advantage, which eventually leads to intention to adopt E-Commerce. The perceived advantage relationship was discussed above but the summary of the results from the relationship is summarised as the survey consists of 8 structured questions, with Cronbach Alpha result of 0.845 and mean of 3.19, SD result of 1.17, SE of 0.084, and level of the significant level of 0.000. The results from the survey are

reliable, but the mean value indicates neutrality from the respondents. SD indicates that the individual data is highly spread-out and very close to the study sample mean. SE indicates the accuracy and reliability of the mean value. Also, the level of significance is significant. Invariably, there is a relationship between perceived advantage and trust. With the level of a significant result, the null hypothesis was rejected.

H5b: The adequate use of **Web Assurance Seal Service (WASS)** (IV) increases citizens' **trust** (DV) in E-Commerce transactions by the citizen.

Web Assurance Seal Services (WASS) is the seal assurance service that proofs more integrity into a particular website. In E-Commerce where every transaction is virtual, the use of WASS becomes important for more trust by the users. When the sign that shows WASS is found on the website, it shows that such a site has passed some privacy and integrity test, and this adds to the trust of the users in E-Commerce. The WASS relationship's result is summarised as 9 structured questions, with Cronbach Alpha of 0.888 and the mean value of 3.33, SD of 1.08, SE of 0.078, and level of 0.000. The Cronbach result shows that the survey results are reliable and the mean value proofs neutrality from the survey respondents. The SD result tells that the individual data are spread out the SE shows the reliability of mean value and the level of significant result shows that there is a relationship between web assurance seal services (WASS) the Trust. Therefore, the null hypothesis is rejected.

H6d: A greater **flexibility/usability** (IV) of an E-Commerce system leads to greater **trust** (DV) in E-Commerce transactions by the citizen.

The usability of an E-Commerce system is very important, especially in developing countries, where citizens are growing in terms of information technology knowledge. Again, the usability relationship model was discussed in the above section. The result of usability relationships is summarised: the survey consists of 34 structured questions with Cronbach Alpha of 0.888, which shows that the results from the survey will be reliable. The mean of 3.51 indicates the agreement from the respondents. The issues of usability are very important. Furthermore, the standard deviation of 1.16 shows that the data is highly spread out and the individual data are very close to the sample mean. Furthermore, the Standard error of 0.084 further proves that the mean value is reliable. The level of significance of 0.000 indicates there is a significant relationship between Usability and trust. Therefore, the null hypothesis is hereby rejected.

H7a: An adequate **trust** (IV) in **E-Commerce** transactions increases **Intention to adopt** (DV) **E-Commerce** by the citizens.

In this research work, security and other variables are directly or indirectly related to E-Commerce trust. Electronic commerce generally requires a customer to interact with several trusted intermediaries before actually contacting the vendor. Trust has been found as the major enabler in E-Commerce, especially in developing countries where the protection policies and other contending factors are not totally in place. In the trust model of the design in this research work, all dependent variables directly lead the trust. Apart from the above-established relationships, the trust relationship to adopt E-Commerce was measured using the experimental scenarios and the survey that has 10 structured questions. The Survey was used to examine the following that determines the intention to adopt E-Commerce: citizens awareness, perceived risk, E-Commerce flexibilities, -commerce benefits, Government policies, security levels, privacy, transaction time, high trust, and reliability.

The survey used has a reliability value of Cronbach Alpha of 0.870, which shows that the survey's results are reliable. Also, the mean result of 3.96 indicates the agreement from the respondents. In developing countries' E-Commerce, a high trust system may bring total adoption. E-Commerce trust may majorly influence users' decisions in adopting E-Commerce. The SD of 0.97 shows that the individual data are spread out and very close to the study sample mean. Again, the standard error of 0.070 further proves the accuracy and reliability of the mean value. SE describes how close the sample mean is to the true mean of the overall population. Lastly, the level of significant result of 0.000 shows that the relationship between E-Commerce trust and the intention to adopt E-Commerce is significant and the null hypothesis is hereby rejected.

## **7.4 Extent of Relationship between the Contending Factors**

The result analyses of the hypothesis relationships from this research work indicate that most of them are either strong or very strong. In this research work, the 3 performance metric yardsticks are used to determine the extent (Effect size, see table, Chapter 6) of relationships that are significant Figure's value, Cohen's value (d), and correlations (r).

The perceived fear has a strong relationship with 3 other independent factors which are finger disorder, identity theft, and privacy. The values (r), (s), and (d) showed that

there are strong relationships. Security is one of the most important factors that enable trust between systems and users. In other words, there are strong relationships between the security and the authenticating techniques which are fingerprints system, digital signature, and CPVA. The relationships indicate how vital is security in the E-Commerce system.

Also, perceived risk plays an important role in the adoption of E-Commerce, especially in developing countries where the users have limited income. Therefore, the perceived risk has strong relationships with security awareness, previous experience, perceived fear, and a very strong relationship with the specific awareness. Again, the perceived advantage is one of the contending factors in E-Commerce adoption in developing countries. There is a strong relationship between perceived advantage and ease of use, general awareness, perceived benefits based on the values of (r), (s), and where the mean values are almost zero in (d) value.

Web Assurance Seal Service (WASS) also plays an important part in providing security assurance through third-party security seal verification. This has not been so much in practice in developing countries. But there is a strong relationship between (WASS) and policy protection, in that case, WASS will assist in building trust in the E-Commerce of developing countries. Besides, Usability has a strong relationship with protection policy, transaction time, and ease of use. Therefore, the author of this thesis argued that usability is very important in any system because it's concerns users directly [2].

Invariably, trust is the most contending factor that has an overall impact on the users. Because the trustable E-Commerce system will witness user patronization. Therefore, trust has a very strong relationship with security. The secured system will be trusted. Moreover, trust has a strong relationship with other contending factors such as perceived fear, perceived risk, perceived advantage, WASS, and usability. This is adequately illustrated in the trust model.



# Chapter VIII

## 8. Conclusion and Recommendations

The previous chapter discussed the result analyses and findings from the respondents that are Nigerian citizens. The relationships were established, their significance and effect size were also discussed. This chapter focuses on the conclusion and appraisal of this thesis, the aim, and objectives are examined, contributions to knowledge made, and recommendations that are detailed in this chapter.

### 8.2 The Summary Overview of the Research

This section provides a summary of each of the chapters in which the overview of the achievement in that chapter has been stated. It's also itemised the process that involves achieving those tasks.

#### **Chapter 1: Stating the Research Question, Statement of Problem, Research Aim and Objectives**

Chapter 1 serves as introductory aspects where the research problem was identified and defined. The research aims and objectives were introduced in which E-Commerce has been identified as a catalyst for economic growth in developed countries. This growth has been attributed to the total adoption of E-Commerce by the citizens of developed countries. But this is contrary in developing countries where the citizens did not have adequate trust in both the E-Commerce system including its intermediary systems which include: payment system, delivery and courier system, and policing system.

In developing countries' E-Commerce, security was identified as a major barrier with other barriers like government policy, technology, cultural heritage, and others that are preventing total adoption of E-Commerce in developing countries. This research aimed at different security authentication technologies that can bridge the vulnerable authenticating system in the E-Commerce of developing countries. The use of digital signature (PIN/Password) was examined and the Identity theft was found to have been associated with such authentication technique. Again, an alternative technique fingerprint identification system was also identified and this proved to have secure and reliable. In order words, fingertips damages have been found associated with it. In a bid to find a very secure Personal Identification Technique (PAT), Contactless Palm Vein Authentication

Technique (CPVA) was examined together with its advantages. Then 3 algorithms of CPVA were examined to know the best performance out of them. The research questions were also formulated in Chapter 1, which will be addressed shortly. Chapter 1 also outlines contributions made by this research work, which is discussed in more detail below.

## **Chapter 2: Defining Literature Survey of the Research Work and the Background Knowledge**

An extensive literature survey was conducted on E-Commerce and E-business in developed and developing countries. The conceptual comparison was done with the E-Commerce adoption, benefits, challenges, and barriers. The proper review of the E-Commerce acceptance technological model (TAM) in contexts of both developed and developing countries. Also, an overview of its implementation in Nigeria was presented. Again, in chapter 2, a critical evaluation of the benefits and contributions of E-Commerce, including its barriers was achieved which serves as the first objective of this thesis.

More so, in chapter 2, all the review of authentication techniques is thoroughly reviewed. The problem of digital signature, including its, weaknesses were examined. Biometric authentication techniques were examined with their features, advantages, and weaknesses. The gap between the developed and developing countries of the world was extensively reviewed. The barrier hindering E-Commerce adoption in developing countries was also examined. The shortcomings of each biometrics technique were analysed and the contactless palm vein authentication technique was examined.

CPVA benefits, implementations, and applications were examined.

In particular, palm vein algorithms were examined and palm vein image acquisitions are also examined as key solutions to improve E-Commerce transaction adoption. These Algorithms include Kernel Principal Component Analysis (KPCA), Kernel Independent Component Analysis, and Kernel Linear Discriminant Analysis (KLDA). The research uses simulated and designed working prototype Palm vein using PHP, SQL, HTML, and other web development tools.

## **Contactless Palm Vein Architecture**

Palm vein architecture and experiment design were achieved in Chapter 4. Palm vein architecture approach. A subspace-based approach that makes use of linear discriminant analysis, principal component analysis (PCA), (LDA), and independent component

analysis (ICA). Statistical approach and other approaches are also discussed. Moreover, appearance-based architecture that comprises linear and nonlinear architectures is reviewed. The introduction of a nonlinear algorithm using the Kernel general framework of the palm vein system is reviewed. The design of this research work is based on the use of the following kernel type algorithm: kernel principal component analysis (KPCA), kernel independent (KICA), and kernel linear discriminant analysis (KLDA). Again, the experimental methodology was also reviewed. The above discussion satisfies part of the aim and objectives of this research work:

This research will consider the design of a Palm Vein system prototype using the selected kernel-based feature extraction methods (KPCA, KICA, and KLDA), Kernel Principal Component Analysis (KPCA), Kernel Independent Component Analysis (KICA), Kernel Linear Discriminant Analysis (KLDA), [28], [84 ], [136]

**Research Question:** How can digital security provide adequate protection for Nigerian citizens against different fraudulent acts for typical E-Commerce applications?

### **Chapter 3: Defining the Research Design and Methodology**

Chapter 3 of this thesis deal with the methodology design of the experiment. Research comparative analysis and the empirical tool are discussed in detail. Design fiction was presented to provide a framework to introduce new technology to the audience. The quantitative method was presented where a survey was used to gather facts from the participants after experimentation. The justification for choosing a typical method was also stated.

Another important task performed in chapter 3 was the hypothesis generation that resulted in a model formulation. Therefore, the research model was generated from the research hypothesis. Also, the issue of dependent and independent variables was discussed in chapter 3. Research questions 1b and 1c were also answered: biometrics techniques and the kind of security measure that can be adopted on E-Commerce were part of the design.

### **Chapter 4: Experimental design**

Another important task executed in chapter 4 is the experimental design, methodology, experimental factor, the 3 important tasks executed are design fiction documentary (DFD), shopping experimental task, and survey questionnaire. Survey administration, data collection, data entry, anonymization, and data verification were also

stated. Pilot studies and sampling size was also examined. The experimental task that was designed using a within-subject design was examined. The design of the questionnaire survey and demographic survey was also examined.

Chapter 4 which is experimental design is used to achieve the processes that answer the hypothesis in this research work. Sub questions of research question 2 are also answered in the Design Fiction Documentary and the feedback through the questionnaire from the participants.

### **Chapter 5, 6 and 7: Experimental Implementation, Data Analysis and Result Discussion**

The experimental procedure was carried out in chapter 5 first, with a pilot study of 30 samples is Nigerians living in the UK, the participants after seeking consent took part in the 2 experimental conditions followed by the survey, and the results were collated. Another pilot of 10 samples was carried out in Nigeria to understand the terrain and the project understandability of the citizens. The results were quickly analysed and based on this, some measures were taken which includes: allocating more time to the participants, assisting in the system and experimental setup, and adjusting to the usage of the only laptop to accommodate offline E-Commerce experimental application of the design fiction documentary and design fiction simulated E-Commerce application that consists of multiple payment application. After which the fieldwork was carried out in Nigeria in 4 cities and their metropolis as stated in the design. There are 3 used case scenarios: the first scenario answered the aim and objective discussed above, the second used case scenario answered research question 3, and the third is the simulated design fiction E-Commerce platform built for the user experience used case scenario.

The experimental procedure answered the research questions 3 a and b which the question states as:

Chapter 6 was used to analyse data in generating the results. Different kinds of tests were carried out in chapter vi: the demographical data collected during the fieldwork were analysed using the Frequency distribution table. After which the central tendency was measured. The statistics tools used include: mean, median, standard deviation, and variance. Also, reliability test like Cronbach Alpha and standard error was used. Then the hypothesis testing tools like F value and P-value are also used.

Besides, the test of relationship strength determination tools like correlation, covariance, and effect size was used in generating the extent of the relationship. While

chapter 7 dealt with discussions and findings. Hypothesis testing was explained and discussed. These answered the hypothesis generated and also answered the questions 2d and 3c stated above. Again, the extent of the relationship between the dependent and independent variables is discussed. Also, the conclusion, summary, and recommendations were achieved in chapter 8.

## **8.3 Developing Countries E-Commerce Adoption Research Model**

The model research in E-Commerce as discussed in Chapters 3 and 4 of this research works explained the relationships between independent and dependent variables.

### **8.3.1 Dependent Variables Relationships Model**

The discussion summarised the relationships between the dependent variables. Below Figure 7.15 shows the relationship.

### **8.3.2 The Research E-Commerce Model in Developing Countries**

The summary of the result presented in this research between both dependent and independent variables including the result of their relationship is explained in chapter 3.4 and summarised in chapter 7. The Figures 3.7 and 4.1. Show the complete model in this research and the hypothesized Relationship Results of the Research Model.

The research model shows that both dependent and independent variables relate and have a relationship with E-Commerce adoption in developing countries. Users are majorly concerned with trust. Trust is a factor that influences the adoption of E-Commerce in developing countries. All the independent variables are factors that have a major influence on dependent variables. Again, all dependent variables lead to a factor called trust therefore, trust is the most enabling factor in the adoption of E-Commerce in developing countries.

## **8.4 Recommendations**

The major objectives of this research were to propose a security authentication technique that will overcome the fear and distrust associated with security authenticating systems, causing the distrust in the E-Commerce of developing countries. Contactless Palm Vein Authentication (CPVA) security architecture proposed for citizens' acceptance is recommended. These recommendations are aimed at the user, vendors,

gateways and government policymakers, IT policymakers, e-services, and E-Transaction providers. The below set of recommendations is written to assist both the provider, users, and policies guidance of E-Commerce, E-Business, E-Transaction, and E-Services, especially in developing countries where E-Commerce still experiences stunted growth.

#### **8.4.1 Recommendation for the Provision of Secure E-Commerce Platforms for the Users**

The following recommendations adequately need to be implemented for the users if E-Commerce in developing countries is to witness total adoption.

##### **1. The Secure Electronic Platforms must be Provided for Users**

Security is one of the most important factors in the development of secure E-Commerce platforms. Users will consider an E-Commerce platform to be secured if their privacy and confidentiality are kept intact. Also, users will fill more saver on the E-Transaction, if they have only CPVA that can authenticate the authorization.

##### **2. Trust in which User will have Confidence must be Integrated into the System**

The E-Commerce system that will yield a fruitful system in developing countries must be encompassed with trust and integrity that users can rely on. The system is said to be trusted if it gives the expected result and behaves as expected by the user. The issues reporting and resolutions must be perfect, accurate, and result-oriented. By these, users will be influenced by this factor and there will be more adoptions.

##### **3. The new E-Commerce Platform must Benefit Users**

The benefits that users derived from E-Commerce are very important and enough to influence the user's adoption. The E-Commerce system is said to be beneficial if it provides values that users expected. In a developing country where Nigeria is one, cultural business transactions are very paramount to the citizens. If the users will eventually prefer online transactions that are purely through virtual means, to the cultural transactions that are known to the citizens, there must be high benefits that users will be able to derive from E-Commerce.

##### **4. The new E-Commerce Platform must be Flexible and Easy to Use**

In developing countries where stunted growth is experienced in E-Commerce. Flexibility is very important if this will be acceptable to the citizens. The E-Commerce system is said to be flexible if it's has a minimized procedure. The operation procedure must be easy to use for the users and the citizens of the developing countries. Usability is very important and it is highly required in E-Commerce, especially in developing countries.

**5. The new E-Commerce Platform must be Equipped with Functional and Quality E-Services**

An E-Commerce platform consists of many functional aspects and must be equipped with many qualities of services. If E-Commerce will be accepted all the functional and quality aspects must be seriously addressed. All the shortcomings must be seriously taken care of so that there will be an effective, flexible, easy to use, and reliable E-Commerce. In E-Commerce, other functional areas must be looking into the platform where booking will be done, examining, choosing, confirmation, payment, tracking, and delivery. All these aspects must be properly addressed so that citizens or users can experience complete satisfaction.

#### **8.4.2 Recommendation for the Provision of Secure E-Commerce Platforms for the Business Providers and Gateways**

The following recommendations will help the gateway or the business providers in getting ready for an effective E-Commerce platform that may widely be acceptable by the citizens of developing countries.

**1. Reliability Enhancement into the E-Commerce Platforms**

Each of the E-Commerce gateway providers must ensure that reliability features are integrated into the E-Commerce platform to be able to meet all the expectations. Many reliability features need to be incorporated into E-Commerce to function effectively. E-Commerce must-have features like tracking system, automated assisted system, returning procedure, and conflict resolution system.

**2. Provision of E-Commerce that has Equipped with Digital Training**

E-Commerce business providers must provide an E-Commerce system that will encompass digital training for the user. Therefore, the researcher suggests that

there should be digital training and awareness, a friendly environment. There may be a small webcast training about what to do and the procedure. This may reduce the mistakes made by users. The adequate training of the users before carrying on e-transaction will enable more E-Commerce by the users.

### **3. Provision of Discounted E-Commerce Platforms**

The researcher recommends that the business providers may provide E-Commerce platforms incorporated with advantages that will be of interest to the users. A platform that will give a discount and a bargaining option may influence citizens' adoptions. In a nutshell, if some citizen cultural beliefs can be incorporated into the E-Commerce platforms these may influence the adoptions.

### **4. Provision of E-Commerce Platform with Simple and Clear Agreement Terms**

In any business, agreement terms are very important, supposed to be simple and clear enough to understand. The business provider may try to do this to help business litigations and legal issues surrounding the E-Commerce system, especially in developing countries. This will also make e-mediations and resolutions to be easy.

### **5. Provision of E-Commerce Platform with the latest development Technology and Updated Software**

Design and Implementation of any system are better to always use the latest technology and updated software. If a system like E-Commerce is not developed with updated software, it may be subjected to cyber-attack, virus attacks, airdropping, or harking. Therefore, software updates and technology updates are very important in system development.

## **8.4.3 Recommendations for the Provision of Secure E-Commerce Platforms for the Government and Governing Bodies**

In businesses: policies, principles, guidelines, and laws are very important. It has been established in the research that the growth of business and economic development depends on the policies guiding such a nation. One of the enablers of E-Commerce advancement in developed countries is the protection policies set up in protecting the



users. In development, E-Commerce growth majorly depends on the policies set up to guide such.

### **1. Setting up a Protective Policy to Guide both Business Vendor and Users**

Governing laws and principles are very important, especially in E-Commerce where every process is virtual. The researcher strongly recommends that the Government needs to enact operating principles that will help both the business vendors and the Users. If citizens feel safe and secure through a productive operating rule, there may be more adoptions. All the E-Commerce participants (Producers and consumers) must know their operating rules which must be obeyed and the offenders must be punishable under the law.

### **2. Government must set up an Initiative that will Encourage and Support E-Commerce Promotions**

There are many ways by which the Government can support or encourage both the producers and consumers of E-Commerce. The reduction in tax and other import duties can go long way in E-Commerce growth. Financial assistance in forms of loans and grants also aid E-Commerce development. The issues of high payment costs or unnecessary charges should be avoided.

### **3. Initiation of Governing and Monitoring Bodies**

Government has to protect both the users and producers so that users will not be cheated and the investors also will not lose their money. Although, E-Commerce operation is virtual Government or governing agencies can intervene on behalf of users and vendors. For instance, the bank can intervene on the third person payment issue. A thorough investigation can easily be done by these monitoring bodies and any offenders can easily be prosecuted.

### **4. The Use of Web Assurance Seal Services (WASS) is Necessary**

The government should mandate or encourage the use of E-Commerce web assurance seal services (WASS) on the website of the E-Commerce vendors. This will prevent fake websites and reduce online stealing of money, identity theft, or confidential information. The use of WASS in developing countries' E-Commerce will protect the citizens from fraudsters.

## **5. Government should Encourage Digital Training and Digital Inclusions**

The digital divide is one of the major problems of why developing countries' E-Commerce is still experiencing stunted growth. Many citizens that would have become potential customers did not have access to a digital device or have enough training to carry out successful E-Transactions. In another word, they require digital and information technology training that will equip them with the required knowledge to carry out e-transactions successfully without making mistakes.

## **8.5 Research Limitations**

In this research: the aim and objectives were achieved, the hypotheses generated and research questions were answered to satisfy the model developed in this research work. Notwithstanding, there are limitations in this research that may allow future research work. The limitations experienced in this research work can be summarized as follows:

### **1. Limitations from the Literature Review**

There is a limitation that arises as a result of little or no availability of literature on Design Fiction. The Design Fiction used in this research is a new predictive method, especially in the history of E-Commerce. There is little literature on the E-Commerce of developing countries. The literature consolidates and solidifies the E-Commerce barriers in developing countries, especially in Nigeria.

### **2. Sampling Formations and Distance Covered**

Initially, the sample to be used in this research was to be taken from 6 geopolitical zones in Nigeria so that there will be even distribution in the representation. But due to unsafe and terror situations in two zones in Nigeria, approval was given to conduct the fieldwork in 4 other safe zones.

### **3. Genders and Occupations Discrepancies**

Initially, the design was to get the same number of males and females to control sex. But the circumstances changed since the random sampling where everybody among the targeted audience has an equal chance to be chosen. Again, in occupations, agricultural-related jobs were given the priorities and others are

industrial and mining workers. Contrarily, the business sector emerges as the highest outcome.

#### **4. Time Limitations in Carryout the Fieldwork.**

There are issues of time limitations in carrying out the fieldwork. Initially, 6 months were scheduled for the fieldwork. But eventually, 3 months were used to get the sampling size chosen. This was able to be achieved shortly before the breakout of the pandemic.

### **8.6 Future Research Work**

E-Commerce security aspects are still an emerging and interesting area probably because of its imminent contributions to the: citizens, organizations, and nations at large. Security is very important in Information Technology in this turbulent time of voluminous cyber-attacks. Online representations are fast developing more than before because of the outbreak of the Pandemic. Every organization tries to get a secure online representation. In light of this, E-Commerce and its security are very interesting to the researcher, especially in developing countries where most of the international investors are focusing.

1. There can be more and larger sampling that will be used to carry out the experimental tasks of CPVA. If the experimental tasks of CPVA are tested with a larger sample, especially from 6 geopolitical zones, there may be more findings and contributions to the knowledge.
2. The Experimental tasks of CPVA can be tested with another method such as Between Subject Design or Mixed Design to explore the advantage of both designs. The result of the findings will also contribute to the knowledge in the research community.
3. The chain can be added to the CPVA design and the experimental tasks to benefit both the CPVA and chain Technologies. This can increase the security strength in financial transactions.
4. Human physiological features such as live palm veins can be incorporated into the CPVA design. But due to ethical factors on data privacy and protection governing the research conduct in the University and the United Kingdom research.

## **8.7 Thesis Closing Remark**

This chapter discussed the summary, conclusion, and recommendations of this thesis. The section summarised the aim and objectives of this research. The research questions and hypothesis formulated were briefly analysed. The model formulation and methodological approach were briefly summarised. Again, both experimental design and procedure were briefly discussed. The section suggests recommendations for the users, E-Commerce providers, Government, and monitoring agents. Again, this section discussed: literature, methodological, practical, and experimental research contributions to the knowledge. The research limitations were also discussed and the future research opportunities were also stated. The thesis thereby concludes.

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# Appendix A

## I. Ethics Approval Certificate



Sciences & Technology C-REC  
crecsitec@admin.susx.ac.uk

### Certificate of Approval

<b>Reference Number</b>	ER/SA405/1
<b>Title Of Project</b>	A randomised trial measuring the effect of biometric digital security methods on online e-commerce applications
<b>Principal Investigator (PI):</b>	Martin White
<b>Student</b>	Sunday Alabi
<b>Collaborators</b>	
<b>Duration Of Approval</b>	2 years 9 months
<b>Expected Start Date</b>	22-May-2019
<b>Date Of Approval</b>	22-May-2019
<b>Approval Expiry Date</b>	01-Feb-2022
<b>Approved By</b>	Karen Long
<b>Name of Authorised Signatory</b>	Sanj Choudhury
<b>Date</b>	22-May-2019

\*NB. If the actual project start date is delayed beyond 12 months of the expected start date, this Certificate of Approval will lapse and the project will need to be reviewed again to take account of changed circumstances such as legislation, sponsor requirements and University procedures.

#### Please note and follow the requirements for approved submissions:

##### Amendments to protocol

- \* Any changes or amendments to approved protocols must be submitted to the C-REC for authorisation prior to implementation.

##### Feedback regarding the status and conduct of approved projects

- \* Any incidents with ethical implications that occur during the implementation of the project must be reported immediately to the Chair of the C-REC.

##### Feedback regarding any adverse(1) and unexpected events(2)

- \* Any adverse (undesirable and unintended) and unexpected events that occur during the implementation of the project must be reported to the Chair of the Science and Technology C-REC. In the event of a serious adverse event, research must be stopped immediately and the Chair alerted within 24 hours of the occurrence.

##### Monitoring of Approved studies

The University may undertake periodic monitoring of approved studies. Researchers will be requested to report on the outcomes of research activity in relation to approvals that were granted (full applications and amendments).

##### Research Standards

Failure to conduct University research in alignment with the Code of Practice for Research may be investigated under the Procedure for the Investigation of Allegations of Misconduct in Research or other appropriate internal mechanisms (3). Any queries can be addressed to the Research Governance Office: [rgoffice@sussex.ac.uk](mailto:rgoffice@sussex.ac.uk)

(1) An "adverse event" is one that occurs during the course of a research protocol that either causes physical or psychological harm, or increases the risk of physical or psychological harm, or results in a loss of privacy and/or confidentiality to research participant or others.

(2) An "unexpected event" is an occurrence or situation during the course of a research project that was a) harmful to a participant taking part in the research, or b) increased the probability of harm to participants taking part in the research.

(3) <http://www.sussex.ac.uk/staff/research/rqi/policy/research-policy>

## II. PARTICIPANT INVITATION SHEET

### Volunteers needed to participate in e-commerce adoption research work

Dear People,

I am conducting an experimental study as part of my Ph.D. research at the University of Sussex on the use of **Authentication Technology Methods for E-Commerce Applications**.

Participation should take 90 minutes or less. It involves following a Design Fiction documentary using scenarios to explain what this research is about, followed by an e-commerce shopping session (the experiment), and then completing some structured questionnaire.

On completion of the experiment, you will be given a small refreshment be paid 500 Naira for your time and effort.

In developing the experiment and the questionnaire we found that many participants find consideration of the issues involved interesting and engaging. We encourage you to forward this request to other people you think might be interested.

The School of Engineering and Informatics' ethics committee has approved the research, and all data collected will be anonymised and kept strictly confidential. All experiments will take place in the Community centre of your respective community for openness and easy access. If you are interested in taking part, please contact me at [sa405@sussex.ac.uk](mailto:sa405@sussex.ac.uk) and [+2348035847057](tel:+2348035847057).

Many thanks for all assistance you can provide.

### III. CONSENT FORM FOR PARTICIPANTS IN E-COMMERCE ADOPTION IN NIGERIA

#### PROJECT TITLE: Authentication Technology Methods for E-Commerce Applications in Developing Countries (A Nigerian Case Study)

Project Approval

Reference:

I agree to take part in the above University of Sussex research project. I have had the project explained to me and I have read and understood the Information Sheet, which I may keep for records. I understand that agreeing to take part means that I am willing to:

- Respond to the given questionnaire (pre and post-questionnaire).
- Make myself available for the Design Fiction explanation of the research, Pre and Post questionnaire.

I understand that any information I provide is confidential and that no information that I disclose will lead to the identification of any individual in the reports on the project, either by the researcher or by any other party. I understand that all data will be anonymised. I also understand that my participation is voluntary, that I can choose not to participate in part or all of the project, and that I can withdraw at any stage of the project without being penalised or disadvantaged in any way.

I consent to the processing of my personal information for this research study. I understand that such information will be treated as strictly confidential and handled in accordance with the Data Protection Act 2018.

Name:-----

Signature-----

Date:-----

This section is for the researcher:

I believe that understands -----the above project and gives his/her consent voluntarily

Name:-----

Signature-----

Address-----

Date-----

#### **IV. PARTICIPANT INFORMATION SHEET**

##### **Authentication Technology Methods for E-Commerce Applications in Developing Countries (A Nigerian Case Study)**

You are invited to take part in a research study. Before you decide whether or not to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully.

I am a Ph.D. student in the Informatics Department, University of Sussex.

I am experimenting to study how citizens of developing countries could make decisions on the adoption of e-commerce when using more secure e-commerce platforms

You are invited to participate in this study because you are within the age of 18 years to 60 years which is believed to be years when e-commerce could be a great advantage.

Your participation is voluntary, it is up to you to decide whether to take part or not. If you do decide to take part you should keep this information sheet for your records and you will be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time and without giving a reason.

Participation should take 90 minutes or less. It involves following a Design Fiction documentary using scenarios to explain what this research is about, followed by an e-commerce shopping session (the experiment) and then completing a questionnaire.

On completion of the experiment, you will be given a small refreshment and be paid 500 Naira for your time and effort.

All data collected in this experiment will be kept strictly confidential. All information will be anonymised and will be used only in a summary form; therefore, any individual or private information will not be presented and will not be shared with a third party. The results of the research will be analysed and used as part of my research thesis.

This research has been approved by the Sciences and Technology Cross-Schools Research Ethics Committee (C-REC). Contact point for further information:

Researcher Contact:

[sa405@sussex.ac.uk](mailto:sa405@sussex.ac.uk)

If you have any concerns about the way in which the study has been conducted, you could contact my supervisor who reviewed the project: Dr Martin White, [m.white@sussex.ac.uk](mailto:m.white@sussex.ac.uk) and/or the ethics committee (C-REC), [crecscitec@sussex.ac.uk](mailto:crecscitec@sussex.ac.uk).

Thank you for taking time to read the information sheet.

## Appendix B

### I. Questionnaire

You must be aged 18 years or over to be eligible to participate in this study. To confirm that you are eligible to participate, please tick the box below:

☐ I confirm that I am aged 18 years or over

Please carefully read the following questions and tick your answer.

#### 1. Demographic

Gender	<input type="checkbox"/> Male <input type="checkbox"/> Female <input type="checkbox"/> Others <input type="checkbox"/> Prefer not to say <input type="checkbox"/> I don't know
Age	<input type="checkbox"/> 18-23 <input type="checkbox"/> 24-29 <input type="checkbox"/> 30-35 <input type="checkbox"/> 36-41 <input type="checkbox"/> 42-47 <input type="checkbox"/> 48-53 <input type="checkbox"/> 54-60
Income level	<input type="checkbox"/> No Income <input type="checkbox"/> #20K <input type="checkbox"/> #20K-50K <input type="checkbox"/> #50K-100K <input type="checkbox"/> #100K-200K+
Education level	<input type="checkbox"/> High School <input type="checkbox"/> Diploma <input type="checkbox"/> Bachelor <input type="checkbox"/> Master <input type="checkbox"/> MPhil <input type="checkbox"/> DPhil
Nationality	<input type="checkbox"/> Nigeria <input type="checkbox"/> Non-Nigeria
Occupation	<input type="checkbox"/> Farming <input type="checkbox"/> Business <input type="checkbox"/> Artisans <input type="checkbox"/> Industry <input type="checkbox"/> Mining Workers
Other occupations	
Marital status	<input type="checkbox"/> Married <input type="checkbox"/> Single <input type="checkbox"/> Widow <input type="checkbox"/> Widower <input type="checkbox"/> Divorced

#### 2. Previous Experience in Computer and Internet Usage

PCE	PreviousComputer&InternetExperience (Previous Experience)
1. Describe your proficiency when using a computer?	<input type="checkbox"/> Very low <input type="checkbox"/> Low <input type="checkbox"/> Satisfactory <input type="checkbox"/> Good <input type="checkbox"/> Very good
2. How often do you use the Internet?	<input type="checkbox"/> Never <input type="checkbox"/> Once/month <input type="checkbox"/> Once/week <input type="checkbox"/> 2-5 times/week <input type="checkbox"/> Daily
3. How satisfied are you with your current access to the Internet?	<input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
4. How often do you transact online?	<input type="checkbox"/> Never <input type="checkbox"/> Once/month <input type="checkbox"/> Once/week <input type="checkbox"/> 2-5 times/week <input type="checkbox"/> Daily
5. How satisfied are you in transacting online?	<input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
6. Has your previous experience with e-commerce encouraged you to continue using e-commerce?	<input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
7. Do you prefer online transactions (e.g. transferring money electronically) rather than offline transactions (e.g. going to the bank)?	<input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly

<p>8. Do you seek or use help when you carry out online transactions?</p> <p><input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly</p>
<p>9. Does your experience have influence on your continuous use of online transactions?</p> <p><input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly</p>
<p>10. Does your previous experience of dealing with an e-commerce operator (e.g. bank) influence your willingness to use the electronic system of the same agency?</p> <p><input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly</p>

**3. Information about the previous e-commerce experience**

PE	PreviousE-CommerceExperience (Specific Awareness)
<b>PE1</b>	<p>How well do you know the meaning of e-commerce before participating in this questionnaire?</p> <p><input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly</p>
<b>PE2</b>	<p>How often did you perform e-commerce transactions before participating in this questionnaire?</p> <p><input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly</p>
<b>PE3</b>	<p>How much are you willing to know more about e-commerce?</p> <p><input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly</p>
<b>PE4a</b>	<p>What level of access to a computer do you have?</p> <p><input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly</p>
<b>PE4b</b>	<p>What level of access do you have to the Internet?</p> <p><input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly</p>
<b>PE4c</b>	<p>Do you find using e-commerce services difficult?</p> <p><input type="checkbox"/> Not at all <input type="checkbox"/> Very Little <input type="checkbox"/> More or Less <input type="checkbox"/> Very Much <input type="checkbox"/> Greatly</p>
<b>PE4d</b>	<p>Does deficiency in security affect your trust in e-commerce platforms?</p> <p><input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly</p>
<b>PE5</b>	<p>Based on your previous e-commerce, how do you rate your experience?</p> <p><input type="checkbox"/> Very negative <input type="checkbox"/> Negative <input type="checkbox"/> Never used <input type="checkbox"/> Positive <input type="checkbox"/> Very positive</p>
<b>PE6a</b>	<p>Does unclear requirements e-commerce applications affect your intention to use e-commerce transactions?</p> <p><input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly</p>
<b>PE6b</b>	<p>Does not getting the expected results affect your intended e-commerce use?</p> <p><input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly</p>
<b>PE6c</b>	<p>Does the difficulty of using e-commerce affect your intention to use?</p> <p><input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly</p>



<b>PE6d</b>	How does the Level of Security in an e-commerce application affect your intention to use?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>PE6e</b>	Does No government Protection and Policies affect your e-commerce intention to use?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>PE6f</b>	Does your perceived risk affect your intended e-commerce use?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>PE6g</b>	Does lack of awareness affect your intended e-commerce transactions?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>PE6h</b>	Does Lack of trust affect your intended e-commerce transaction use?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>PE7a</b>	Is calling customer service by phone your preferred method to seek help when you are facing problems with e-commerce transactions?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>PE7b</b>	Do you prefer to use online chat or emails to seek help when encountering a problem while using an e-commerce platform?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>PE7c</b>	Do you prefer to use searching on the Internet to seek help when problems while using an e-commerce platform?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>PE7d</b>	Do you prefer to seek help from Previously Experienced users when you make an e-commerce transaction?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>PE7e</b>	Do you prefer to use Frequently Asked Questions (FAQ) to seek help when encountering a problem while using an e-commerce platform?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>PE8a</b>	How often do you prefer to use Online Banking to make a payment in your e-commerce transactions?  <input type="checkbox"/> Not at all <input type="checkbox"/> Fairly often <input type="checkbox"/> Not sure <input type="checkbox"/> Often <input type="checkbox"/> Very often
<b>PE8b</b>	How often do you prefer to use ATM Machines to make a payment in your e-commerce transactions?  <input type="checkbox"/> Not at all <input type="checkbox"/> Fairly often <input type="checkbox"/> Not sure <input type="checkbox"/> Often <input type="checkbox"/> Very often
<b>PE8c</b>	How often do you prefer to use Phone Banking in your e-commerce transactions?  <input type="checkbox"/> Not at all <input type="checkbox"/> Fairly often <input type="checkbox"/> Not sure <input type="checkbox"/> Often <input type="checkbox"/> Very often
<b>PE8d</b>	How often do you prefer to use PayPal to make a payment in your e-commerce transactions?  <input type="checkbox"/> Not at all <input type="checkbox"/> Fairly often <input type="checkbox"/> Not sure <input type="checkbox"/> Often <input type="checkbox"/> Very often

<b>PE8e</b>	How often do you prefer to use Mobiles Wallets to make payments in e-commerce transactions?  <input type="checkbox"/> Not at all <input type="checkbox"/> Fairly often <input type="checkbox"/> Not sure <input type="checkbox"/> Often <input type="checkbox"/> Very often
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**4. Information about e-commerce Awareness. Please choose appropriately**

<b>EA</b>	<b>E-Commerce Awareness (General Awareness)</b>
<b>EA1a</b>	Does advertising e-commerce platforms on social media influence your intention to adopt e-commerce?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EA1b</b>	Does advertising e-commerce platforms on Government agencies 'websites influence your intention to adopt e-commerce?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EA1c</b>	Does advertising e-commerce platforms in Newspapers and magazines influence your intention to adopt e-commerce?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EA1d</b>	Does advertising e-commerce platforms in public areas influence your intention to adopt e-commerce?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EA1e</b>	Does advertising e-commerce platforms through emails and text messages influence your intention to adopt e-commerce?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EA1f</b>	Does advertising e-commerce platforms on TV and radio channels influence your intention to adopt e-commerce?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EA2a</b>	What effect do advertising e-commerce platforms on social media have on your participation?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EA2b</b>	What effect do advertising e-commerce platforms on governmental agencies' websites have on your participation?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EA2c</b>	What effect do advertising e-commerce platforms in newspapers and magazines have on your participation?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EA2d</b>	What effect do Advertising e-commerce platforms in public areas have on your participation?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EA2e</b>	What effect do advertising e-commerce platforms through emails and text messages have on your participation?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EA2f</b>	What effect can advertise e-commerce platforms on TV and radio channels have on your participation?

	<input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EA3</b>	Does having a good knowledge about what benefits to obtain from using e-commerce services help your intention to adopt e-commerce?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EA4</b>	How do workshops and visual presentations about e-commerce help your intention to adopt e-commerce?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EA5</b>	How do awareness campaigns and advertisements of e-commerce activities in Nigeria help your intention to adopt e-commerce?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EA6</b>	To what extent does the difficulty of reaching e-commerce platform links reduce your willingness to perform online transactions?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EA7</b>	Do you think Nigerian Citizens have enough and adequate knowledge about e-commerce fraud?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EA8</b>	Do Banks and other e-commerce stakeholders perform up to expectations in terms of awareness about various cybercrime methods?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly

**5. Statement about the expected benefits from using e-commerce**

<b>EB</b>	<b>E-CommerceBenefits (Perceived benefits)</b>
<b>EB1</b>	To what extent do you believe that using e-commerce will enable you to perform more transactions quickly (i.e. order and paying for a product instead of going to shop to purchase it)?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EB2</b>	To what extent do you believe using e-commerce will save time, money, and effort?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EB3</b>	To what extent do you believe that e-commerce may reduce the need for some longer manual transaction procedures, e.g. going to the bank?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EB4</b>	To what extent does your ability to perform e-commerce transactions (24 hours/7 days) encourage you to use it?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EB5</b>	To what extent do you believe that continued use of e-commerce will enhance your perception of its adoption?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EB6</b>	To what extent do you believe that using e-commerce will reduce your ability to benefit from personal relationships (e.g. speaking to the bank manager) in transactions processing?

	<input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EB7</b>	To what extent do you believe that using e-commerce might increase your purchasing power because of the cheaper rate?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly

**6. Statements about the simplicity of using e-commerce (Ease of Use)**

<b>EE</b>	<b>E-CommerceEaseOfUse (EaseofUse)</b>
<b>EE1</b>	To what extent do you believe that e-commerce services are easy to use?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EE2</b>	To what extent do you know that e-commerce transactions need more concentration to avoid transactions rejection?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EE3</b>	To what extent do you believe that e-commerce facilitates and aids economic developments?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EE4</b>	To what extent do you know that bad layout and unattractive interfaces of e-commerce websites reduce willingness to use e-commerce?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EE5</b>	To what extent do you prefer that all e-commerce websites be identical in terms of design?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EE6</b>	To what extent do you think the existence of many authorised/Legalised offices to help users with their e-commerce transaction and their correspondence with agencies is a good idea?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly

**7. Statements about the e-Readiness and the quality aspects of e-commerce systems**

<b>EQ</b>	<b>E-CommerceReadiness&amp;Quality (Protection Policy)</b>
<b>EQ1</b>	To what extent did you believe that Infrastructure in Nigeria is sufficient to implement e-commerce systems?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EQ2</b>	To what extent did you believe that e-commerce Government policies are adequate?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EQ3</b>	To what extent did you know that Government & Organisations (Banks and others) are not able to protect citizens satisfactorily?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EQ4</b>	To what extent are you willing to learn how to use e-commerce services?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EQ5</b>	To what extent did you feel that the quality of e-commerce services in Nigeria is high?

	<input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EQ6</b>	To what extent did you think the current post mail services in Nigeria are reliable to deliver the required e-commerce services?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EQ7</b>	To what extent did you think that the existence of technical errors reduces your willingness to use such e-Services?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly

**8. The importance of providing the following necessary information in e-commerce**

<b>EI</b>	<b>E-CommereUserEssentalInformation (Security Awareness)</b>
<b>EI1</b>	To what extent did you need detailed steps on how to perform transactions electronically?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EI2</b>	To what extent did you need help, e.g. text/image (examples) in the instructions for e-Services?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EI3</b>	To what extent did you have an explanation of how your e-commerce transactions are being processed?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EI4</b>	To what extent did you know the expected time to complete your e-commerce transactions?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EI5</b>	To what extent did you know the expected time that you should spend when performing an e-commerce transaction?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EI6</b>	To what extent did you know the last updated date of the e-commerce website?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EI7</b>	To what extent did you know that the about us of e-commerce website should always be checked?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>EI8</b>	To what extent did you know that checking the number of existing users of e-commerce websites is helpful?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly

**9. The importance of Web of Assurance Seal Services (WASS) and other e-commerce policies.**

<b>WASS</b>	<b>E-CommerceWebAssuranceSealServices (WASS)</b>
<b>WASS1</b>	To what extent did you know that Information privacy policies are helpful in e-commerce?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>WASS2</b>	To what extent did you know that e-commerce protection policies are helpful?

	<input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>WASS3</b>	<p>To what extent are you aware of the regulations and laws that are concerned with the right of the citizens and agencies?</p> <p><input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly</p>
<b>WASS4</b>	<p>To what extent did you know that the Consumer Protection Council of Nigeria is helpful?</p> <p><input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly</p>
<b>WASS5</b>	<p>To what extent did you know Central Bank Monetary Policies in Nigeria are helpful?</p> <p><input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly</p>
<b>WASS6</b>	<p>To what extent did you know the independent body's effectiveness in Nigeria?</p> <p><input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly</p>
<b>WASS7</b>	<p>To what extent do you know the Nigerian Police Force in combatting e-commerce crime?</p> <p><input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly</p>
<b>WASS8</b>	<p>To what extent did you know Government Willingness in combatting crime?</p> <p><input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly</p>
<b>WASS9</b>	<p>To what extent do you know how the Monetary Gateways (e.g. Interswitch) and Bank operator's policies work in Nigeria?</p> <p><input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly</p>

**10. The importance of implementing the following features in e-commerce systems**

<b>ER</b>	<b>E-Commerce Essential Features (Perceived Advantage)</b>
<b>ER1</b>	<p>To what extent do you know the ability to track the status of your performed transactions?</p> <p><input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly</p>
<b>ER2</b>	<p>To what extent do you know the ability to view the history of your performed transactions?</p> <p><input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly</p>
<b>ER3</b>	<p>To what extent do you know the ability to evaluate and rate the quality of the provided e-commerce services?</p> <p><input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly</p>
<b>ER4</b>	<p>To what extent do you know the ability to share the link of the performed e-commerce service with others (through social media for example)?</p> <p><input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly</p>
<b>ER5</b>	<p>To what extent do you know the existence of official mobile applications that enable you to complain about any problem you encountered while transacting on e-commerce?</p> <p><input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly</p>
<b>ER6</b>	<p>To what extent do you know the existence of electronic machines in public areas to perform some transactions?</p>

	<input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>ER7</b>	<p>To what extent do you Communicate (by emails or text messages) using a secure e-commerce platform?</p> <p> <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly </p>

**11. Statements about the reliability aspects in e-commerce (Trust)**

<b>ET</b>	<b>E-CommerceReliabilityTrust (Security)</b>
<b>ET1</b>	<p>To what extent do you feel that the Internet is not safe to deal with e-commerce?</p> <p> <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly </p>
<b>ET2</b>	<p>To what extent do you feel that e-commerce is a safe environment that can be used to perform transactions?</p> <p> <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly </p>
<b>ET3</b>	<p>To what extent would you hesitate to provide financial information (such as your bank account or credit cards details) through e-commerce systems?</p> <p> <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly </p>
<b>ET4</b>	<p>To what extent would you hesitate to provide personal information (such as your address, your income .... etc.) through e-commerce systems?</p> <p> <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly </p>
<b>ET5</b>	<p>To what extent do you think that users' data that is stored in e-commerce systems are shared with other parties without users' permission?</p> <p> <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly </p>
<b>ET6</b>	<p>To what extent do you feel that users' data that is stored in e-commerce systems can be misused?</p> <p> <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly </p>
<b>ET7</b>	<p>To what extent do you believe that users have full control over their data that is stored in an e-commerce system where they can delete it whenever they want?</p> <p> <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly </p>
<b>ET 8</b>	<p>To what extent do you think that governmental parastatals in Nigeria can be trusted to provide e-commerce successfully?</p> <p> <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly </p>
<b>ET9</b>	<p>To what extent do you believe that Personal Authentication Techniques (PAT) such as CPVA will increase the trust of citizens in e-commerce?</p> <p> <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly </p>
<b>ET10</b>	<p>To what extent do you know that adequate protection for citizens will increase e-commerce adoption?</p> <p> <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly </p>

**12. This part deals with overall user perception after the Design Fiction Documentary and Shopping in an e-commerce environment. QUESTIONS ON OVERALL USER EXPERIENCE WITH SHOPPING EXPERIENCE AND PAYMENT AUTHENTICATION.**

<b>ESTE</b>	<b>UserExperienceOnDesignFictionExperiment (Perceived Risk)</b>
<b>ESTE1</b>	Overall in general, the application is easy to use <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>ESTE2</b>	In general, the functions are in the right places <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>ESTE3</b>	Controls like buttons and text fields are appropriately sized <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>ESTE4</b>	It was easy to use the shopping application at first attempt; I did not struggle to reach any buttons. <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>ESTE5</b>	It is easy to understand what the different icons mean <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>ESTE6a</b>	The shopping application behaves as explained by the researcher and the scenario sketch <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>ESTE6b</b>	Moving to and from the different areas of the application is clear and not disorienting <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>ESTE7</b>	I always knew what to do next to perform a specific task <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>ESTE8</b>	In these two scenarios, you just completed, determine the level of your agreements in the area of navigations <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>ESTE9</b>	The interface is aesthetically pleasing <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree

**13. User perception on e-commerce security**

<b>UP</b>	<b>User Perception on e-commerce Security (UP) PP, FP, CPVA</b>
<b>UserPerceptionOnPinAndPassword</b> (otherwise known as Digital Signature)  This can be hidden from the participants because it is tracking codes for data analysis	
<b>UPPP1</b>	Do you think that the use of PIN/PASSWORD could lead to Identity theft? <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>UPPP2</b>	Do you think that the Increase in Identity theft leads to an increase in online theft? <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>UPPP3</b>	Do you think that the increase in online theft leads to a decrease in the trust of citizens towards e-commerce?



	<input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>UPPP4</b>	Do you think that User privacy is highly risky with the use of the PIN/PASSWORD security authenticating method?  <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>UPPP5</b>	Do you think that the PIN/PASSWORD stolen discourages citizens' adoption in e-commerce?  <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>UPPP6</b>	Do you think that the Citizens' privacy is more porous when using PIN/PASSWORD in e-commerce?  <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>UPPP7</b>	Do you think that the Banks staff are likely to be conniving with fraudsters in identity stolen?  <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>UPFP</b>	<b>UerPerceptionOnFingerPrint (FingerprintSystem)</b>
<b>UPFP1</b>	Do you think that Fingertip damage is common in developing countries because of manual labour and handlings?  <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>UPFP2</b>	Do you think that the Privacy of Fingerprint system Is less risky than PIN/PASSWORD?  <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>UPFP3</b>	Do you think that Security Authentication needs an improvement to have trust in e-commerce applications?  <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>UPFP4</b>	Do you think that the False rejection in user's authentication is more common in the Finger Print Identification System?  <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>UPFP5</b>	Do you think that the Fingertip damage usually affects Fingerprint Identification System thereby reducing its effectiveness?  <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>UPFP6</b>	Do you think that the Citizens' fears are quite high as a result of False Rejection (i.e., the system is not able to recognize and authenticate genuine account owners)?  <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>UPFP7</b>	Do you think that the Finger Print Identification System only is not enough to build user confidence and trust in e-commerce?  <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>UPCPVA</b>	<b>UserPerceptiononContactlessPalmVeinAuthentication Known as CPVA)</b>
<b>UPCPVA1</b>	As illustrated in the scenarios, do you think that finger and palm disorder cannot affect Contactless Palm Vein Identification?

	<input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>UPCPVA2</b>	Do you think that the Contactless Palm Vein Identification is reliable and has the Lowest False Acceptance Rate (i.e. wrongly acceptance of the wrong owner)?  <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>UPCPVA3</b>	Do you think that the Privacy of CPVA is better since liveliness is involved during the Authentication?  <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>UPCPVA4</b>	Do you think that the False rejection in CPVA is negligible?  <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>UPCPVA5</b>	Do you think that CPVA Security Authentication will reduce citizens' fear of using e-commerce?  <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>UPCPVA6</b>	Do you think that the Citizen's Perceived Risk is low when authenticating with CPVA in e-commerce?  <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>UPCPVA7</b>	Do you think that the CPVA is capable of increasing citizens' trust towards the adoption of e-commerce?  <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree

**14. This part deals with the potential for users to adopt E-COMMERCE.**

**PSYCHOMETRIC QUESTIONS ON USER DISPOSITION TOWARDS THE DESIGN FICTION AND SHOPPING PAYMENT AUTHENTICATION SCENARIOS**

<b>UPEA</b>	<b>UserExperienceOnDesignFictionExperience (Usability/Flexibility)</b>
<b>UPEA1</b>	In the context of the given scenarios that you just completed, which authenticating technique you would prefer in your e-commerce finance transactions?  <input type="checkbox"/> Deal with cash <input type="checkbox"/> Go to bank <input type="checkbox"/> PIN/PASSWORD <input type="checkbox"/> Fingerprint  <input type="checkbox"/> Palm vein
<b>UPEA2</b>	Does your experience with the e-commerce Design Fiction and shopping' authentication scenario that you just completed aligning with your experience using already existing digital technologies?  <input type="checkbox"/> Very dissatisfied <input type="checkbox"/> Dissatisfied <input type="checkbox"/> Not sure <input type="checkbox"/> Satisfied <input type="checkbox"/> Very satisfied
<b>UPEA3</b>	Given the context of the scenarios you just completed, how much will you be ready to pay for a complete product and service?  <input type="checkbox"/> Nothing <input type="checkbox"/> Less than #20K <input type="checkbox"/> From #20K-50K <input type="checkbox"/> From #50K-100K  <input type="checkbox"/> More than #100k
<b>UPEA4</b>	Given that the services illustrated in the scenarios might form part of e-commerce applications like how much would you be ready to spend?  <input type="checkbox"/> Nothing <input type="checkbox"/> Less than #20K <input type="checkbox"/> From #20K-#50K <input type="checkbox"/> From #50K to #100K

	<input type="checkbox"/> More than #100k
<b>UPEA5a</b>	To what extent do you prefer to use Google Play store apps for e-commerce applications?  <input type="checkbox"/> Not at all <input type="checkbox"/> Fairly often <input type="checkbox"/> Not sure <input type="checkbox"/> Often <input type="checkbox"/> Very often
<b>UPEA5b</b>	To what extent do you prefer to use Apple store apps for e-commerce applications?  <input type="checkbox"/> Not at all <input type="checkbox"/> Fairly often <input type="checkbox"/> Not sure <input type="checkbox"/> Often <input type="checkbox"/> Very often
<b>UPEA5c</b>	To what extent do you prefer to use the Chrome apps store for e-commerce applications?  <input type="checkbox"/> Not at all <input type="checkbox"/> Fairly often <input type="checkbox"/> Not sure <input type="checkbox"/> Often <input type="checkbox"/> Very often
<b>UPEA5d</b>	To what extent do you prefer to use Mozilla store apps for e-commerce applications?  <input type="checkbox"/> Not at all <input type="checkbox"/> Fairly often <input type="checkbox"/> Not sure <input type="checkbox"/> Often <input type="checkbox"/> Very often
<b>UPEA5e</b>	To what extent do you prefer to use the Nokia store app for e-commerce applications?  <input type="checkbox"/> Not at all <input type="checkbox"/> Fairly often <input type="checkbox"/> Not sure <input type="checkbox"/> Often <input type="checkbox"/> Very often
	<b>UserExperienceOnDesignFictionExperiment (Perceived Fear)</b>
<b>UPEA6</b>	Are you likely to agree that authenticating using Contactless Palm Vein attracts little additional charges?  <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>UPEA7</b>	Do you agree that fear of stealing Palm Vein Identity (PVI) can prevent users to accept e-commerce?  <input type="checkbox"/> Strongly disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Not sure <input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
<b>UPEA8a</b>	Does the Aesthetics (beautiful design) determine your satisfaction in e-commerce?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>UPEA8b</b>	How much does Ease of use determine your satisfaction in e-commerce?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>UPEA8c</b>	How much do Security & Reliability determine your satisfaction in e-commerce?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>UPEA8d</b>	How much do Customer Guidance and policies determine your satisfaction in e-commerce?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>UPEA8e</b>	How much do Privacy & Security determine your satisfaction in e-commerce?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>UPEA8f</b>	How much do Trust & Loyalty determine your satisfaction in e-commerce?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>UPEA9</b>	Do you require training for the usage of this CPVA technology?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> Not sure <input type="checkbox"/> required <input type="checkbox"/> Highly required

<b>UPEA10a</b>	Do you prefer to use a Soft copy user manual for CPVA training?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>UPEA10b</b>	Do you prefer to use on-site at the Company solution center for CPVA training?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>UPEA10c</b>	Do you prefer to use a Hardcopy user manual for CPVA training?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>UPEA10d</b>	Do you prefer to use Virtual training by an e-assistant for CPVA training?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>UPEA10e</b>	Do you prefer to use Online training for CPVA training?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>UPEA10f</b>	Do you prefer to use In house training for CPVA training?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>UPEA11a</b>	Do you prefer rules or policies from the Federal Government to be used with CPVA?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>UPEA11b</b>	Do you prefer rules or policies from Rule from CBN to be used with CPVA?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>UPEA11c</b>	Do you prefer rules or policies from Rule External Body (WASS /Security Company to be used with CPVA?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>UPEA11d</b>	Will you prefer rules or policies from Operator (Banks & monetary gateways) to be used with CPVA?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>UPEA12a</b>	In the context of the completed scenarios, do you prefer to use a Credit card with CPVA?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>UPEA12b</b>	In the context of the completed scenarios, do you prefer to use a Debit card with CPVA?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>UPEA12c</b>	In the context of the completed scenarios, do you prefer to use Direct debit with CPVA?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>UPEA12d</b>	In the context of the completed scenarios, do you prefer to use Mobile payment CPVA?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
<b>UPEA12e</b>	In the context of the completed scenarios, do you prefer to use PayPal CPVA?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly

<b>UPEA12f</b>	In the context of the completed scenarios will you prefer to use Online payment with CPVA?  <input type="checkbox"/> Not at all <input type="checkbox"/> Very little <input type="checkbox"/> More or less <input type="checkbox"/> Very much <input type="checkbox"/> Greatly
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**15. User Appraisal for New CPVA Authenticating Method in the Shopping Experiment**

<b>UACPVA</b>	<b>UserAppraisalForCPVA (CPVA)</b>
<b>UACPVA1</b>	How would you describe the level of satisfaction that you have in the scenarios that you just completed?  <input type="checkbox"/> Very dissatisfied <input type="checkbox"/> Dissatisfied <input type="checkbox"/> Not sure <input type="checkbox"/> Satisfied <input type="checkbox"/> Very satisfied
<b>UACPVA2</b>	Would you recommend e-commerce applications that have CPVA Authentication to friends and family members?  <input type="checkbox"/> Not very likely <input type="checkbox"/> Not likely <input type="checkbox"/> I don't know <input type="checkbox"/> Likely <input type="checkbox"/> Very likely
<b>UACPVA3</b>	In these completed scenarios, how would you rate your trust for using the CPVA Authentication technique?  <input type="checkbox"/> Very dissatisfied <input type="checkbox"/> Dissatisfied <input type="checkbox"/> Not sure <input type="checkbox"/> Satisfied <input type="checkbox"/> Very satisfied
<b>UACPVA4</b>	How likely will your cultural values determine your acceptance of any of the completed scenarios in e-commerce application platforms?  <input type="checkbox"/> Not very likely <input type="checkbox"/> Not likely <input type="checkbox"/> I don't know <input type="checkbox"/> likely <input type="checkbox"/> Very likely
<b>UACPVA5</b>	In the context of the Design Fiction and CPVA Authentication paradigm scenarios you just completed, would you consider e-commerce adoption as a necessity?  <input type="checkbox"/> Not highly consider <input type="checkbox"/> Not consider <input type="checkbox"/> Fairly consider <input type="checkbox"/> Consider  <input type="checkbox"/> Highly consider
<b>UACPVA6</b>	In the context of the use of scenario that you just completed, how important do you see user authentication being incorporated with the CPVA method?  <input type="checkbox"/> Not at all important <input type="checkbox"/> Not so important <input type="checkbox"/> Fairly important  <input type="checkbox"/> Important <input type="checkbox"/> Very important
<b>UACPVA7</b>	How do you consider the seamless e-commerce application highlighted in the use of the scenario that you just completed?  <input type="checkbox"/> Not at all important <input type="checkbox"/> Not so important <input type="checkbox"/> Fairly important  <input type="checkbox"/> Important <input type="checkbox"/> Very important
<b>UACPVA8</b>	Would you prefer tracking your transaction in the use of the e-commerce application?  <input type="checkbox"/> Very unlikely <input type="checkbox"/> Unlikely <input type="checkbox"/> Fairly likely <input type="checkbox"/> Likely <input type="checkbox"/> Very likely
<b>UACPVA9</b>	Will your perceived fear be greatly reduced with the use of the CPVA technique in e-commerce authentication?  <input type="checkbox"/> Very unlikely <input type="checkbox"/> Unlikely <input type="checkbox"/> Fairly likely <input type="checkbox"/> Likely <input type="checkbox"/> Very likely

**16. Intention to adopt e-commerce systems depends on the following:**

**Please rate according to their degree of Importance**

<b>UIET</b>	<b>IntentionToAdoptE-Commerce</b>
<b>UIETa</b>	Does Citizens Awareness determine your total adoption of e-commerce with this CPVA?  <input type="checkbox"/> Very unlikely <input type="checkbox"/> Unlikely <input type="checkbox"/> Fairly likely <input type="checkbox"/> Likely <input type="checkbox"/> Very likely
<b>UIETb</b>	Does Perceived Risk determine your total adoption to e-commerce with this CPVA?  <input type="checkbox"/> Very unlikely <input type="checkbox"/> Unlikely <input type="checkbox"/> Fairly likely <input type="checkbox"/> Likely <input type="checkbox"/> Very likely
<b>UIETc</b>	Does E-commerce Flexibility determine your total adoption to e-commerce with this CPVA?  <input type="checkbox"/> Very unlikely <input type="checkbox"/> Unlikely <input type="checkbox"/> Fairly likely <input type="checkbox"/> Likely <input type="checkbox"/> Very likely
<b>UIETd</b>	Do E-commerce Benefits determine your total adoption to e-commerce with this CPVA?  <input type="checkbox"/> Very unlikely <input type="checkbox"/> Unlikely <input type="checkbox"/> Fairly likely <input type="checkbox"/> Likely <input type="checkbox"/> Very likely
<b>UIETe</b>	Does Government Policies determine your total adoption of e-commerce with this CPVA?  <input type="checkbox"/> Very unlikely <input type="checkbox"/> Unlikely <input type="checkbox"/> Fairly likely <input type="checkbox"/> Likely <input type="checkbox"/> Very likely
<b>UIETf</b>	Does Security level determine your total adoption to e-commerce with this CPVA?  <input type="checkbox"/> Very unlikely <input type="checkbox"/> Unlikely <input type="checkbox"/> Fairly likely <input type="checkbox"/> Likely <input type="checkbox"/> Very likely
<b>UIETg</b>	Does Privacy determine your total adoption to e-commerce with this CPVA?  <input type="checkbox"/> Very unlikely <input type="checkbox"/> Unlikely <input type="checkbox"/> Fairly likely <input type="checkbox"/> Likely <input type="checkbox"/> Very likely
<b>UIETh</b>	Does Transaction timing determine your total adoption to e-commerce with this CPVA?  <input type="checkbox"/> Very unlikely <input type="checkbox"/> Unlikely <input type="checkbox"/> Fairly likely <input type="checkbox"/> Likely <input type="checkbox"/> Very likely
<b>UIETi</b>	Does High Trust determine your total adoption to e-commerce with this CPVA?  <input type="checkbox"/> Very unlikely <input type="checkbox"/> Unlikely <input type="checkbox"/> Fairly likely <input type="checkbox"/> Likely <input type="checkbox"/> Very likely
<b>UIETj</b>	Does Reliability determine your total adoption to e-commerce with this CPVA?  <input type="checkbox"/> Very unlikely <input type="checkbox"/> Unlikely <input type="checkbox"/> Fairly likely <input type="checkbox"/> Likely <input type="checkbox"/> Very likely

## Appendix C

	Null Hypothesis	Test	Sig.	Decision
1	The categories defined by GENDER = F and M occur with probabilities .500 and .500.	One-Sample Binomial Test	.385	Retain the null hypothesis.
2	The categories of AGE GROUP occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
3	The categories of INCOME LEVEL occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
4	The categories of EDUCATION LEVEL occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
5	The categories defined by NATIONALITY = NIG and NON NIG occur with probabilities .500 and .500.	One-Sample Binomial Test	.000	Reject the null hypothesis.
6	The categories of OCCUPATION occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
7	The categories of MARITAL STATUS occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
8	The categories of PEProficiency occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
9	The categories of PEOften occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
10	The categories of PESatisfaction occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
11	The categories of PEOnterTransaction occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
12	The categories of PETransactionSatisf occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
13	The categories of PEEncouragement occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
14	The categories of PEOntertranPreferred occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
15	The categories of PESkillTransaction occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
16	The categories of PEInfluenceToUse occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
17	The categories of PEE-COctor occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
18	The categories of PE1 occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
19	The categories of PE2 occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
20	The categories of PE3 occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
21	The categories of PE4a occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
22	The categories of PE4b occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
23	The categories of PE4c occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.













184	The categories of UACPVA4 occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
185	The categories of UACPVA5 occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
186	The categories of UACPVA6 occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
187	The categories of UACPVA7 occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
188	The categories of UACPVA8 occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
189	The categories of UACPVA9 occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
190	The categories of UIETa occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
191	The categories of UIETb occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
192	The categories of UIETc occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
193	The categories of UIETd occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
194	The categories of UIETe occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
195	The categories of UIETf occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
196	The categories of UIETg occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
197	The categories of UIETh occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
198	The categories of UIETi occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
199	The categories of UIETj occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.

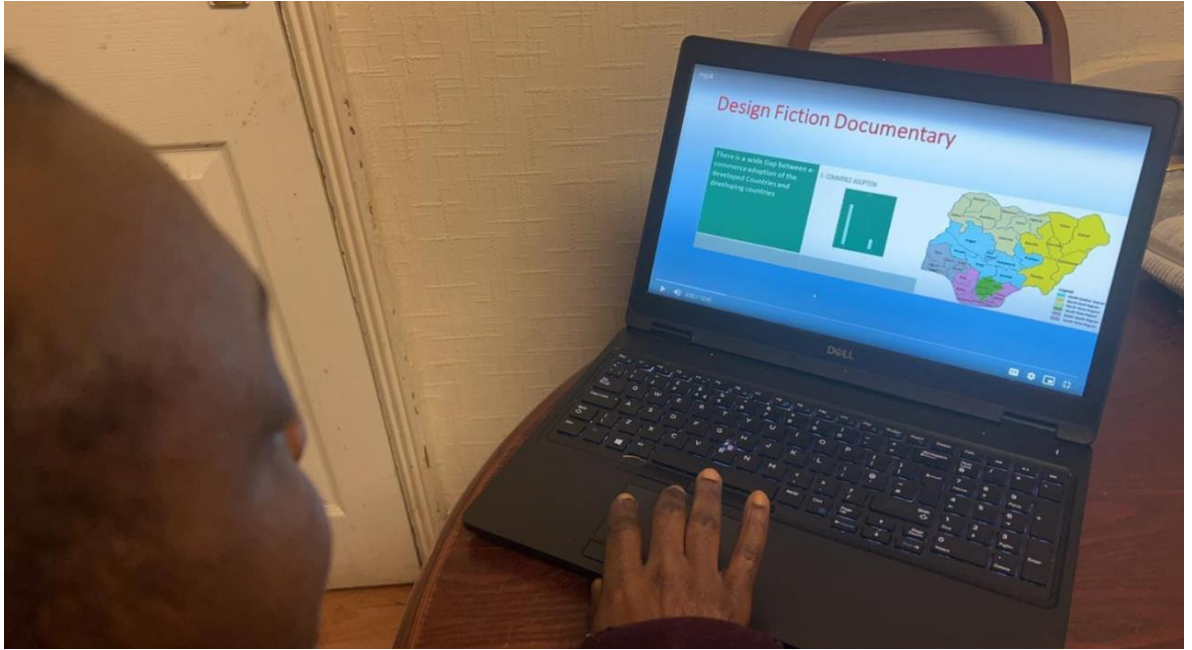
## Appendix D

		Descriptive				
		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval Lower Bound
PEOften	1	19	2.16	1.537	.353	1.42
	2	21	3.62	1.322	.288	3.02
	3	53	4.08	1.035	.142	3.79
	4	62	4.15	1.084	.138	3.87
	5	36	4.33	1.042	.174	3.98
	Total	191	3.91	1.286	.093	3.72
PEsatisfaction	1	19	1.79	1.084	.249	1.27
	2	21	2.81	1.123	.245	2.30
	3	53	3.53	.890	.122	3.28
	4	62	3.87	.966	.123	3.63
	5	36	4.06	.893	.149	3.75
	Total	191	3.49	1.165	.084	3.32
PEOnLTransaction	1	19	1.84	1.068	.245	1.33
	2	21	2.67	1.354	.295	2.05
	3	53	3.43	1.029	.141	3.15
	4	62	3.44	1.034	.131	3.17
	5	36	3.64	1.175	.196	3.24
	Total	191	3.23	1.214	.088	3.06
PETransatSatisf	1	19	1.63	.955	.219	1.17
	2	21	2.52	1.209	.264	1.97
	3	53	3.57	.888	.122	3.32
	4	62	3.68	.954	.121	3.44
	5	36	3.94	.955	.159	3.62
	Total	191	3.37	1.184	.086	3.20
PEEncouragent	1	19	1.84	.834	.191	1.44
	2	21	2.71	1.309	.286	2.12
	3	53	3.55	.972	.134	3.28
	4	62	3.81	.920	.117	3.57
	5	36	3.69	1.091	.182	3.33
	Total	191	3.40	1.169	.085	3.23
PEOnlintranPreferred	1	19	2.37	1.383	.317	1.70
	2	21	3.14	1.315	.287	2.54
	3	53	3.94	.770	.106	3.73
	4	62	4.10	.844	.107	3.88
	5	36	4.31	.624	.104	4.09

	Total	191	3.82	1.077	.078	3.66
PEskHlpTransaction	1	19	1.79	1.032	.237	1.29
	2	21	2.10	1.091	.238	1.60
	3	53	2.17	1.236	.170	1.83
	4	62	2.26	1.342	.170	1.92
	5	36	2.64	1.496	.249	2.13
	Total	191	2.24	1.300	.094	2.06
PEInfluenceToUse	1	19	2.37	1.383	.317	1.70
	2	21	2.76	1.221	.266	2.21
	3	53	3.43	.971	.133	3.17
	4	62	3.84	.927	.118	3.60
	5	36	4.03	.696	.116	3.79
	Total	191	3.50	1.114	.081	3.34
PEE-COpor	1	19	2.32	1.250	.287	1.71
	2	21	2.76	1.375	.300	2.14
	3	53	3.28	1.063	.146	2.99
	4	62	3.68	1.004	.128	3.42
	5	36	3.86	.833	.139	3.58
	Total	191	3.37	1.157	.084	3.20



## Appendix E: Design Fiction Documentary

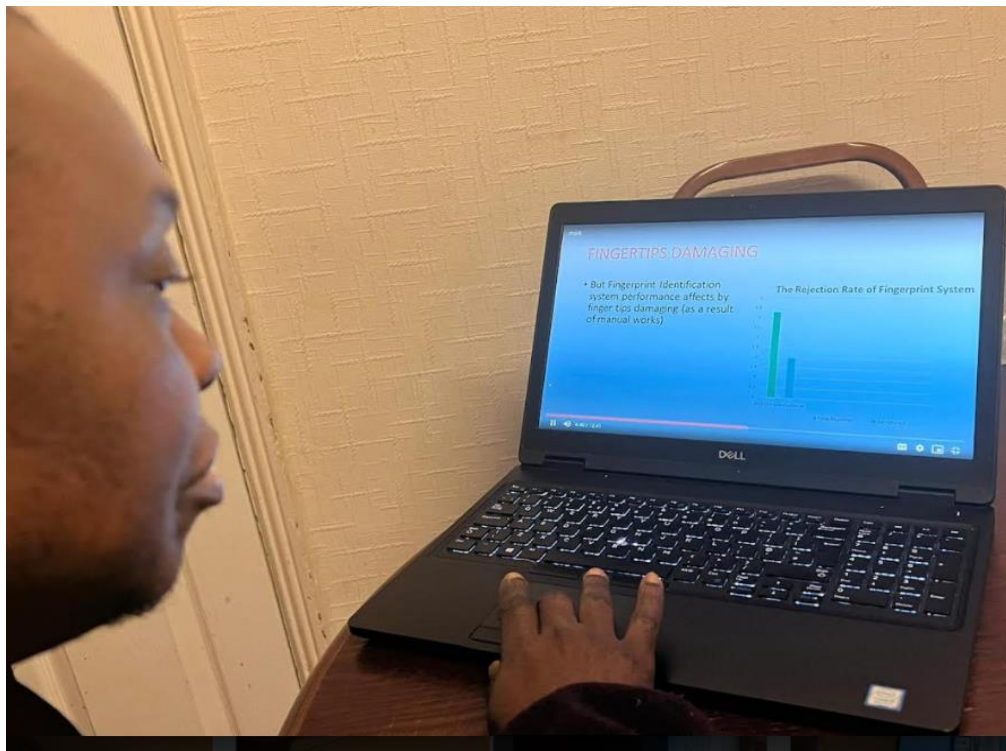


**Figure AE1: Design Fiction Documentary**

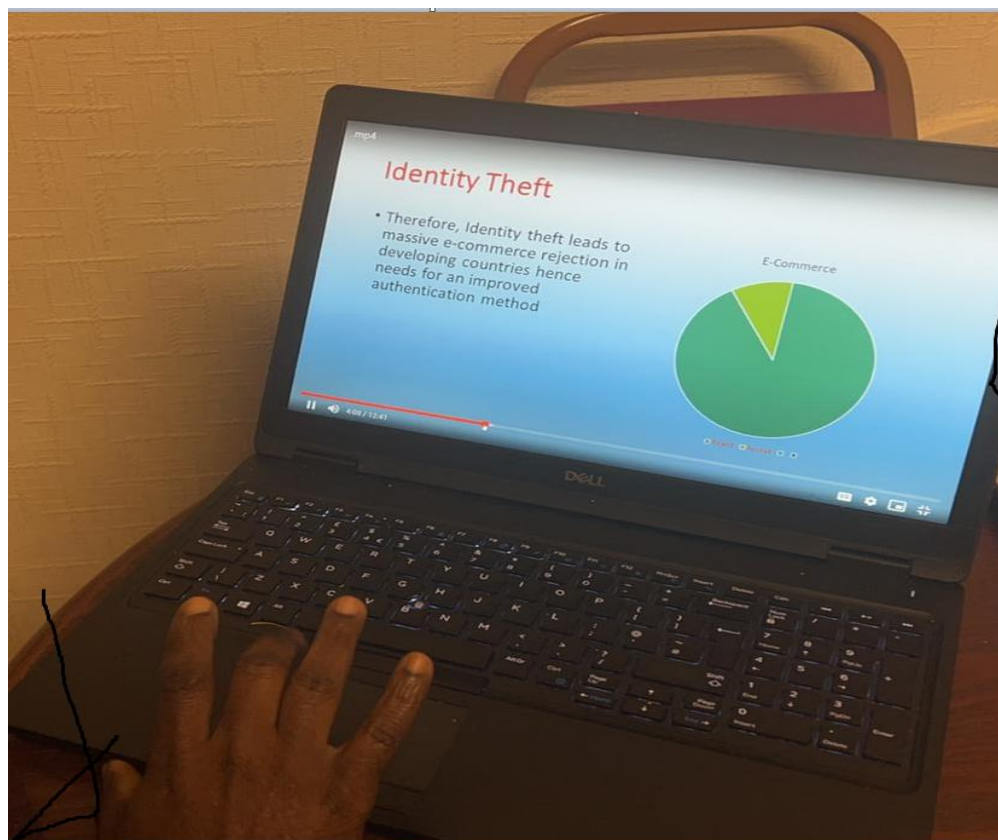


**Figure AE2 3 Authentication Techniques**

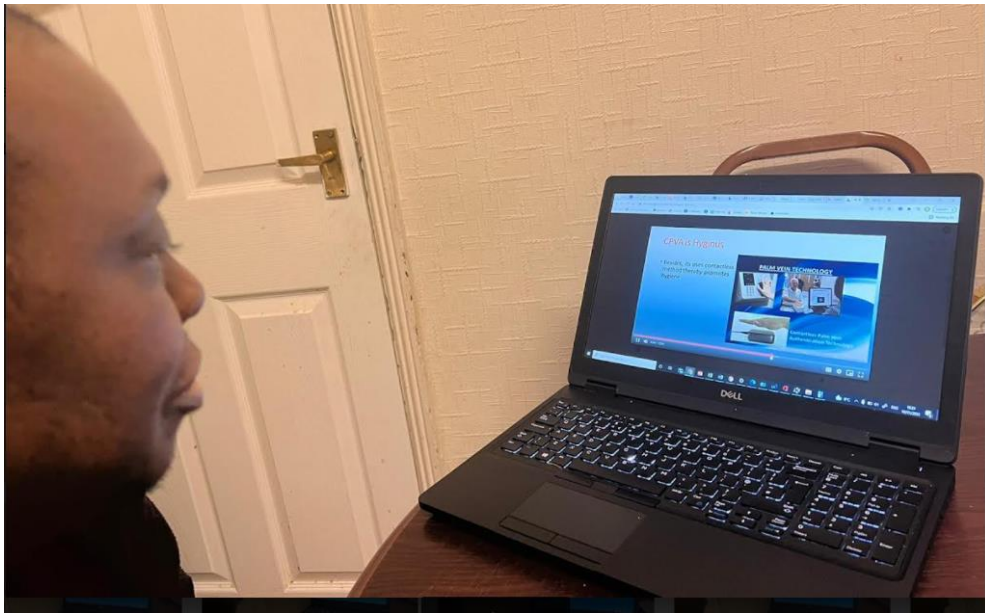




**Figure AE3 E-Commerce Rejection due to Fingertips Damaging**



**Figure AE4 E-Commerce Rejection due to Identity theft using Pin/Password**



**Figure AE5 Payment using Palm Vein Authentication**

## Appendix F: E-Commerce Shopping Simulation Image

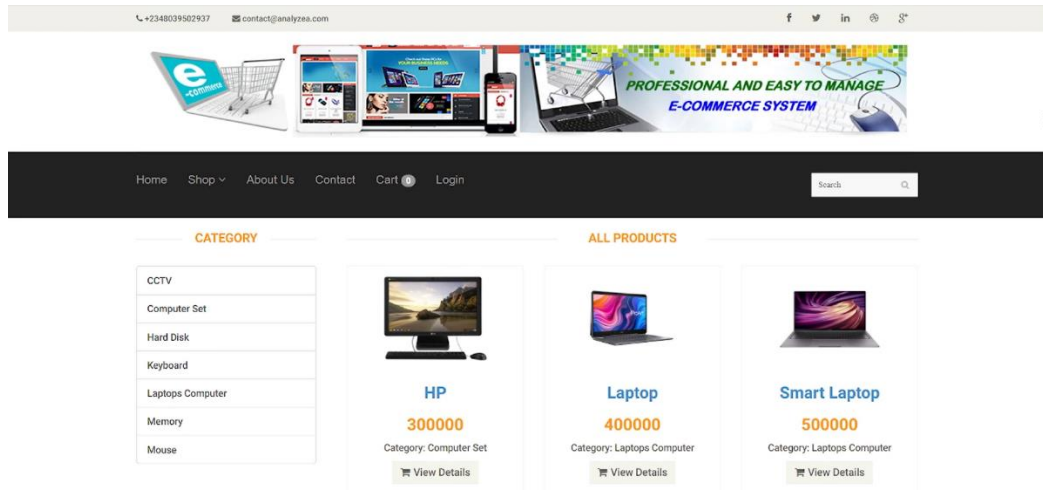


Figure AF 1 E-Commerce Shopping Simulation Website interphase

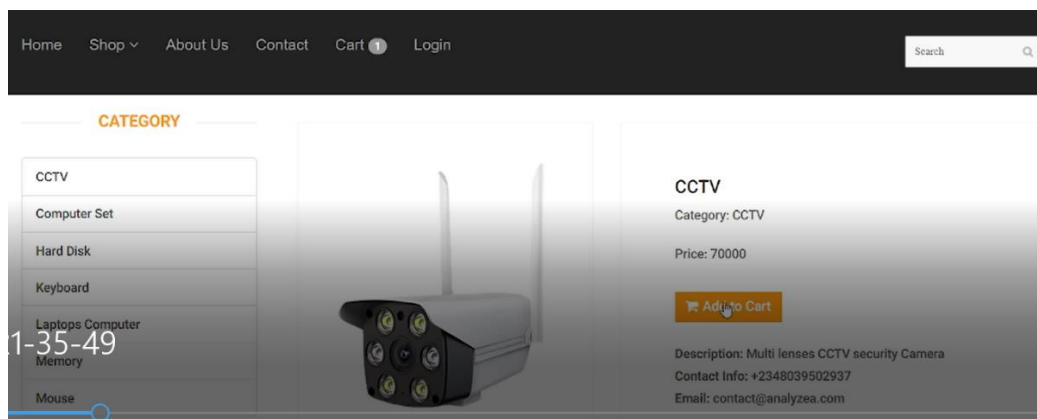


Figure AF 2 E-Commerce Shopping Image of Item to be added to catalogue

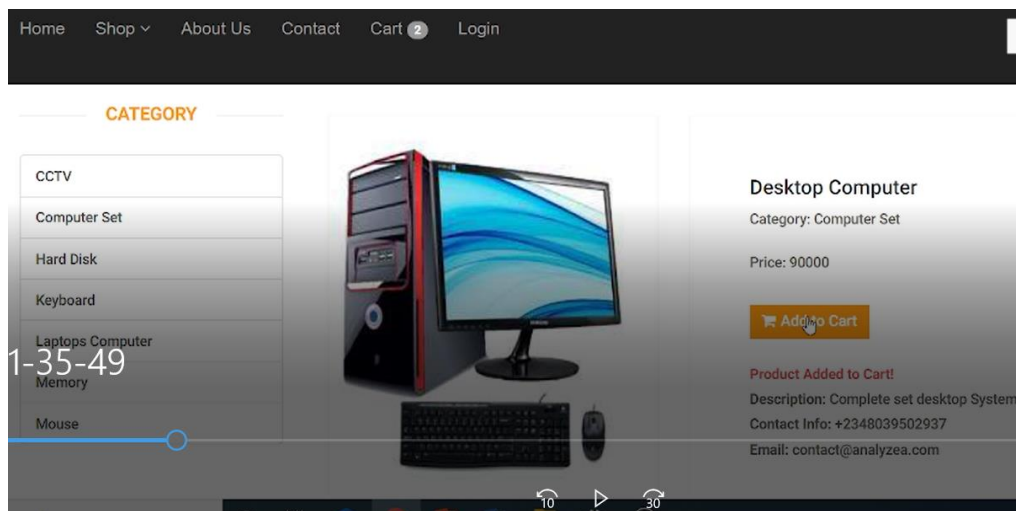
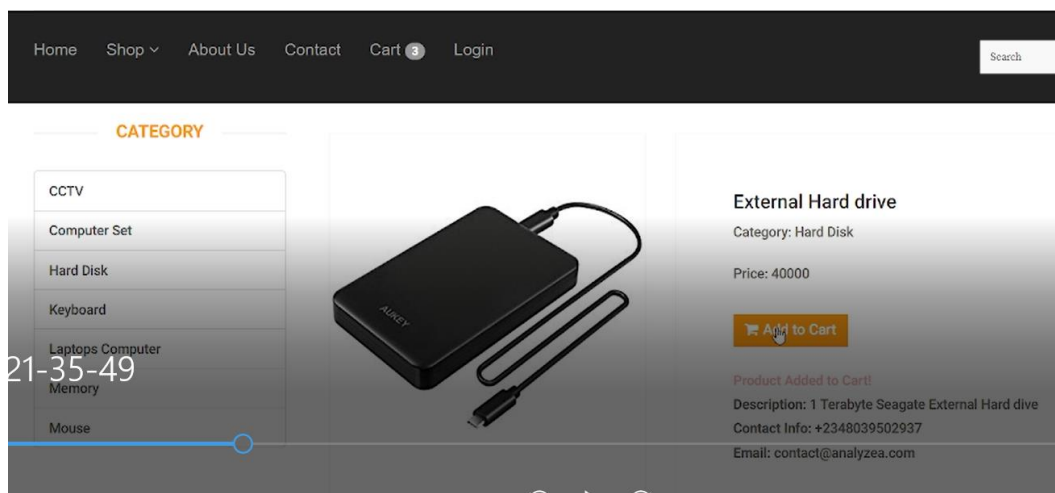


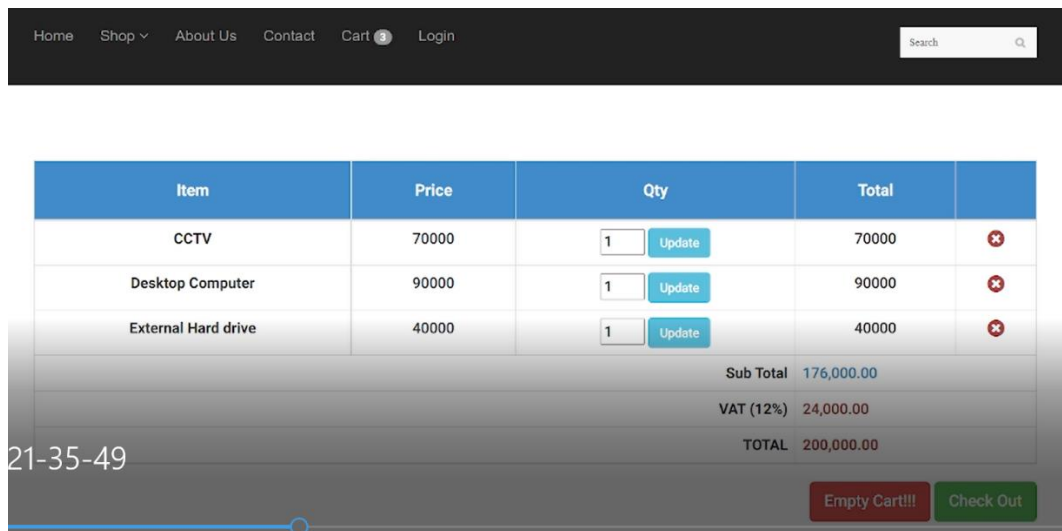
Figure AF 3 E-Commerce Shopping Image of Item to be added to catalogue



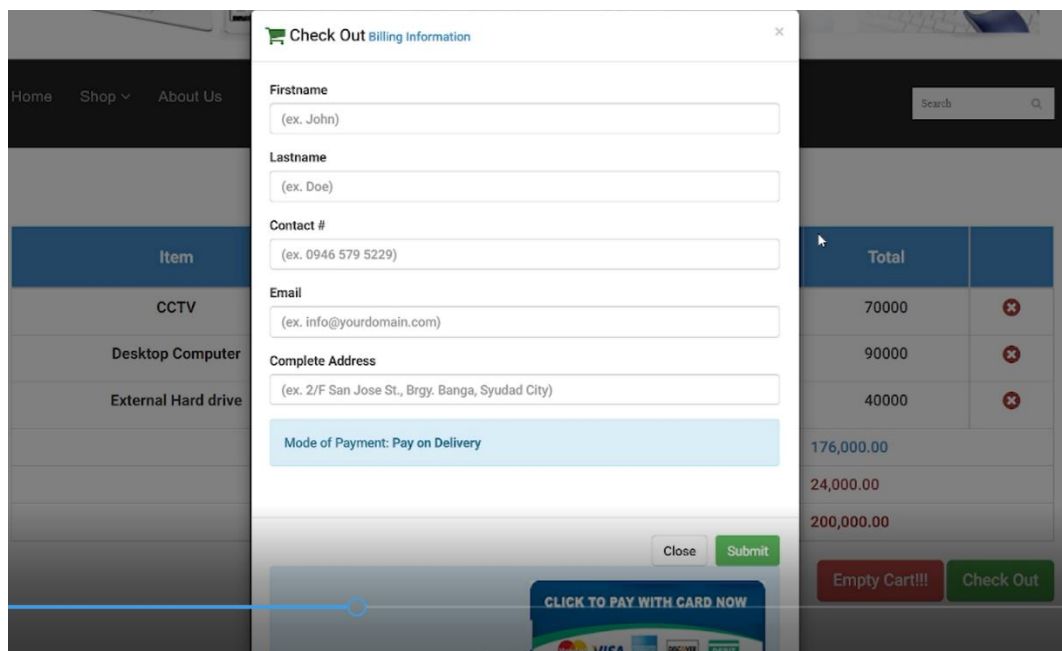
**Figure AF 5 E-Commerce Shopping Image of Item to be added to catalogue**



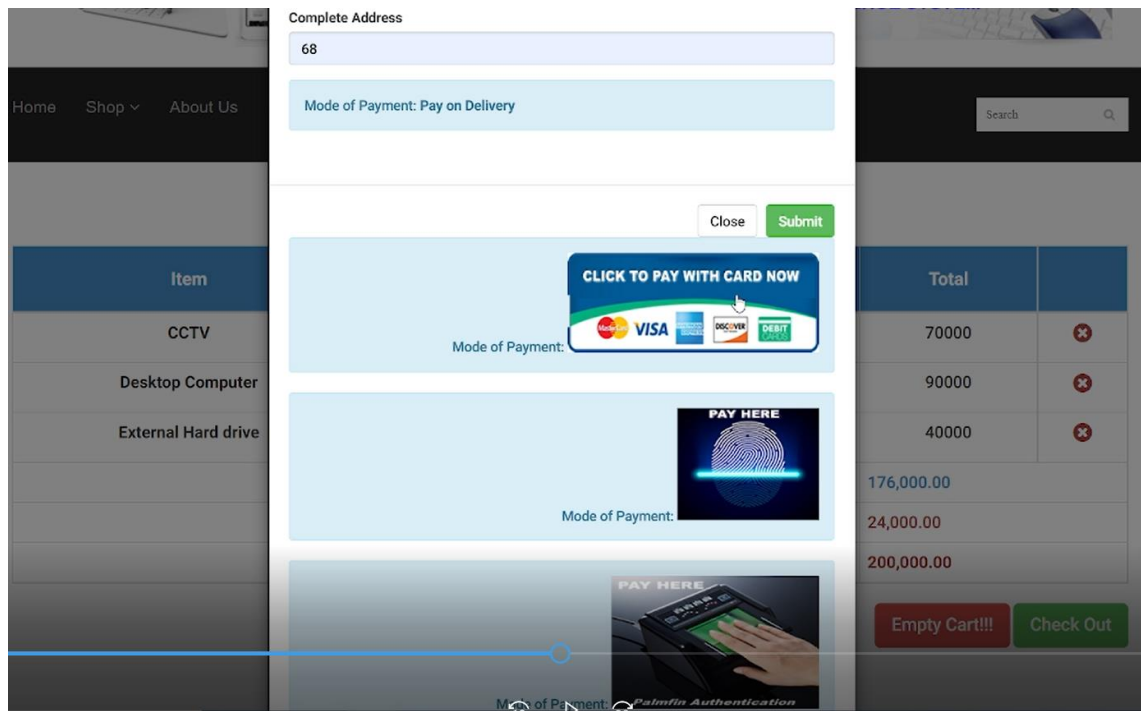
**Figure AF 6 E-Commerce Shopping Image of Item to be added to catalogue**



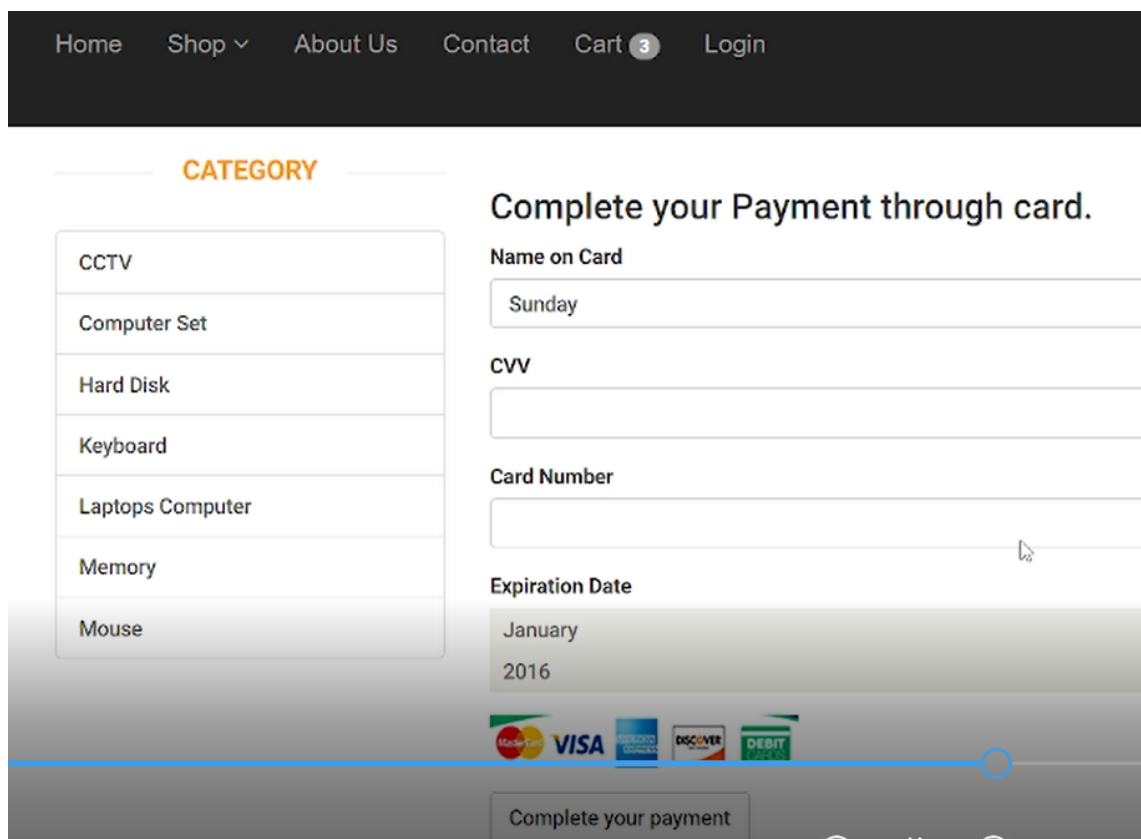
**Figure AF 7 E-Commerce Shopping of Items added to catalogue**



**Figure AF 8 E-Commerce Shopping Billing Information Template**



**Figure AF 9 E-Commerce Shopping Modes of Payment**



**Figure AF 10 E-Commerce Shopping Payment using Cards**



**CATEGORY**

CCTV

Computer Set

Hard Disk

Keyboard

Laptops Computer

Memory

Mouse

### Complete your Payment through card.

**Name on Card**

Sunday

**CVV**

333






**Card Number**

124567867

**Expiration Date**

December

2021

Complete your payment

cancel

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**Figure AF 11 E-Commerce Shopping Payment using Cards with Data Supplied**

Home Shop ▾ About Us

alabisundayadebayo1@gmail.com

Complete Address


68

Mode of Payment: Pay on Delivery

Item
CCTV
Desktop Computer
External Hard drive


Mode of Payment:

CLICK TO PAY WITH CARD NOW



Mode of Payment:

PAY HERE

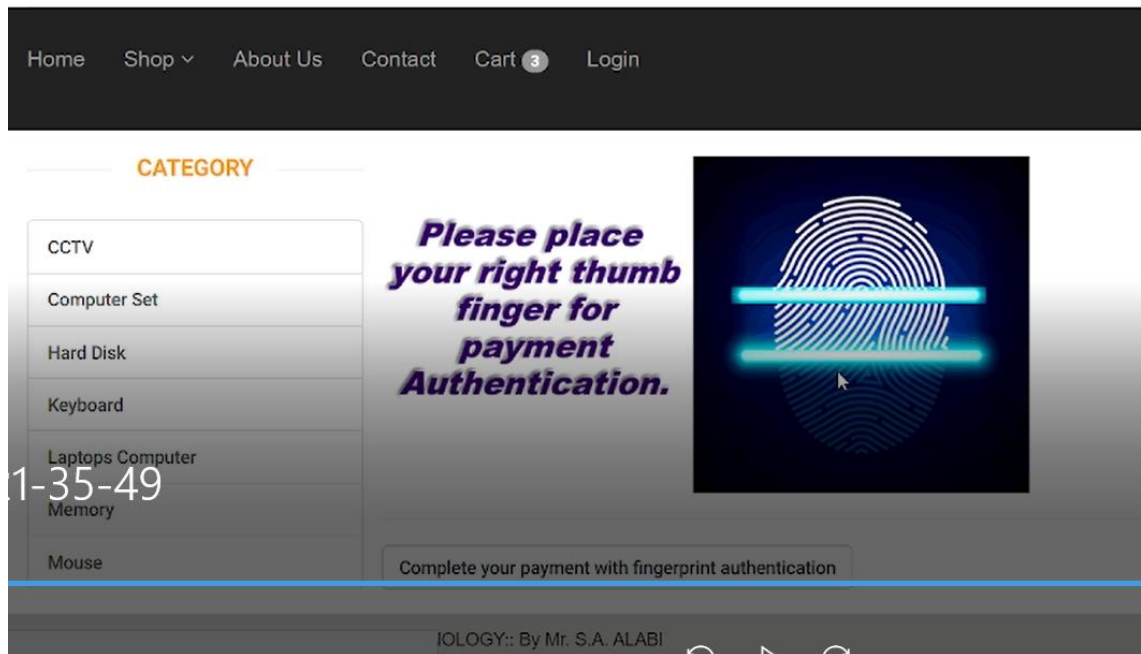


Search

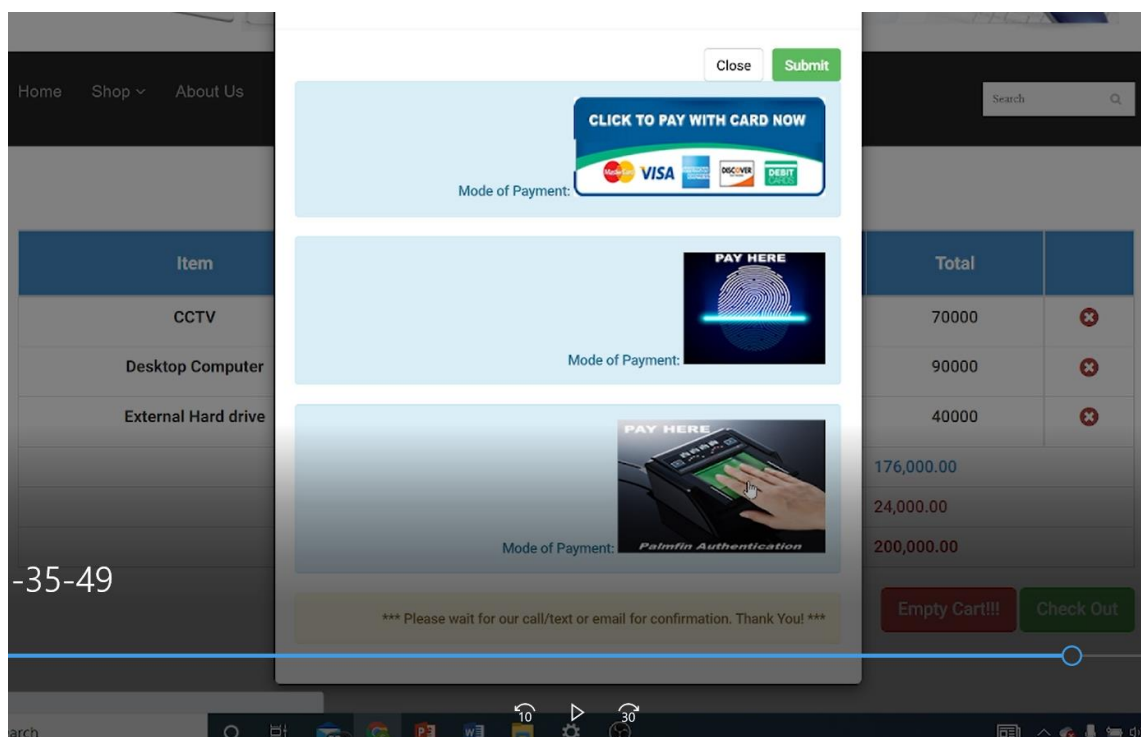
Total	
70000	✖
90000	✖
40000	✖
176,000.00	
24,000.00	
200,000.00	

Empty Cart!!! Check Out

**Figure AF 12 E-Commerce Shopping Payment using Fingerprint for Authentication**

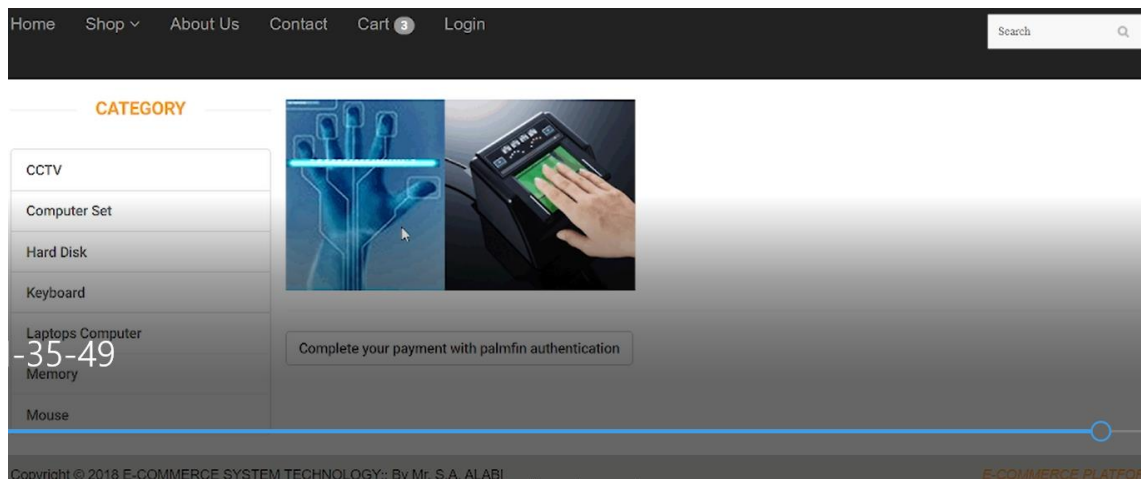


**Figure AF 13 Fingerprint indicator after Authentication**



**Figure AF 14 E-Commerce Shopping Payment using Palm Vein Authentication**





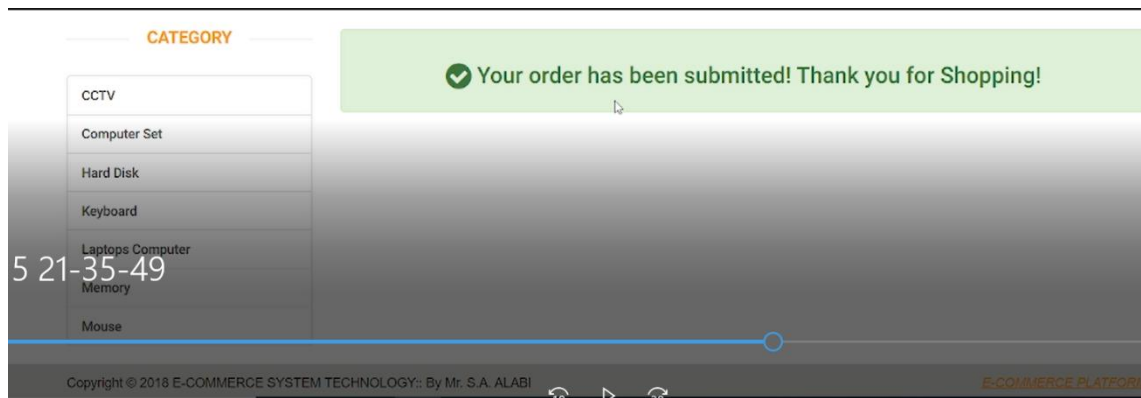
**Figure AF 15 Palm Vein indicator after Authentication**

Item	Price	Qty	Total	
CCTV	70000	1 <a href="#">Update</a>	70000	✖
Desktop Computer	90000	1 <a href="#">Update</a>	90000	✖
External Hard drive	40000	1 <a href="#">Update</a>	40000	✖
			Sub Total	176,000.00
			VAT (12%)	24,000.00
			TOTAL	200,000.00

**Figure AF 16 Catalogue Items Viewing**

Item	Price	Qty	Total	
*** Your Cart is Empty ***				

**Figure AF 17 Items in the Catalogue Emptied**



## Fingerprint AF 18 Ordering Confirmation Message After Payment

### Appendix G: Shopping Website Simulation Code

```
<html lang="en" class="js-focus-visible" data-js-focus-visible=""><head>

  <meta charset="utf-8">

  <meta name="viewport" content="width=device-width, initial-scale=1.0">

  <meta name="description" content="">

  <meta name="author" content="">

  <title>Ecommerce System</title>

  <link href="css/bootstrap.min.css" rel="stylesheet">

  <link href="css/font-awesome.min.css" rel="stylesheet">

  <link href="css/main.css" rel="stylesheet">

  <link href="css/responsive.css" rel="stylesheet">

  <link href="css/style.css" rel="stylesheet">

  <!--[if lt IE 9]>

  <script src="js/html5shiv.js"></script>

  <script src="js/respond.min.js"></script>

  <![endif]-->

  <style type="text/css">@font-face{ font-family:Gilroy;font-style:normal;font-
weight:100 400;src:url(https://pouch-global-font-assets.s3.eu-central-
1.amazonaws.com/Gilroy-Medium.otf) } @font-face{ font-family:Gilroy;font-
```

```
style:normal;font-weight:500 900;src:url(https://pouch-global-font-assets.s3.eu-central-1.amazonaws.com/Gilroy-Bold.otf)}@font-face{font-family:"Font Awesome 5 Free";font-style:normal;font-weight:900;src:url(https://use.fontawesome.com/releases/v5.6.3/webfonts/fa-solid-900.woff2) format("woff2")}@font-face{font-family:"Font Awesome 5 Brands";font-style:normal;font-weight:normal;src:url(https://use.fontawesome.com/releases/v5.6.3/webfonts/fa-brands-400.woff2) format("woff2")}
```

```
</style><style piggy-ext="" data-styled-version="4.4.1"></style><style piggy-ext="" data-styled-version="4.4.1"></style><style type="text/css">
```

```
@font-face {
```

```
font-weight: 400;
```

```
font-style: normal;
```

```
font-family: 'Circular-Loom';
```

```
src: url('https://cdn.loom.com/assets/fonts/circular/CircularXXWeb-Book-cd7d2bcec649b1243839a15d5eb8f0a3.woff2') format('woff2');
```

```
}
```

```
@font-face {
```

```
font-weight: 500;
```

```
font-style: normal;
```

```
font-family: 'Circular-Loom';
```

```
src: url('https://cdn.loom.com/assets/fonts/circular/CircularXXWeb-Medium-d74eac43c78bd5852478998ce63dceb3.woff2') format('woff2');
```

```
}
```

```
@font-face {
```

```
font-weight: 700;
```

```
font-style: normal;
```

```
font-family: 'Circular-Loom';
```

```
src: url('https://cdn.loom.com/assets/fonts/circular/CircularXXWeb-Bold-83b8ceaf77f49c7cfa44107561909e4.woff2') format('woff2');
```

```
}
```

```

@font-face {

font-weight: 900;

font-style: normal;

font-family: 'Circular-Loom';

src: url('https://cdn.loom.com/assets/fonts/circular/CircularXXWeb-Black-
bf067ecb8aa777ceb6df7d72226febca.woff2') format('woff2');

}</style></head><!--/head-->

<body style="" data-new-gr-c-s-check-loaded="14.1047.0" data-gr-ext-installed="">

<header id="header"><!--header-->

    <div class="header_top"><!--header_top-->

        <div class="container">

            <div class="row">

                <div class="col-sm-6">

                    <div class="contactinfo">

                        <ul class="nav nav-pills">

                            <li><a href="#"><i
class="fa fa-phone"></i> +2348039502937</a></li>

                            <li><a href="#"><i
class="fa fa-envelope"></i> contact@analyzea.com</a></li>

                        </ul>

                    </div>

                </div>

                <div class="col-sm-6">

                    <div class="social-icons pull-right">

                        <ul class="nav navbar-nav">

                            <li><a href="#"><i
class="fa fa-facebook"></i></a></li>

```

```

class="fa fa-twitter"></i></a></li>
class="fa fa-linkedin"></i></a></li>
class="fa fa-dribbble"></i></a></li>
class="fa fa-google-plus"></i></a></li>
</ul>
</div>
</div>
</div>
</div>
</div><!--/header_top-->
<div class="header-middle"><!--header-middle-->
<div class="container">
<div class="row">
<div class="col-lg-12">
<div class="logo pull-left">
<center><a
href="index.php"></a></center>
</div>
</div>
</div>
</div><!--/header-middle-->
<div class="header-bottom navbar navbar-inverse"><!--header-bottom--
>

```

```

<div class="container">

    <div class="row">

        <div class="col-sm-9">

            <div class="navbar-header navbar-
default">

                <button type="button"
class="navbar-toggle" data-toggle="collapse" data-target=".navbar-collapse">

                    <span class="sr-
only">Toggle navigation</span>

                    <span class="icon-
bar"></span>

                    <span class="icon-
bar"></span>

                    <span class="icon-
bar"></span>

                </button>

            </div>

            <div class="mainmenu pull-left">

                <ul class="nav navbar-nav collapse
navbar-collapse">

                    <li><a
href="index.php">Home</a></li>

                    <li class="dropdown"><a href="#">Shop<i class="fa fa-angle-
down"></i></a>

                        <ul role="menu" class="sub-menu">

                            <li><a href="category.php?filter=Laptops Computer">Laptops
Computer</a></li><li><a href="category.php?filter=Computer Set">Computer
Set</a></li><li><a href="category.php?filter=Hard Disk">Hard Disk</a></li><li><a
href="category.php?filter=CCTV">CCTV</a></li><li><a
href="category.php?filter=Mouse">Mouse</a></li><li><a
href="category.php?filter=Keyboard">Keyboard</a></li><li><a
href="category.php?filter=Memory">Memory</a></li>

                        </ul>

```

```

        </li>

        <li><a
href="about.php">About Us</a></li>

        <li><a
href="contact.php">Contact</a></li>

        <li><a
href="cart.php">Cart <span class="badge">0</span></a></li>

        <li><a
href="login.php">Login</a></li>

    </ul>

</div>

</div>

<div class="col-sm-3">

    <div class="search_box pull-right">

        <form action="index.php" method="post">

            <input type="text"
placeholder="Search" name="filter">

        </form>

    </div>

</div>

</div>

</div>

</div><!--/header-bottom-->

</header><!--/header-->

<section>

    <div class="container">

        <div class="row">

            <section>

```

```

<div class="container">

    <div class="row">

        <div class="col-sm-3">

            <div class="left-sidebar">

                <h2>Category</h2>

                <div class="list-group">

                    <a href="category.php?filter=CCTV" class="list-group-
item">CCTV</a><a href="category.php?filter=Computer Set" class="list-group-
item">Computer Set</a><a href="category.php?filter=Hard Disk" class="list-group-
item">Hard Disk</a><a href="category.php?filter=Keyboard" class="list-group-
item">Keyboard</a><a href="category.php?filter=Laptops Computer" class="list-
group-item">Laptops Computer</a><a href="category.php?filter=Memory" class="list-
group-item">Memory</a><a href="category.php?filter=Mouse" class="list-group-
item">Mouse</a>

                </div>

            <!--/category-products-->

        </div>

    </div>

    <div class="col-sm-9 padding-right">

        <div class="features_items"><!--features_items--
>

        <h2 class="title text-center">All Products</h2>

        <!--php starts here-->

        <ul class="col-sm-4"><div class="product-image-wrapper">

            <div class="single-products">

                <div class="productinfo text-center">

                    <a href="product-details.php?prodid=83"
rel="bookmark" title="HP"></a>

                    <h2><a href="product-details.php?prodid=83"
rel="bookmark" title="HP">HP</a></h2>

```



```

<h2>3000000</h2>

<p>Category: Computer Set</p>

<a href="product-details.php?prodid=83"
class="btn btn-default add-to-cart"><i class="fa fa-shopping-cart"></i>View
Details</a>

</div></div></div></ul><ul class="col-sm-
4"><div class="product-image-wrapper">

<div class="single-products">

<div class="productinfo text-center">

<a href="product-details.php?prodid=84"
rel="bookmark" title="Laptop"></a>

<h2><a href="product-details.php?prodid=84"
rel="bookmark" title="Laptop">Laptop</a></h2>

<h2>4000000</h2>

<p>Category: Laptops Computer</p>

<a href="product-details.php?prodid=84"
class="btn btn-default add-to-cart"><i class="fa fa-shopping-cart"></i>View
Details</a>

</div></div></div></ul><ul class="col-sm-
4"><div class="product-image-wrapper">

<div class="single-products">

<div class="productinfo text-center">

<a href="product-details.php?prodid=85"
rel="bookmark" title="Smart Laptop"></a>

<h2><a href="product-details.php?prodid=85"
rel="bookmark" title="Smart Laptop">Smart Laptop</a></h2>

<h2>5000000</h2>

<p>Category: Laptops Computer</p>

```

[<i class="fa fa-shopping-cart"></i>View Details</a>](product-details.php?prodid=85)

</div></div></div></ul><ul class="col-sm-4"><div class="product-image-wrapper">

<div class="single-products">

<div class="productinfo text-center">

<h2><a href="product-details.php?prodid=86" rel="bookmark" title="Desktop Computer">Desktop Computer</a></h2>

<h2>80000</h2>

<p>Category: Computer Set</p>

[<i class="fa fa-shopping-cart"></i>View Details</a>](product-details.php?prodid=86)

</div></div></div></ul><ul class="col-sm-4"><div class="product-image-wrapper">

<div class="single-products">

<div class="productinfo text-center">

<h2><a href="product-details.php?prodid=87" rel="bookmark" title="Desktop Computer">Desktop Computer</a></h2>

<h2>90000</h2>

<p>Category: Computer Set</p>

<a href="product-details.php?prodid=87"  
class="btn btn-default add-to-cart"><i class="fa fa-shopping-cart"></i>View  
Details</a>

</div></div></div></ul><ul class="col-sm-  
4"><div class="product-image-wrapper">

<div class="single-products">

<div class="productinfo text-center">

<a href="product-details.php?prodid=88"  
rel="bookmark" title="Hard drive"></a>

<h2><a href="product-details.php?prodid=88"  
rel="bookmark" title="Hard drive">Hard drive</a></h2>

<h2>30000</h2>

<p>Category: Hard Disk</p>

<a href="product-details.php?prodid=88"  
class="btn btn-default add-to-cart"><i class="fa fa-shopping-cart"></i>View  
Details</a>

</div></div></div></ul><ul class="col-sm-  
4"><div class="product-image-wrapper">

<div class="single-products">

<div class="productinfo text-center">

<a href="product-details.php?prodid=89"  
rel="bookmark" title="External Hard drive"></a>

<h2><a href="product-details.php?prodid=89"  
rel="bookmark" title="External Hard drive">External Hard drive</a></h2>

<h2>40000</h2>

<p>Category: Hard Disk</p>

<a  
href="product-details.php?prodid=89" class="btn btn-default add-to-cart"><i class="fa  
fa-shopping-cart"></i>View Details</a>

</div></div></div></ul><ul class="col-sm-4"><div class="product-image-wrapper">

<div class="single-products">

<div class="productinfo text-center">

<a href="product-details.php?prodid=90" rel="bookmark" title="CCTV "></a>

<h2><a href="product-details.php?prodid=90" rel="bookmark" title="CCTV ">CCTV </a></h2>

<h2>55000</h2>

<p>Category: CCTV</p>

<a href="product-details.php?prodid=90" class="btn btn-default add-to-cart"><i class="fa fa-shopping-cart"></i>View Details</a>

</div></div></div></ul><ul class="col-sm-4"><div class="product-image-wrapper">

<div class="single-products">

<div class="productinfo text-center">

<a href="product-details.php?prodid=91" rel="bookmark" title="CCTV "></a>

<h2><a href="product-details.php?prodid=91" rel="bookmark" title="CCTV ">CCTV </a></h2>

<h2>70000</h2>

<p>Category: CCTV</p>

<a href="product-details.php?prodid=91" class="btn btn-default add-to-cart"><i class="fa fa-shopping-cart"></i>View Details</a>

</div></div></div></ul><ul class="col-sm-4"><div class="product-image-wrapper">

<div class="single-products">

<div class="productinfo text-center">

```
<a href="product-details.php?prodid=92"
rel="bookmark" title="Mouse"></a>
```

```
<h2><a href="product-details.php?prodid=92"
rel="bookmark" title="Mouse">Mouse</a></h2>
```

```
<h2>2000</h2>
```

```
<p>Category: Mouse</p>
```

```
<a
href="product-details.php?prodid=92" class="btn btn-default add-to-cart"><i class="fa
fa-shopping-cart"></i>View Details</a>
```

```
</div></div></div></ul><ul class="col-sm-
4"><div class="product-image-wrapper">
```

```
<div class="single-products">
```

```
<div class="productinfo text-center">
```

```
<a href="product-details.php?prodid=93"
rel="bookmark" title="Bluetooth Mouse"></a>
```

```
<h2><a href="product-details.php?prodid=93"
rel="bookmark" title="Bluetooth Mouse">Bluetooth Mouse</a></h2>
```

```
<h2>3000</h2>
```

```
<p>Category: Mouse</p>
```

```
<a
href="product-details.php?prodid=93" class="btn btn-default add-to-cart"><i class="fa
fa-shopping-cart"></i>View Details</a>
```

```
</div></div></div></ul><ul class="col-sm-
4"><div class="product-image-wrapper">
```

```
<div class="single-products">
```

```
<div class="productinfo text-center">
```

```
<a href="product-details.php?prodid=94"
rel="bookmark" title="Keyboard"></a>
```

<h2><a href="product-details.php?prodid=94" rel="bookmark" title="Keyboard">Keyboard</a></h2>

<h2>1500</h2>

<p>Category: Keyboard</p>

<a href="product-details.php?prodid=94" class="btn btn-default add-to-cart"><i class="fa fa-shopping-cart"></i>View Details</a>

</div></div></div></ul><ul class="col-sm-4"><div class="product-image-wrapper">

<div class="single-products">

<div class="productinfo text-center">

<a href="product-details.php?prodid=95" rel="bookmark" title="Keyboard"></a>

<h2><a href="product-details.php?prodid=95" rel="bookmark" title="Keyboard">Keyboard</a></h2>

<h2>2000</h2>

<p>Category: Keyboard</p>

<a href="product-details.php?prodid=95" class="btn btn-default add-to-cart"><i class="fa fa-shopping-cart"></i>View Details</a>

</div></div></div></ul><ul class="col-sm-4"><div class="product-image-wrapper">

<div class="single-products">

<div class="productinfo text-center">

<a href="product-details.php?prodid=96" rel="bookmark" title="Memory"></a>

<h2><a href="product-details.php?prodid=96" rel="bookmark" title="Memory">Memory</a></h2>

<h2>4000</h2>

<p>Category: Memory</p>

<a href="product-details.php?prodid=96" class="btn btn-default add-to-cart"><i class="fa fa-shopping-cart"></i>View Details</a>

</div></div></div></ul>

<!--php ends here-->

</div>

</div>

</div>

</div>

</section></div>

</div></section>

<div class="footer-bottom">

<div class="container">

<div class="row">

<p align="center" class="pull-left">Copyright © 2018 E-COMMERCE SYSTEM TECHNOLOGY: By Mr. S.A. ALABI </p>

<p class="pull-right"><span><a target="\_blank" href="#">E-COMMERCE PLATFORM</a></span></p>

</div>

</div>

</div>

<script src="js/jquery.js"></script>

```

<script src="js/bootstrap.min.js"></script>

<script src="js/main.js"></script>

<script src="js/script.js"></script>

<div id="pouch-root" style="display: block;"></div></body><style
id="superstyle"></style><loom-container id="lo-engage-ext-container"><loom-shadow
classname="resolved"></loom-shadow></loom-container><loom-container id="lo-
companion-container"><loom-shadow classname="resolved"></loom-shadow></loom-
container><grammarly-desktop-integration data-grammarly-shadow-
root="true"></grammarly-desktop-integration><div id="piggyWrapper"
style="position: fixed; top: 0px; right: 0px; line-height: initial; z-index: 2147483647;
width: auto; font-family: &quot;Open Sans&quot;, sans-serif; font-size: initial; display:
block; text-transform: none; font-style: normal;"></div></html>

<div class="header-bottom navbar navbar-inverse"><!--header-bottom-->

    <div class="container">

        <div class="row">

            <div class="col-sm-9">

                <div class="navbar-header navbar-
default">

                    <button type="button"
class="navbar-toggle" data-toggle="collapse" data-target=".navbar-collapse">

                        <span class="sr-
only">Toggle navigation</span>

                        <span class="icon-
bar"></span>

                        <span class="icon-
bar"></span>

                        <span class="icon-
bar"></span>

                    </button>

                </div>

                <div class="mainmenu pull-left">

                    <ul class="nav navbar-nav collapse
navbar-collapse">

```



```

</li><a
href="index.php">Home</a></li>

<li class="dropdown"><a href="#">Shop<i class="fa fa-angle-
down"></i></a>

<ul role="menu" class="sub-menu">

<li><a href="category.php?filter=Laptops Computer">Laptops
Computer</a></li><li><a href="category.php?filter=Computer Set">Computer
Set</a></li><li><a href="category.php?filter=Hard Disk">Hard Disk</a></li><li><a
href="category.php?filter=CCTV">CCTV</a></li><li><a
href="category.php?filter=Mouse">Mouse</a></li><li><a
href="category.php?filter=Keyboard">Keyboard</a></li><li><a
href="category.php?filter=Memory">Memory</a></li>

</ul>

</li>

</li><a
href="about.php">About Us</a></li>

<li><a
href="contact.php">Contact</a></li>

<li><a
href="cart.php">Cart <span class="badge">0</span></a></li>

<li><a
href="login.php">Login</a></li>

</ul>

</div>

</div>

<div class="col-sm-3">

<div class="search_box pull-right">

<form action="index.php" method="post">

<input type="text"
placeholder="Search" name="filter">

</form>

</div>

```

</div>

</div>

</div>

</div>

### **Note**

All the working procedures, Experimentations (Design Fiction Documentary and Simulated website), Research Raw Data and the complete Data Analysis are kept in the Research Archives of this research.