TraceX: A Mobile Application for Verifying the Authenticity and Originality of ICT products

By CS2022-05

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Dedication

This report is dedicated to all the group members of GROUP 5 who spared their precious time available to make sure that this work is up to this stage. We further dedicate this report to our supervisor Mr. DANIEL Ogenrwot who made himself available to us whenever we needed guidance and to the love, support and hard work that our parents have endlessly invested and showed to us. God Bless you all.

Acknowledgement

We would love to thank the almighty God for keeping us all this long since we began our academic pursuit. More so, his sufficient mercy and grace have been upon us all through this project. Appreciation also goes to our beloved Lecturers who took a hand in directing us and answering our consultation questions. Super special thanks to our parents who are giving us emotional and financial support in our endeavors to acquire degree level of learning. In a special way we appreciate our dear supervisor Mr. DANIEL Ogenrwot for the wonderful time and guidance he showed us, may you find joy wherever you go in life.

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List of Acronyms

ICT	Information and Communictions Technology
GDP	Gross Domestic Product
QR	Quick Response
IMEI	International Mobile Equipment Identity
USD	United States Dollars
UCC	Uganda Communicattions Commission
OCED	Organization for Economic Cooperation and Development
2D	Two Dimension
3D	Three Dimension

Abstract

Counterfeiting of products is one of the leading illegal activities in the world with lots of billion dollars exchanged on annual basis. The rapid proliferation of ICT infrastructure and demand for ICT goods makes it an attractive target for counterfeiters. The government of Uganda recognizes ICT as a critical component to realizing its nation vision 2040. ICT has accelerated the country's development by improving public and private sector service delivery, providing better access to information, creating jobs and spurring economic growth by boosting exports. Unfortunately, there is no readily available mechanism to ascertain the authenticity and originality of the ICT Products that the public uses. Traditional methods such as physical visual inspection of the product to examine its brand identifiers have not been successful since counterfeits and authentic products are becoming more alike. To this far, our study aims to develop a mobile application that can verify the authenticity and originality of ICT products. The prototype validation app "TraceX" was developed using the agile software development methodology, particularly the scrum model to allow for an iterative and incremental development process. Our finding shows that the developed solution is able to verify the originality of approximately 30 ICT products currently uploaded on the platform and capable of scaling according to the user requirement. Therefore, "TaceX" application allows users to verify ICT products through the use of IMEI number inputs, serial numbers and barcode scanners and get recommendations on product authenticity thus reducing the number of victims of counterfeit ICT products and increasing manufacture's sales.

Chapter One

Introduction

Counterfeiting of products is one of the leading illegal activities in the world with lots of billion dollars exchanged on annual basis. According to Githii (2014), USD 600 billion is an estimated amount in the trade that is higher than the GDP of many developing countries

The effect of the counterfeiting is an intermission of innovation and thus impairment of economic growth. The economic damage affects countries that use advanced production and manufacturing process based on intensive research and development to produce high quality goods.

According to Pascal (2007), the annual report of European Union customs enforcement of intellectual property rights of the European Union in 2012 shows a continuous upward trend in the number of shipments suspected of violating intellectual rights for the last years. To get an idea of the world-wide amount of economic damage for the last years this reports about a total loss of 250 billion dollars in 2007 (Brandenburg et al., 2015). Shah et al., (2010) argues that counterfeits makeup more than 10% of the global medicines market and it is estimated that 25 % of the medicines consumed in poor countries are counterfeits.

Therefore, in this research we developed a mobile application for verifying the authenticity and originality of ICT products. It is conceptualized as an innovative solution that leverages the power of data mining and computer vision to present a holistic platform for verifying the authenticity and originality of ICT products. It allows consumers to provide "meta-data" about a product they wish to verify such as IMEI number, service tag or serial number. The application uses data mining to scrap and extract relevant information from the internet about the product based on the "meta-data" provided. Similarly, consumers are able to scan barcodes (using computer vision's optical character recognition technique) and QR at the comfort of their smartphones (Padhy et al., 2012). It then validates this information against a wide range of publicly available barcode databases and provide meaningful recommendations.

1.1 Background

Counterfeit is not a new term but has rather existed for years, It is regarded as one of the oldest crime in history (Githii et al., 2014). Counterfeiting can basically be defined as unauthorized representation of registered trademark carried on goods identical or similar to goods for which the trademark is registered with an aim of deceiving the buyer into believing that he/she is buying the original goods. Counterfeit products are products that violate registered copyrights and patent rights provision by illegally duplicating a brand (Shah et al., 2010).

Authors stress that the demand price curves in markets where authentic and counterfeit products provide a starting point for identification of counterfeit trade effects (Butticè et al., 2020). The trade in Kenyan economy is the key foreign exchange source such as tourism and horticulture. This trade in regards to the international Anti-Counterfeiting Coalition ranges from jewelry, electronic cords, Compact Disks (CDs) and pirated software since it touches all categories of products and doesn't discriminate (Githii et al., 2014).

The government of Uganda recognises ICT as a critical component to realizing its nation vision 2040. ICT has accelerated the country's development by improving public and private sector service delivery, providing better access to information, creating jobs and spurring economic growth by boosting exports. According to National Planning Authority (2007), the ICT sector is noted to be growing by 19.7 % on average each year since 2013, adding 2.5% to the country's Gross Domestic Product (GDP).

The rapid proliferation of ICT infrastructure and demand for ICT goods makes it an attractive target for counterfeiters. A report by the Organization for Economic Co-operation and Development (OECD) on the trade in counterfeit ICT products found that nearly 1 in 5 mobile phones and 1 in 4 video games consoles shipped internationally is fake. Recent advancements in technology have been breathtaking, as reflected by the plethora of powerful and innovative digital devices and tools in our homes, workplaces, and communities. This has changed the way we live and interact with each other. Although this is the case, a large percentage of ICT products circulating within the market are not genuine. As previously noted, counterfeiters are very attracted to ICT products due to their rapid proliferation. Unfortunately, there is no readily available mechanism to ascertain the authenticity and originality of the ICT Products that the public uses. Traditional meth-

ods such as visual inspection of the product to examine its brand identifiers have not been successful since counterfeits and authentic products are becoming more alike. More advanced methods such as forensic are expensive, time-consuming and not suitable for the local community who are highly affected by this problem.

Over the years, advances in data mining and computer vision, coupled with smartphone usage has paved the way for the design and implementation of smart and low-cost solutions. ICT products are normally shipped with several identifiers (meta-data) which references the manufacturers such as IMEI number in a mobile phone and any GSM enabled device, barcode, QR code, service tag, serial number and many others. Some of these identifiers are images while others are text (Padhy et al., 2012). According to Ramalingam et al. (2018), there are many types of barcode system using QR code, one is a two dimensional (2D) encrypted barcode with a matrix structure which consists of black module arranged in square grid on a white background .This barcode serve as a mobile bridge between physical platforms and digital information hence the proposed system ,i.e., The application uses barcodes to get all information on any product since barcodes allows real time data to be collected accurately and rapidly.

By leveraging data mining and computer vision, we can begin to build solutions around the aforementioned identifiers to provide headway towards achieving an optimal solution against counterfeit ICT products.

Therefore, this research presents a platform for verifying the authenticity and originality of ICT products through the use of barcodes, IMEI number and serial numbers of the respective products. The application detects the encoded-decoded patterns of the product and compares it with metadata that captured through data mining and the related database which allows real time data to be collected accurately and rapidly and in turn the app displays information indicating whether the product is genuine or not.

1.2 Statement of the problem

In 2013, a study by the Uganda Communications Commission (UCC) found that 29.5% of all phones used in Uganda are counterfeits. The effect of counterfeit ICT products is easily observed by various consumers. For instance, manufacturers are known to lose billions of shillings over counterfeit products. On the other hand, generic consumers (local public) always opt for low-cost products and stand prey to counterfeit products. Unfortunately, there is no

readily available mechanism to ascertain the authenticity and originality of the ICT Products that the public uses. Traditional methods such as physical visual inspection of the product to examine its brand identifiers have not been successful since counterfeits and authentic products are becoming more alike.

This study therefore aims to design a prototype to enhance the verification of authenticity and originality of ICT products.

1.3 Main Objective

This study aims to develop a mobile application for verifying the authenticity and originality of ICT products.

1.3.1 Specific Objectives

i. To investigate the requirements for the application for verifying the authenticity and originality of ICT products through analysis of related and existing systems

ii. To design an application that supports both android and iOS for verifying the authenticity and originality of ICT products.

iii. To implement and test the effectiveness of this application by including the consumers, retailers, and manufacturers

1.4 Scope

The main focus of the study is to develop a counterfeit detection app for ICT products. The counterfeit detection app will fully function in Android and IOS devices and to ensure full efficiency and functionality, the app will be developed using a combination of Python and php programming languages, and Django to handle database. It will be using image processing for the unique codes (barcodes) printed on the product and the app will make use of the cameras within the device to scan and verify the codes with that of the brand to check the authenticity and originality of the product in addition to allowing IMEI and Serial number inputs. After scanning or providing the IMEI or serial number of the product, the proposed app will automatically detect the encoded-decoded patterns and the numbers of it which will be

present in the database of that specific brand. Each user will have access to all brands and their prospective products. If verification and authentication is a success, a full description of the product will be will be displayed on screen of the device being used and an alert message will pop up on the mobile device informing the user to buy the product that it is genuine or not.

1.4.1 System Scope

The main focus of the study is to develop a counterfeit detection app for ICT products. The counterfeit detection app will fully function in Android and IOS devices and to ensure full efficiency and functionality, the app will be developed using a combination of Python and php programming languages, and Django to handle database. It will be using image processing for the unique codes (barcodes) printed on the product and the app will make use of the cameras within the device to scan and verify the codes with that of the brand to check the authenticity and originality of the product in addition to allowing IMEI and Serial number inputs. After scanning or providing the IMEI or serial number of the product, the proposed app will automatically detect the encoded-decoded patterns and the numbers of it which will be present in the database of that specific brand. Each user will have access to all brands and their prospective products. If verification and authentication is a success, a full description of the product will be will be displayed on screen of the device being used and an alert message will pop up on the mobile device informing the user to buy the product that it is genuine or not.

1.4.2 Geographical Scope

The geographical scope of this study will be Gulu City with target areas being Laroo Division at Gulu University, Gulu main street (local ICT product retail shops), NGOs and other companies within Gulu city. This is because Gulu city is one of the fast-growing cities recently established by the government. The city hosts a number of ICT product users as well as local ICT businesses. Similarly, Laroo Division has Gulu University with a several students and staff who use ICT products.

1.5 Justification

Trade in counterfeits has steadily increased by a percentage of 3.3 % according to the OCED and the EU's intellectual property rights offices. Counterfeits create serious problems for people and business but a lot of people are always unaware of the impact of the counterfeits and some continue to buy them willingly. On part of the brands, counterfeiting damage authentic brand's reputation leaves companies to deal with the fallout, also loss of sales among others. And on the consumers' side, counterfeit cosmetics can cause serious skin reactions, fake computer accessories like ink cartridge can as well cause skin reactions. Therefore, this application enables uses to scan and verify the authenticity of the product before buying. The application either scans the barcode printed on the product, allow IMEI number or Serial number user inputs to find out whether they match with the data available in the databases of the various ICT companies. In addition, the counterfeit detection app after verifying the authenticity and originality of the product gives out a pop message indicating whether the product is real or fake and to be able to meet all customers

Chapter Two

Literature Review

2.1 Counterfeiting

Counterfeiting is a general world problem that has accompanied by the rise of prominence of well- known and identified branded items. Spink et al. (2013) explains counterfeiting as the authorized representation of a registered trademark carried on goods identical or similar to goods for which the trademark is registered, with the view of deceiving a purchaser into believing that he/she is buying the original goods.

2.2 Counterfeits

According to Ibrahim et al. (2018), counterfeits are brands that bear a trade mark that is similar to or indistinguishable from the original trade mark. Counterfeiting of goods means a series of actions aimed at producing goods which violate intellectual property rights (IPRs) and supplying them to a conscious or unconscious consumer. It is argued that at times, some consumers don't know that the goods they are buying are not genuine. While for other products customers are fully aware that they are buying fake brands and this is because some customers always want to save since these products are always sold cheaply compared to the prices of the original brands. Counterfeiting is common in electronic products such as phones, solar systems, batteries, wire cables, also common in cosmetics products and clothes. An estimate of 5-7 percent of the world's trade is in illegitimate goods and trading in counterfeits has increased to 8600 billion annually on the world market (Norum & Cuno, 2011). The manufacturing and the sale of counterfeit goods cause significant problems to consumer products including luxury goods, electronics and fashion (De Barnier, 2014). Not only to the consumer goods but counterfeits cause serious problems to the governments and the whole economy at large. According to De Barnier (2014), the sale of counterfeit products robs the market share from legitimate manufacturers and retailers and also due to the sale of counterfeits, the governments lose substantial tax revenue which could be important in helping to provide health and welfare services to citizens hence creating a very negative impact

on the economy. Counterfeiting does not only affect goods whose brands is synonymous but also goods which need high level of research plus marketing (Chaudary et al., 2014).

2.3 Current trends

This section discusses the new trends in the technologies to fight against counterfeiting

2.3.1 Anti Counterfeiting Techniques

In the past, the counterfeit market has increased to the extent of reaching online where it can be easy to trick customers or buyers with fake websites and photographs copied from real brands. This can be termed as a change from local methods of distributing counterfeits which involved shipping companies as of current counterfeits can be sold directly online. Due to the fact that counterfeits are no longer transported in containers but shipped directly to customers, the impact to fight against them can be registered as significant. This is because physical ports entries are always the same and can always be monitored by local authority. However, the new trends require new tools and approaches to detect counterfeit items. various counterfeits can be brought through mobile e-commerce sites and these can be shoes, luxury, electronics among others. Therefore, to achieve new approaches, there is a need to understand that most counterfeit goods are sold through identified distribution channels and these are fake websites which tend to be real, web blogs and social network websites, retail e-commerce outlets which don't control their distribution among others. Therefore, among the new approaches, there is TraceX counterfeit detection app which can be used to track all goods through the use of the camera to scan barcodes, IMEI and Serial numbers that shall be read from the product and provided by the user before making or ordering a transaction from an online e-commerce site and find out whether the product is a genuine one not.

2.3.2 Application of Internet of Things (IOT) to fight against counterfeiting

This section describes how the internet of things has helped to fight against counterfeits. The Internet of Things (IOT) is a concept that has increasingly

been supported by many organizations, business men and all stake Holders. The idea is to connect various devices through wired and wireless connections and unique addressing schemes to create an environment where a person can interact with a digital world (Thirugnanam & Ragupathy, 2019). IOT depends on clear identification of a "thing" or on the possibilities to acquire information environment through sensors. Basing on these capabilities, IOT can become a new technique to fight against counterfeits. This is because IOT can help to improve on serialization to enable companies protecting their brands by making counterfeiting very difficult. IOT can mitigate the risk of imitating product series numbers or phony packaging, because authentication information to a bar- code could be checked to a remote server. Thus, making it easy to track counterfeits

2.4 Related Systems

This section provides a description of some of the existing counterfeit detection systems that are developed and being used in the world today. These systems have help to reduce on counterfeiting and these include; Barcode Reader System, QR code and Two-Dimensional Barcodes systems, Track and Trace System.

2.4.1 Barcode Reader System

The development of this software mainly depends on the capturing and decoding operations that applied on the barcode image. Al-Saedi et al. (2015), argues that the system was achieved and implemented by using the 2.2 Counterfeitsalgorithms of capturing image routines that is capturing the barcode image via a USB webcam and decoding procedures of defined set of barcode symbology's (e.g.EAN-13, UPC-A). In this system, digital image processing techniques were used to enhance the captured bar code image and to give it a custom feature to facilitate the decoding procedures. Furthermore, the development of this system is categorized into three parts: part 1 involves the use of a USB webcam device drivers to capture the barcode, part 2 deals with filters of digital processing that is applied on the captured image and finally part 3 which consists of the decoding processing of the barcode and the display of the results. However, this system mainly depends on the USB webcam to capture the image or barcodes and therefore for users without a USB device cannot be able to detect the barcodes and match with original

patterns of the product when buying a product. To improve on this, the proposed application shall use an inbuilt camera of any device to scan and capture barcodes and match an image taken with patterns of original product which shall be available on secure databases. And is achievable be9cause all the target devices have inbuilt camera system no need to first have a USB.

2.4.2 QR code and Two Dimensional Barcode Systems

The QR (Quick Response) code is a two-dimensional (2-D) barcode. According to Chang (2014), the QR codes are able to store more information in the same space and are designed to be read and understood (decoded) by computers, using machine-vision systems consisting of optical laser scanners or cameras and barcode-interpreting software. QR code is a 2-D matrix that collects information not by the size and position of the bars and spaces in a single dimension but by the arrangement of dark and lights elements that is modules. QR code and Two-Dimensional Barcodes systems only focuses on two dimensional barcodes and the barcodes in a 3-D cannot be captured using this system, therefore the proposed system, i.e., counterfeit detection app shall be applicable on all types barcodes such as 1-D, 2-D, and 3-D barcodes and being able to capture all the codes printed on any product hence displaying the information of the product.

2.4.3 Track and Trace System

This is the process by which a unique identity is given to an item during the manufacture which then remains with it through the supply chain until final consumption. According to Shamsuzzoha and Helo (2011), the information is attached to a product in form of a unique identity code that enables a user to access same data on a secure database. Shamsuzzoha and Helo (2011)further argues that pedigree is one of the types of track and traces system and is commonly used on drugs in a place before being finally consumed. A pedigree is the electronic piece of file that contains the details of distribution of a prescription drug from its manufacture through wholesale transaction until it's received by the final user and majorly by a pharmacy

2.4.4 Fake Note Detector Machine

This is the process by which a unique identity is given to an item during the manufacture which then remains with it through the supply chain until final

consumption. According to Shamsuzzoha and Helo (2011), the information is attached to a product in form of a unique identity code that enables a user to access same data on a secure database. Shamsuzzoha and Helo (2011)further argues that pedigree is one of the types of track and traces system and is commonly used on drugs in a place before being finally consumed. A pedigree is the electronic piece of file that contains the details of distribution of a prescription drug from its manufacture through wholesale transaction until it's received by the final user and majorly by a pharmacy

2.5 Why a Mobile Application for Verifying the Authenticity and Originality of ICT Products

The existing systems don't involve the use of a smart phone concept which are commonly used currently. Also, the existing systems only operate using the barcodes but the proposed counterfeit detection app shall also allow the use of IMEI numbers and Serial numbers thus catering for all categories of products.

2.6 Ugandan Context

In Uganda, counterfeiting is at a high rate and the target is the first moving consumer goods and drugs like cosmetics and toothpastes, tires, and vehicle spare parts, electronics, Drugs, hardware products and generators. According to people of Uganda, some clues to detect and identify counterfeits are very low prices of goods, altered trademarks, Raged and poor-quality labels, Misspelt words on labels, blurred littering, strange codes on products packaging materials among others. So once one of the above is identified on the product, a conclusion is made that the product is probably a counterfeit.

Chapter Three

Methodology

This section provides insights on key methodologies that will be used to develop the TraceX application. The agile methodology was used in developing the application in addition to the data collection methods that we used gathering the data.

3.1 Agile Methodology

We used the agile methodology, particularly the scrum model. This enabled an iterative and incremental development process. We developed the project in several phases, each of which resulted in a ready-to-use application. At the end of each sprint, we delivered a working application for testing. The feedback helped reveal changes in the initial development plan when needed to ensure that we were on the right path.

3.1.1 Product Backlog Creation

We identified the product backlog with a list of features to be implemented during the development process. This was through prioritizing the features and every component into a user story in order to meet the user requirements and track our progress. Below is a sample user story that represents the actual requirements that we implemented in the development of this mobile application:

ID	User Story
001	As a user, I would wish to buy an ICT product and would like to understand if the product is counterfeit or not before the purchase
002	As a brand owner, I would be interested in detecting the distribution of counterfeit items in the market.
003	As a system administrator, I would be interested in registering and deregistering user accounts, making system backups, updating and receiving queries from users about the system performance

Figure 3.1: A sample of a backlog

3.1.2 Sprint Planning and Sprint Backlog Creation

Under this, we determined what our sprint's duration to be one week and we set sprint goals that yielded results on every review. This enabled us to identify all the possible bugs and errors that we would include to be tackled in the next sprint. We further designed a sprint backlog that focused on the feedback obtained from the previous review. This would be followed by identifying the key items that we would split among ourselves to meet the next sprint goal. This enabled us to finish our tasks on time.

3.1.3 Working on the Sprint and Daily Scrum Meetings

Under this phase, the development process began following the tasks defined within the backlogs. We used the task board within the Trello software that consists of user stories that needed implementation within a given sprint. We arranged the cards according to their relevance which we tracked in detail: Started work on a task represented by a card would be moved from the "To do" field to the "In progress" one. On completion, the sticker would be moved to the "Testing" field, and after the task is successfully tested, the sticker would be taken to the "Done" field indicated below;

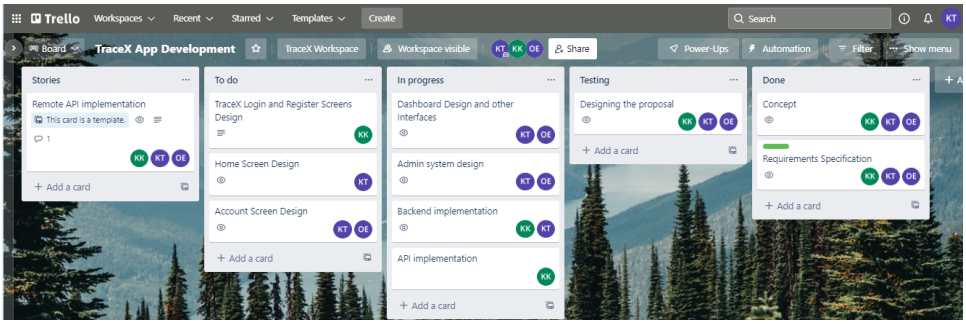


Figure 3.2: A sample of card board for progress tracking on Trello software

3.1.4 Daily Scrum Meetings

In the due course, we held daily meetings to get full and veracious information about the current project status and ensure that all the team members are on the same page. During Scrum meetings, every single team member would tell what he has done for the Sprint Goal, which task would be the next, and what problems team members might have faced during the work.

3.1.5 Product Increment and Sprint Review

The result of every sprint would be worthy of testing. After each iteration, we created an updated version of the application with increased value. During the Sprint Review, the overall results would be demonstrated and analyzed using the results of every end of each sprint. On the basis of all this information, we would take a decision about further project changes and plan the next sprint.

3.1.6 Retrospective and Next Sprint Planning

Under this, we discussed the results and determined the ways how to improve the development process on the next step. An important feature at this stage is that we discussed the processes of work and interaction to improve the work of the Scrum team as a whole. We concluded about what went well and what needed to be done better during future iterations. In addition to that, we defined the ways of improvement and decided to put more concentration on the next sprint planning.

3.2 Data Collection Methods

This section involved identifying and discovering the details of the problem and gathering requirements through data collection.

3.2.1 Questionaires

In this method we came up with a draft of structured simple and open-ended questions that we distributed among pottential application users to enable us capture detailed feedback and their perception regarding the effect of counterfeit ICT products in the market.

We had a sample size of 60 respondents and our study population consisted of Students, Civil Cervants, Self employed and, Peasants. Our study area was Laroo Division Gulu City.

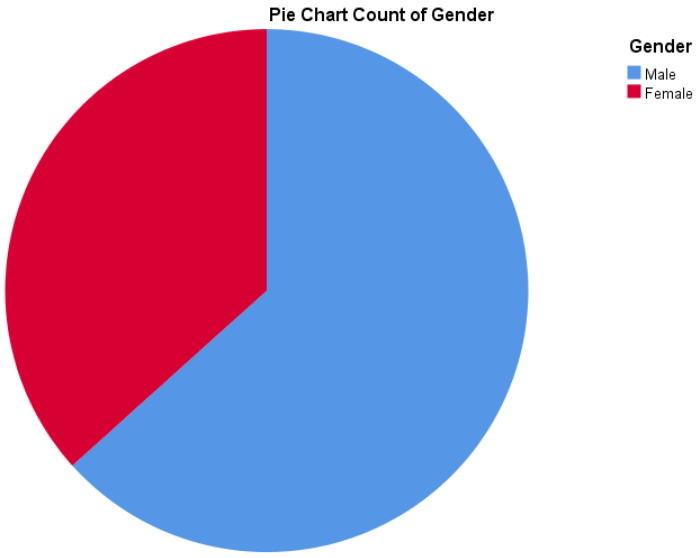
We perfomed data analysis to analyse the data which was gathered from questionares. The main advantage of the analysis is that it helped us reduce, simplify, and produce results that we measured using quantitative techniques. During this, we perfomed statistical data coding and analysis using the SPSS software. This was suitable since the data we dealt with was numerical in

nature. We perfomed cross tabulation accross various variables that gave us a clear view of the system.

Below is are analysis results,

Socio-demographic characteristics of sample population

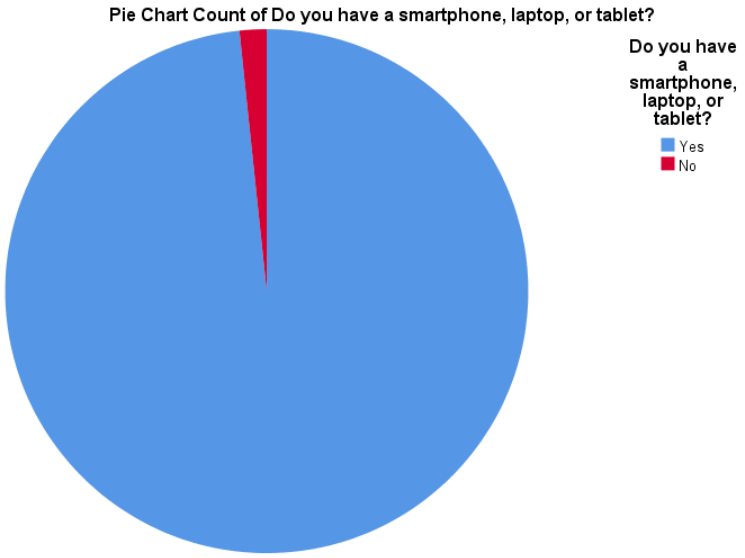
The graph below shows the gender statistics



The highest size of the respondents were male.

Technology preparedness

The piechart below shows the technology device ownership distribution



The largest population size of the respondents own smartphones therefore are in position to verify product authenticity using "TraceX"

Below is an analysis of occupation against user preference in knowing productt authenticity.

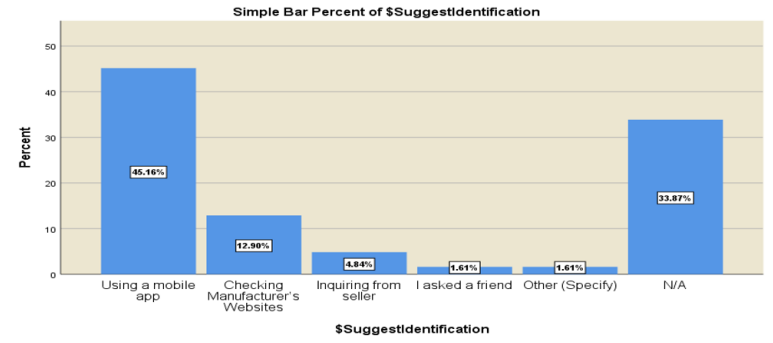
Occupation * . Would you prefer to know whether the ICT product is genuine or fake after buying it? Crosstabulation

			Would you prefer to know whether the ICT product is genuine or fake after buying?		
			Yes	No	Total
Occupation	Civil Servant		1	5	6
			16.7%	83.3%	100.0%
			1.7%	8.3%	10.0%
	Self-employed		3	6	9
			33.3%	66.7%	100.0%
			5.0%	10.0%	15.0%
	Student		20	18	38
			52.6%	47.4%	100.0%
			33.3%	30.0%	63.3%
	Others		3	4	7
			42.9%	57.1%	100.0%
			5.0%	6.7%	11.7%
Total		Count	27	33	60
		% within Occupation	45.0%	55.0%	100.0%
		% of Total	45.0%	55.0%	100.0%

The above describes the relationship between respondents occupation and their preference on when to detect authenticity of ICT products; 10% of the respondents where civil servants, 15% self-employed, 63.3% students and 11.7% fell in other job categories. 55% of these respondents prefered to know the authenticity of their products before buying.

Qtn2*$Counterfeit Identification (Crosstabulation)									
			How did you know it was fake?						
			Using a mobile app	Checking Manufacturer's website	Inquiring from seller	I asked a friend	Other (specify)	N/A	Total
Education	Primary		0	0	0	0	0	1	1
			0.0%	0.0%	0.0%	0.0%	0.0%	1.7%	1.7%
	Secondary		1	3	1	0	0	3	8
			1.7%	5.1%	1.7%	0.0%	0.0%	5.1%	13.6%
	Tertiary		4	10	5	15	9	6	49
			6.8%	16.9%	8.5%	25.4%	15.3%	10.2%	83.1%
	Not educated		0	0	0	0	1	0	1
			0.0%	0.0%	0.0%	0.0%	1.7%	0.0%	1.7%
Total		Count	5	13	6	15	10	10	59
		% of Total	8.5%	22.0%	10.2%	25.4%	16.9%	16.9%	100.0 %

The above figure describes the relation ship between education levels of the respondents and the technique they used to identify fake ICT products. From the analysis, 83.1% of the respondents had tertiary level as the highest level of education and 25.4% of the respondents verified the authenticity of ICT products by asking a friend. Therefore there is need for better and genuine technique to verify product authenticity as suggested by the respondents in the graph below;



In the above graph, 45.16% of the respondents suggested the use of a mobile app to verify the authenticity an originality of ICT products, 12.9% preffered manufacturer's website, 4.84% preffered inquiring from the seller, 1.61% asking friends and others mechanisms. Based on the above analysis, we developed a mobile application to verify the authenticity and originality of ICT products.

Chapter Four

System Design and Implementation

This looks at finding out the weaknesses of the related systems and analyzing the data collected for the system to be built, whether it is capable of catering for these weaknesses.

4.1 Existing Systems

Currently there is no readily available mechanism to ascertain the authenticity and originality of the ICT Products that the public uses. Therefore, the need to develop a mobile aplication for verifying the authenticity and originalty of ICT products.

4.2 The Proposed System

To address all these loop holes, the proposed system will enable users to provide meta-data about the product, through achieving the following.
• The application aims at providing much detailed information about the verified ICT product.
• We are looking at bringing a variety of ICT products for verification through different techniques such as IMEI, Serial Number, QR code and Barcode Scanning
• Building a user-friendly application

4.3 User Requirements

This system can be used by several clients such as generic citizens, law enforcers, brand owners, retailors and companies. The user requirements will be divided into two parts; Functional requirements and non-functional requirements.

4.3.1 Functional Requirements

These are actions that the system is able to perform. They include;

• The system administrator should be able to register and deregister user accounts, make system backups, manage user categories based on the packages that is ordinary users and premium users.
• The generic users should be able to verify products through scanning barcode, entering IMEI number, service tag or serial number before buying.

4.3.2 Non functional Requirements

These are requirements that are not directly concerned with specific functioning but are being delivered by the system. They include the following
• The application should adhere to privacy and data protection regulations.
• The application should be easy and to use by both sophiscated and naive users.
• The application should be secure enough not to be compromised by security intruders like hackers.
• The application should be scalable enough to support over 5000 users.
• The application should be fast enough possibly real time delivery of results. This is to ensure satisfaction of the user.

4.3.3 System Requirements

System requirements describe both hardware and software that were required to implement and test the application

4.4 System Design

This provides a detailed information about how our system structure is built. This has been represented using the Use-case diagram, ER diagram and the Conceptual diagram. The purpose of system design was to enable us come up with a guiding model that we adopted to build the application. It includes the entities, functionalities of the system and relationships among various entities.

4.4.1 Use Case Diagram

This describes the relationship among the functionalities and their internal/external controllers

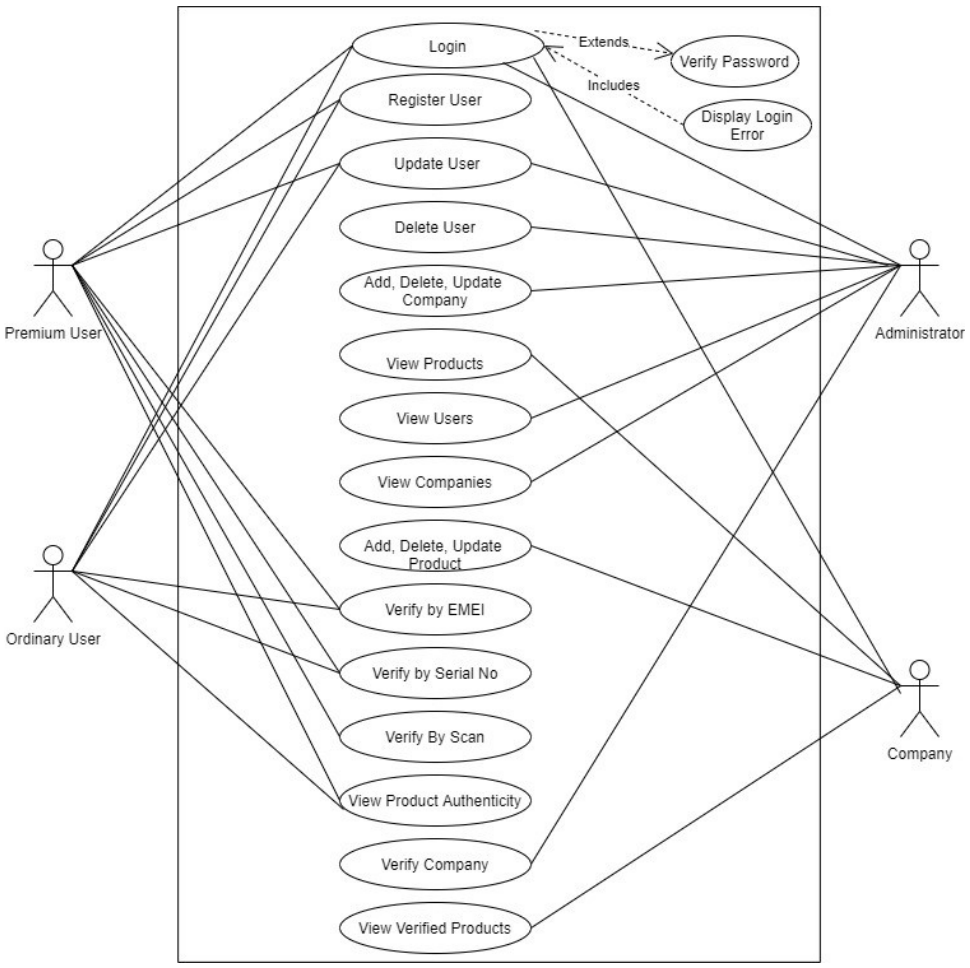


Figure 4.1: Use Case Diagram Showing User Interactions

The above figure describes the user roles involved within the system, ie; the ordinary user can verify by EMEI, serial number and update user profile, the company can manage products and administrator manages companies and users.

4.4.2 Entity Relationship Diagram

This helps to identify different TraceX elements and their relationships with each other

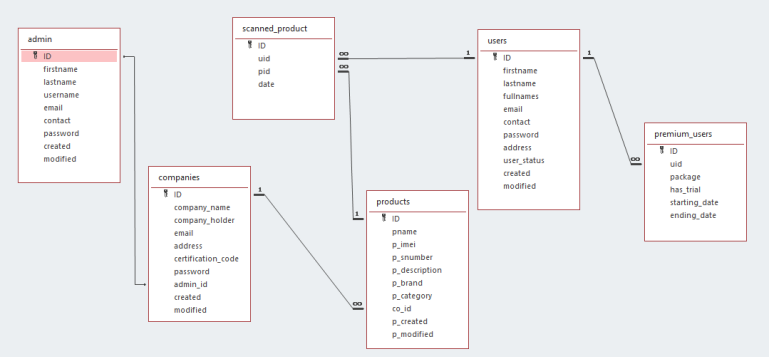


Figure 4.2: Entity Relationship Diagram

The above shows how the different entities communicate with each other through primary and foreign keys to ensure efficiency and cordination among the different tables.

4.5 Implementation

Access to a smart phone is the main pillar of this mobile application. We used react native, JavaScript, html, bootstrap and php languages for front and backend development, Nox emulator for compiling the programs to be run on Android phones and Visual Studio Code as out text editor.

Chapter Five

5 Presentation and Discussion of results

In this chapter, we show what we implemented through providing photographic evidence. This gives the user of the application a clear view of how the system is functional to one's demands and it also gives us the developers a platform to implement a business mind through a model of our invention.

5.1 Presentation of the system

5.1.1 Control Panel Login Page

The User is expected to login either as a manufacturer or an administrator

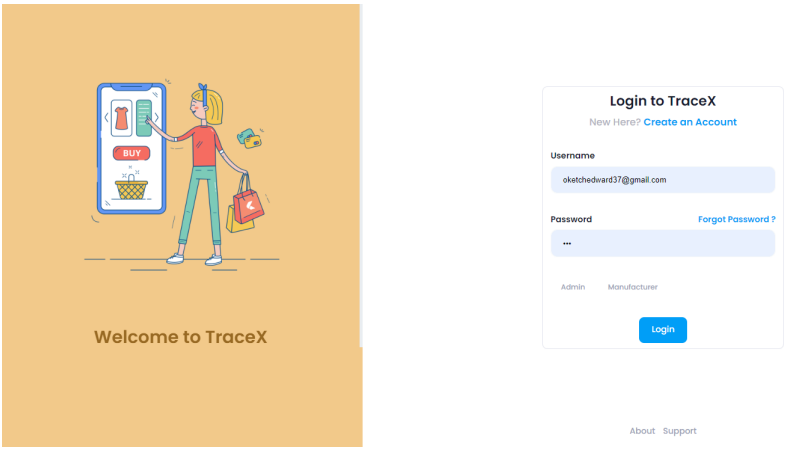


Figure 5.1: Admin Login Page

The above figure displays the login page where the administrator or company provides the username and password to loginto the system

5.1.2 Manage Companies Page

This figure displays the interface for registering manufacturers (companies) the product owners and it requires the administrator to keep track of the companies using the system and to provide various information like users' details

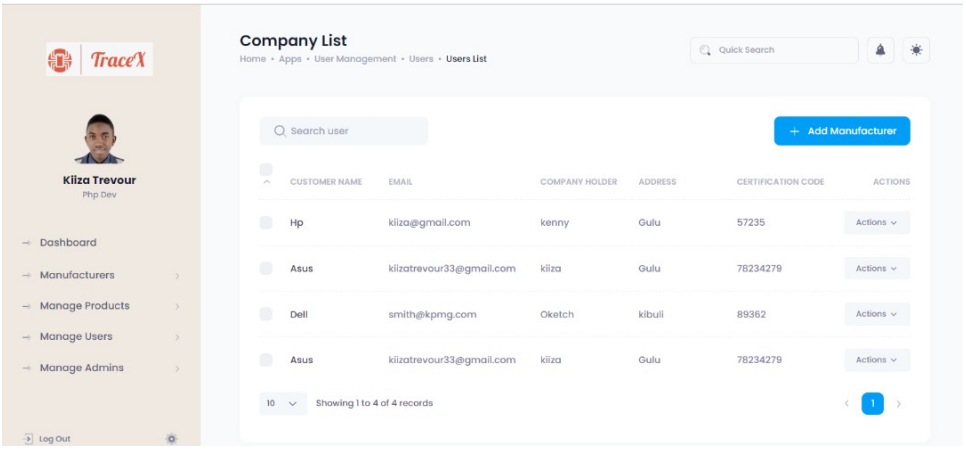


Figure 5.2: Manage Companies Page

The interface above contains the actions the administrator can perfom such as adding , viewing, updating and deleting companies. On the left is the side bar navigation that consists of the dashboard, manufacturers, manage products, manage users and manage admins tabs

5.1.3 The Administrator Dashboard

The page in the figure below can be accessed by only administrators when they Login to the system.

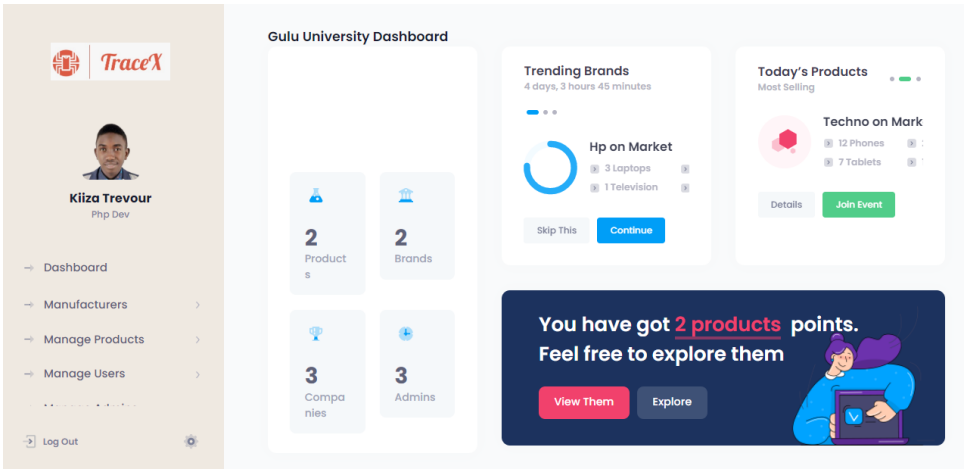


Figure 5.3: Admin Dashboard

The figure above shows the system statistics including the total companies, total brands, total administrators, most selling or trending products and on the ledt

5.1.4 The Register Product Page

The interface for registering products by the manufacturer appears here. The manufacturer is required to enter product details and click the submit button to complete product registration.

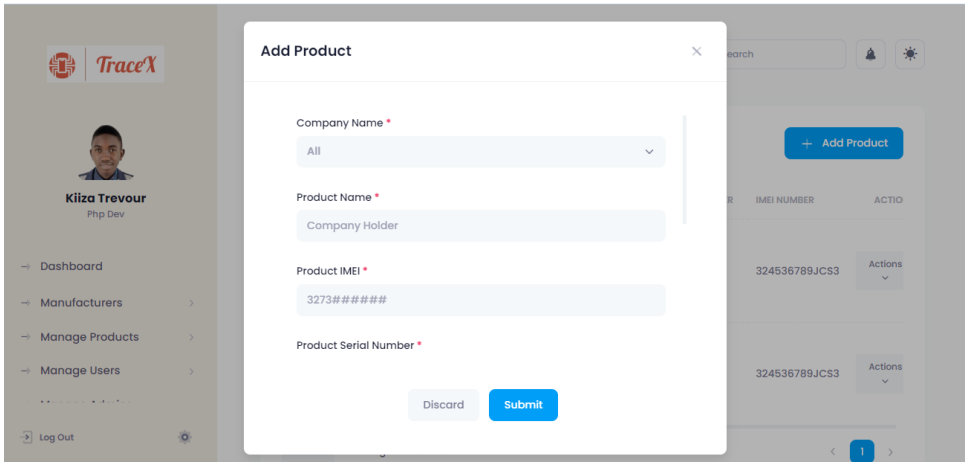


Figure 5.4: Add Product page

The figure above shows the system statistics including the total companies, total brands, total administrators, most selling or trending products

5.1.5 User Interface

The type of interface chosen was home page interface display so as to make the users entry faster. The figure below is the first page in the application which prompts the user to continue. It contains the intro slider that describes the system overview.

This figure below displays the user login page

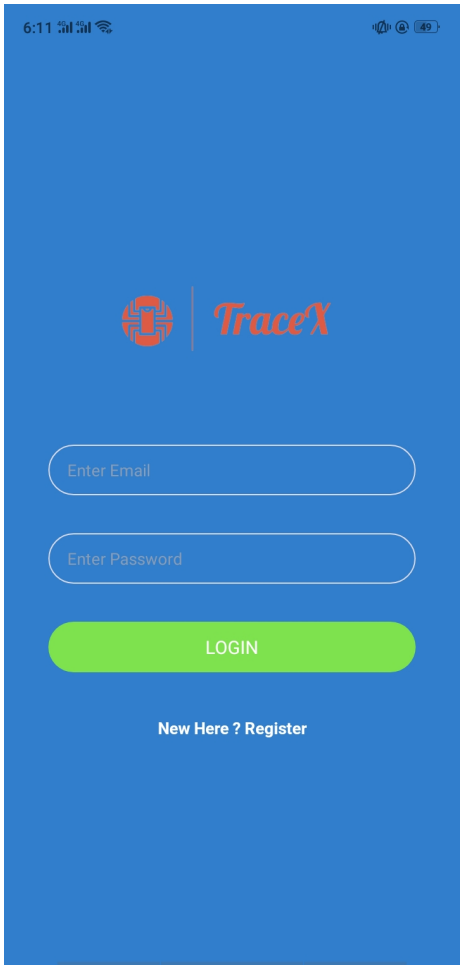


Figure 5.5: User Login Page

The user is required to enter his phone number and password in order to access the services provided by the application. In case the user is new and has never accessed the application, he/she is required to register again.

The figure below shows the homepage of the application with various options of verification of the product.

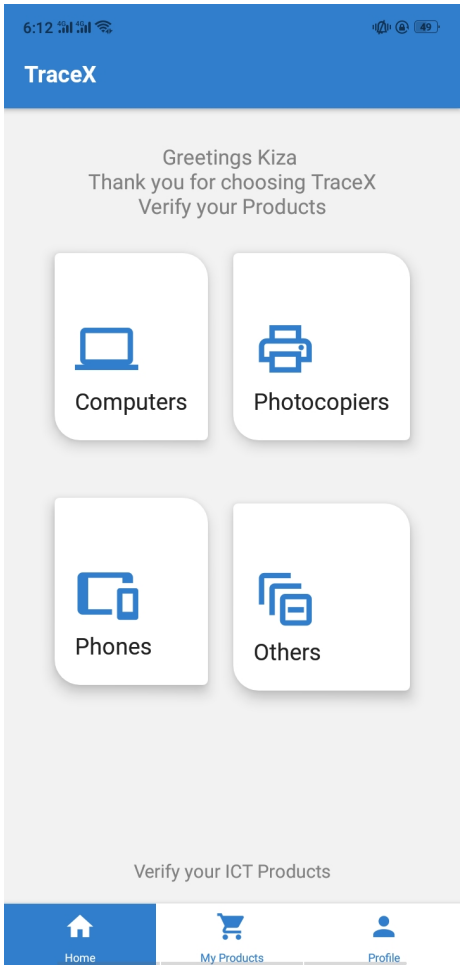


Figure 5.6: User Home Page Interface

The homepage interface contains cards that link you to specific product categories that you need to verify among which are; computers, printers, phones and photocopiers. It as well has a well coming message for the user upon entry.

The figure below shows the barcode scanning screen.

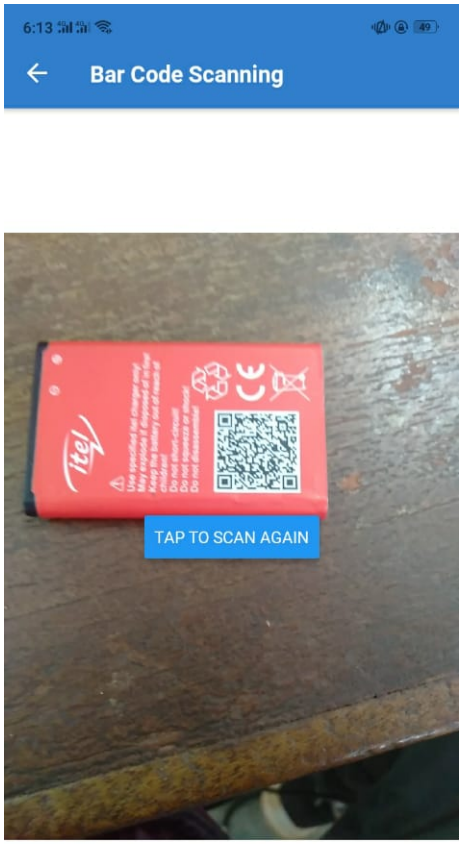


Figure 5.7: Barcode Scanning Intrface

The application allows QR code scanning that requires you to allow camera permissions to scan a particular product.

The figure below shows the profile screen

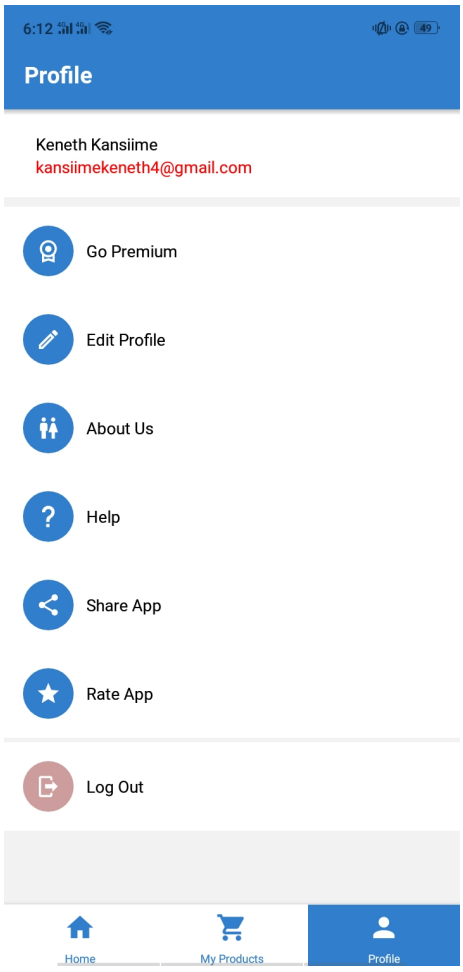


Figure 5.8: Profile Screen Interface

The figure above shows the profile screen and account details of the user. It contains edit profile features, about details action among others.

The figure below shows the products details page

Figure 5.9: Product Details Screen Interface

It contains product details and relevant recommendations on scanned products. Product Details include the serial number, IMEI number, product name and brand in addition to the recomendation of whether the product is genuine or fake.

The figure below describes the premium screen interface.

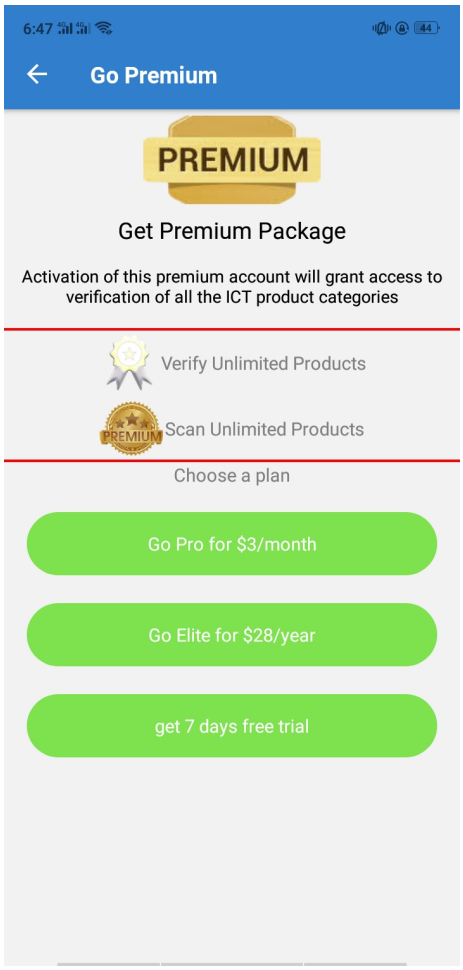


Figure 5.9: Premium Screen Interface

It contains previledge levels within the application, the ordinary users who can only verify limited number of products, premium users who have access to all priviledges, and the trial period that is limited to a given product number and period of time.

5.2 Discussion of results

This section includes the findings, the achievements and the limitations that we encountered during the development of TraceX Application.

5.2.1 Findings

Following the data collection results as discussed in chapter 3, the application prototype was developed and was tested. During the testing of the system, the user register and login interfaces were able to allow the users to register and then log into application. The application then allowed users to verify the products based on their category through the use of IMEI and Serial number inputs. The application was able to give a recommendation about the product authenticity.

5.2.2 Achievements

In line with our objectives, we achieved the following:

- We designed the application based on the requirements.
- We implemented the application based on the design.
- We tested the application within Laroo Division, Gulu City.

5.2.3 Limitations

Although this system allows users' ease of access, there are some disadvantages or limitations and they are as follows;

- Our application has a limited number of product categories
- There was a general problem of power coupled with slow internet speed at campus which made us to really spend a lot especially on internet.
- Since our project is Android based, it required that all its users should have smart phones

Chapter Six

Conclusions and Recommendations

6.1 Conclusions

This research found out that the majority of the ICT users in the market are great victims of counterfeit ICT products who are always uncertain about the product authenticity. The development of TraceX mobile application was to reduce the number of victims of counterfeit ICT products and increase manufacture's sales. This will be due to the recommendations and product details provided by the application such as Serial Number, Brand, Company, Product name among others. However, the research will need to be improved when time and resources are available. We were not able to connect the system to company databases to verify all ICT product categories.

6.2 Recommendations

We recommend the government, general public(local users) to embrace technology authentication mechanisms. In addition, law enforcers should design policies that govern counterfeit ICT products such as legal entitlement to a refund within a certain timeframe from the date of purchase of a counterfeit product.

6.3 Future Work

We recommend developers to;

i. Increase the categories of ict products to be verified.

ii. Deploy the application on Google play store to provide the application to many users.

iii. Implement the use of USSD technology to accomodate those that use feature phones.

iv. Implement the use of company APIs.

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Appendix

Sample of the Questionaires

SECTION A: Demographic Data

Qtn 1. Are you a male or female?

◯ Male ◯ Female

Qtn 2. What is your level of education?

◯ Primary ◯ Secondary ◯ Tertiary Level ◯ Not Educated

Qtn 3. What is your occupation?

◯ Peasant ◯ Civil Servant ◯ Self-employed ◯ Student ◯ Others (Specify)

SECTION B: Technology Preparedness

Qtn 4. Do you have a smartphone, laptop, or tablet?

◯ Yes ◯ No

Qtn 5. Do you have access to internet?

◯ Yes ◯ No

Qtn 6. If yes, how often do you access the internet?

◯ Daily ◯ Weekly ◯ Monthly

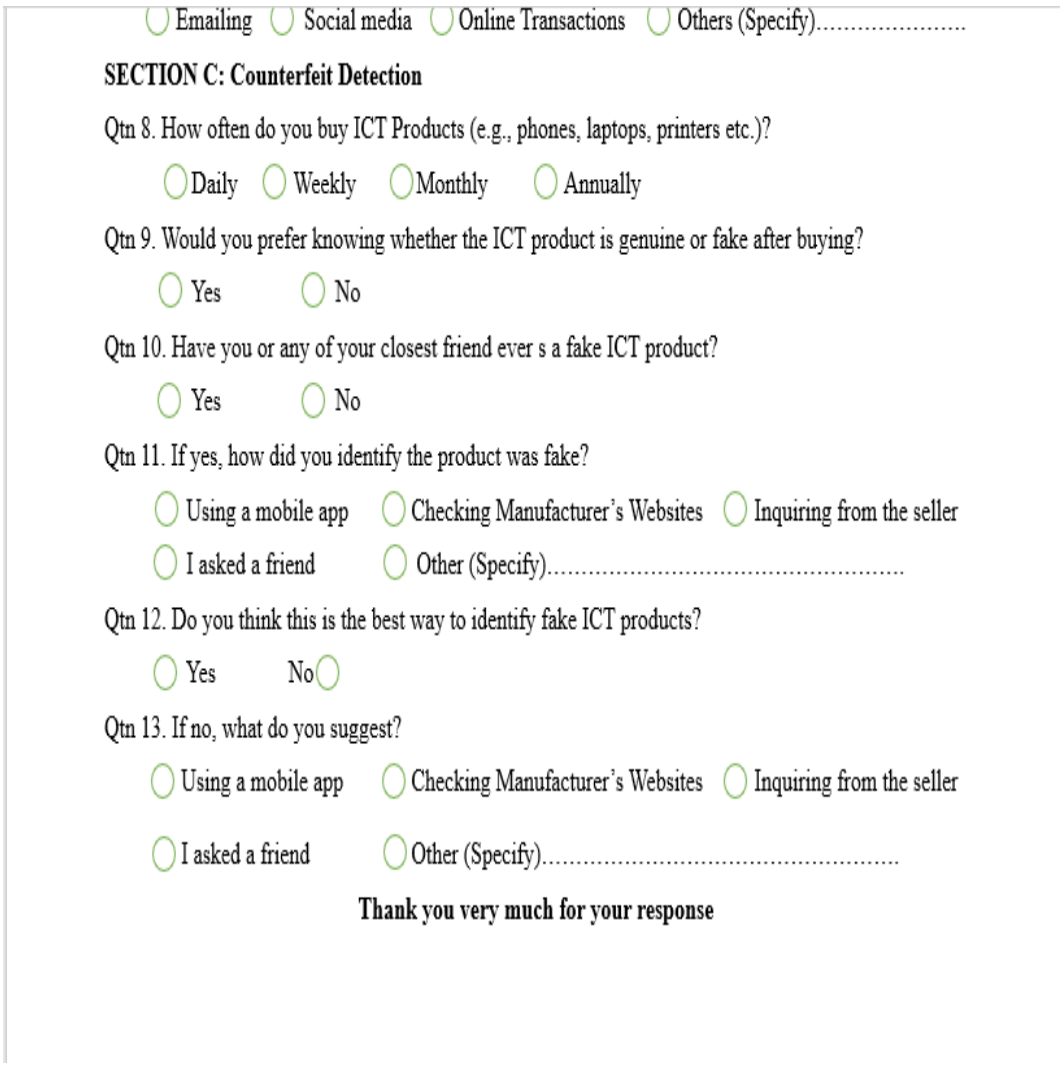
Qtn 7. What you do when you access the internet?

◯ Emailing ◯ Social media ◯ Online Transactions ◯ Others (Specify).....

SECTION C: Counterfeit Detection

Qtn 8. How often do you buy ICT Products (e.g., phones, laptops, printers etc.)?

◯ Daily ◯ Weekly ◯ Monthly ◯ Annually



Emailing Social media Online Transactions Others (Specify).....

SECTION C: Counterfeit Detection

Qtn 8. How often do you buy ICT Products (e.g., phones, laptops, printers etc.)?

Daily Weekly Monthly Annually

Qtn 9. Would you prefer knowing whether the ICT product is genuine or fake after buying?

Yes No

Qtn 10. Have you or any of your closest friend ever s a fake ICT product?

Yes No

Qtn 11. If yes, how did you identify the product was fake?

Using a mobile app Checking Manufacturer's Websites Inquiring from the seller

I asked a friend Other (Specify).....

Qtn 12. Do you think this is the best way to identify fake ICT products?

Yes No

Qtn 13. If no, what do you suggest?

Using a mobile app Checking Manufacturer's Websites Inquiring from the seller

I asked a friend Other (Specify).....

Thank you very much for your response

Sample code for implementing product verification by IMEI or serial number

```
import React, {useState, createRef, useContext} from 'react';
import {
  StyleSheet,
  TextInput,
  View,
  Text,
  Image,
  KeyboardAvoidingView,
  Keyboard,
  TouchableOpacity,
  ScrollView,
} from 'react-native';
import auth from '../auth/auth';
import AuthContext from '../auth/context';
import Loader from '../Components/Loader';

const VerifyPhone = (props) => {
  const {user, setUser} = useContext(AuthContext)
  const [serialNo, setSerialNo] = useState('');
  const [imei, setImei] = useState('');
  const [loading, setLoading] = useState(false);
  const [errortext, setErrortext] = useState('');
  const [pName, setPname] = useState('');
  const [pSerial, setPserial] = useState('');
  const [pBrand, setPbrand] = useState('');
  const [traceXmsg, setMessage] = useState('');
  const handleSubmitButton = async () => {
    setErrortext('');
    // if (!serialNo || !imei) {
    //   alert('Please Eneter Phone IMEI or Serial Number ');
    //   return;
    // }

    //Show Loader
```

```
    setLoading(true);

    let userId = user[0].id
    const user_status = user[0].user_status;

    const result = await auth.verify_phone(imei,serialNo, userId, user_status);
    const res = result.data;
    setLoading(false);
    if(res.error === false){
      console.log(res.product)
      setPname(res.product['0']['p_name'])
      setPserial(res.product['0']['p_snumber'])
      setPbrand(res.product['0']['p_brand'])
      setMessage(res.message)
      setErrortext('good');
    }else{
      alert(res.message);
      // setErrortext(res.message);
    }
    console.log(result);
  };
  if (errortext == 'good') {
    return (
      <View
        style={{
          flex: 1,
          backgroundColor: '#307ecc',
          justifyContent: 'center',
        }}>
        {/* <Image
          source={require('../Image/success.png')}
          style={{
```

</Text>
<View
style={{
flex: 1,
// alignItems: 'center',
// justifyContent: 'center',
padding: 10
}}>
<Text
style={{
fontSize: 20,
// textAlign: 'center',
// marginBottom: 16,
}}>
Product Name: {pName+'\n\n'}
Product Brand: {pBrand+'\n\n'}
Serial Number: {pSerial}
</Text>
</View>
<Text style={styles.successTextStyle}>
{traceXmsg}
</Text>
{/* <TouchableOpacity
style={styles.buttonStyle}
activeOpacity={0.5}
onPress={() => props.navigation.navigate('LoginScreen')}>
<Text style={styles.buttonTextStyle}>Login Now</Text>
</TouchableOpacity> */}
</View>
);
}
return (
<View style={{flex: 1, backgroundColor: '#307ecc'}}>
<Loader loading={loading} />