**DEVELOPMENT OF A FAKE PRODUCT DETECTION SYSTEM**

**BY**

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**SEPTEMBER, 2024**

**CERTIFICATION**

This is to certify that this project was carried out by with matriculation number under the supervision of. , and that this project is an original work which has not been submitted to this University or any other institution for the award of a degree or diploma.

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**DEDICATION**

This work is dedicated to God.

**ACKNOWLEDGEMENTS**

Firstly, I wish to appreciate my supervisor for invaluable guidance, and careful supervision which contributed to the success of this work. My gratitude also goes to the Head of the Department of Computer Science, Dr. Edje Abel as well as other lecturers and staff of the school whose efforts saw my successful passage through the university. I specially thank my parents, as well as my siblings for moral and financial support, reason of which I have gotten this far in my educational pursuit, and life in general.

**ABSTRACT**

The purpose of this report is to detail the development of a system for the detection of fake products which are in constant circulation. Such products pose a serious problem to the health of people and has resulted in loss of lives. A notable case occurred in 2008 when over 80 children died after consuming a teething syrup contaminated with diethylene glycol, a toxic substance used in industrial applications. There is thus a need for these fake products to be identified and removed from circulation to safeguard the lives of individuals. This project proposes a method by which companies can ensure that the products they make are not adulterated in any means. It does this by the use of the blockchain, particularly using Non-Fungible Tokens (NFTs). A QR code can be embedded on products which users can scan to verify products authenticity. On scanning these QR codes, the NFTs (which certify the true owners) will be transferred to these users. The website is implemented using Python, QR code tech, blockchain tech and web technologies (HTML, CSS and JS)

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**CHAPTER ONE: INTRODUCTION**

**1.1 Background of the Study**

The rise of counterfeit products in Nigeria has become a pressing issue, with significant implications for public health, economic stability, and consumer trust. These fake goods, including food items, beverages, and pharmaceuticals, often infiltrate the market due to weak regulatory enforcement, or the high demand for cheaper alternatives. The prevalence of counterfeit products not only undermines the credibility of genuine brands but also poses severe risks to consumers who unknowingly purchase these inferior products. In Nigeria, counterfeit pharmaceuticals are particularly problematic. The country has faced numerous challenges with fake drugs, which are often nearly indistinguishable from authentic ones. These counterfeit medicines, are typically sold at a lower price, making them appealing to consumers with limited financial resources (Klantschnig & Huang 2024). However, the consequences of using these substandard or falsified drugs can be fatal. The National Agency for Food and Drug Administration and Control (NAFDAC) has documented several tragic incidents where counterfeit drugs led to treatment failures and deaths. According to Schep, et. al. (2008), A notable case occurred in 2008 when over 80 children died after consuming a teething syrup contaminated with diethylene glycol, a toxic substance used in industrial applications.

The food and beverage sector in Nigeria are equally affected by the issue of counterfeit products. Fake versions of popular brands, such as cooking oils and packaged foods, are commonly sold in markets and stores. These counterfeit consumables are often produced in unsanitary conditions with substandard ingredients, posing significant health hazards. For example, the rampant increase of counterfeit alcoholic beverages, frequently laced with methanol, has resulted in numerous cases of poisoning and death (Cornellier, 2022). In 2017, several individuals in Rivers State died after consuming fake gin containing lethal levels of methanol, highlighting the urgent need for effective solutions to this pervasive problem (George, 2017).

To address these challenges, the integration of blockchain technology into a Fake Product Identification System (FPIS) offers a promising solution. Blockchain technology, with its inherent transparency and immutability, can revolutionize the way products are tracked and verified throughout the supply chain. In the context of Nigeria's consumable goods market, blockchain technology can be employed to verify the authenticity of products. The use of blockchain in FPIS can be extended to other consumables, such as food and beverages. For instance, a blockchain-enabled system could verify that a bottle of cooking oil is genuine, protecting consumers from the dangers of counterfeit products.

The integration of blockchain technology into the Fake Product Identification System offers a robust and reliable method for combating the proliferation of counterfeit consumable products in Nigeria. This not only protects public health and strengthens consumer trust but also preserves the integrity of legitimate businesses. As Nigeria continues to grapple with the challenges of counterfeiting, blockchain technology represents a critical tool in safeguarding the authenticity and safety of consumable products.

**1.2 Statement of the Problem**

The economy, consumer confidence, and public health in Nigeria are seriously threatened by the pervasive distribution of fake consumable goods. Despite regulatory agencies' best efforts, counterfeit goods especially in the food, beverage, and pharmaceutical industries continue to creep into the market, posing serious health hazards and eroding the legitimacy of legitimate companies. The primary problem being the inability of consumers and businesses to effectively differentiate between genuine and counterfeit products leading to financial losses, damaged brand reputations, and potential health hazards. Existing systems for combating this problem, although effective, require the user to manually task himself/herself in using such systems. For example, the system developed by Kishan et. al.(2023) require the user to inspect the records of the product’s movement through the supply chain. Not only is the user likely to make mistakes in doing the observation, such system only verifies that a product is actually produced by the said company as well as authentically passed through the supply chain. However, there is also no way to verify if this product has been used before and the QR code is simply reused from an already purchased/verified product. This system aims to solve these aforementioned issues.

**1.3 Aim and Objectives of the Study**

This project is aimed at developing a Fake Product Identification System through the use of blockchain technology. Some of the objectives of the system are as follows

* design and development of an NFT based fake identification system
* development of a web interface through which other users can gain access to the system’s functionality
* evaluation of the reliability of the developed system using end-to-end testing

**1.4 Significance of the Study**.

* Improved safety and reduced health risk on everyday consumers of such products
* increased revenue for production companies as more consumers purchase their products due to increased trust

**1.5 Scope of the Study**

This study is focused on the detection of fake products particularly on consumable products that come in bottles or tins such as food, beverage, and pharmaceutical products, where there are substantial hazards associated with counterfeit goods. The study analyzes the frequency of fake goods, the shortcomings of current identification techniques, and the creation of a system that monitors product authenticity. The study also provides insight into safety methods that should be followed on consumable product purchase.

**1.6 Limitations of the Study**

* **Cost** The cost of actually minting and using Non Fungible Tokens (NFT) on an actual main net such as Ethereum for the purpose of this project was not feasible. Thus, tokens were minted and transferred using a test net.
* The study also focuses primarily on few use cases such as pharmaceutical, food, and beverage industries, which may limit the applicability of the findings to other sectors facing counterfeit issues.

**1.7 Definition of Terms**

* **NFT (Non Fungible Tokens)** According to the U.S. National Archives and Records Administration (2024), an NFT is a digital item representing a physical or digital asset.
* **immutable** to be immutable means cannot be changed easily
* **Supply Chain**: The sequence of processes involved in the production and distribution of a product, from the initial sourcing of raw materials to the delivery of the final product to consumers. This includes manufacturers, suppliers, distributors, and retailers
* **phished website** .this refers to a fake replica of an authentic website, usually for the purpose of misleading people

**CHAPTER TWO : LITERATURE REVIEW**

**2.1 THEORETICAL REVIEW**

**2.1.1 Counterfeit Products: Definition and Types**

Fake products, or counterfeit goods, are unauthorized replicas designed to deceive consumers into believing they are purchasing genuine items. These imitations span various industries, including pharmaceuticals, food and beverages, electronics, and luxury goods, and pose significant risks to health, safety, and economic stability. Counterfeit products are crafted without the approval of the original brand owner and often replicate the appearance and packaging of authentic items. They are typically sold at lower prices and are characterized by poor quality and misleading labeling. Such products often fail to meet safety standards, creating potential hazards for consumers.

Counterfeit products are unauthorized replicas or imitations of genuine items, created to deceive consumers into believing they are purchasing authentic goods. These products are typically manufactured and distributed without the consent of the original brand owner, and they often mimic the appearance, branding, and packaging of legitimate products. The primary objective of counterfeit goods is to exploit the reputation and trust associated with established brands, while avoiding the costs of legitimate production and quality assurance.

**Types of Counterfeit Products**

i. **Pharmaceuticals**: Counterfeit pharmaceuticals include imitation drugs that may contain incorrect or harmful ingredients, lack active substances, or have incorrect dosages. These counterfeits are particularly dangerous because they can lead to ineffective treatments, adverse health effects, or fatalities. Examples include fake antibiotics, antimalarials, and cancer drugs. For instance, counterfeit anti-malarial drugs in several developing countries have led to severe health crises, including increased mortality rates.

ii. **Food**: Counterfeit food products involve imitations or substandard versions of genuine food items. These can include products with fraudulent labeling, misleading ingredients, or contamination. Common examples are fake or adulterated cooking oils, mislabeled packaged foods, and counterfeit dietary supplements. In recent years, there have been cases of counterfeit honey and olive oil being sold as premium products, with significant health risks due to contamination or mislabeling.

iii. **Beverages**: Counterfeit beverages, including alcoholic drinks and non-alcoholic beverages, pose significant health risks. Fake alcoholic beverages are often produced with harmful substances like methanol, which can lead to poisoning and death. Examples include counterfeit spirits and soft drinks that fail to meet safety standards. For example, in 2015, counterfeit gin containing methanol caused multiple deaths in Nigeria, underscoring the dangers of such counterfeit products. (George, 2017).

iv. **Electronics**: Although not covered in this overview, counterfeit electronics, including components and devices, are another significant category. These products often fail to meet safety and performance standards and can pose risks such as fire hazards or electrical failures.

**2.1.2 Prevalence and Impact of Counterfeit Products**

Counterfeit products have become a pervasive issue globally, with significant implications across various industries. According to a 2020 report by the Organization for Economic Co-operation and Development (OECD) and the European Union Intellectual Property Office (EUIPO), counterfeit and pirated goods accounted for approximately 3.3% of world trade, representing over $500 billion in value. This substantial figure highlights the extensive reach of counterfeit products in the global

market. The prevalence of counterfeit goods varies by region and industry. For example, the pharmaceutical sector is particularly affected, with estimates suggesting that up to 10% of all medicines in circulation in some developing countries are counterfeit. In the food and beverage industry, counterfeit products are also widespread, with numerous reports of fake or adulterated items entering the market. A 2018 report by the International Chamber of Commerce (ICC) estimated that the global trade in counterfeit goods could reach $1.8 trillion by 2022, reflecting the growing scope of the problem.

**2.1.2.1 Impact on Health**

The impact of counterfeit products on health is severe and far-reaching. In the pharmaceutical industry, counterfeit drugs can contain incorrect or harmful ingredients, leading to ineffective treatments, adverse health effects, or even death. Counterfeit vaccines and other medical products can undermine public health efforts and erode trust in healthcare systems.

In the food and beverage sector, counterfeit products pose significant health risks, including food poisoning, allergic reactions, and long-term health issues.

**2.1.2.2 Economic Impact**

The economic impact of counterfeit products is substantial. The loss of revenue for legitimate businesses due to counterfeit goods is significant, affecting industries ranging from pharmaceuticals to luxury goods. The global economy loses hundreds of billions of dollars annually due to counterfeiting, which also leads to job losses and reduced investment in research and development. Counterfeit products undermine the competitive advantage of genuine brands, distort market dynamics, and result in substantial financial losses for businesses.

**2.1.2.3 Impact on Consumer Trust**

Counterfeit products erode consumer trust and confidence in legitimate brands. When consumers unknowingly purchase counterfeit goods, they may experience poor product performance, health issues, or financial losses. This negative experience can lead to diminished trust in the brand and reluctance to purchase similar products in the future.

**2.1.3 Blockchain**

Blockchain refers to a distributed ledger. According to the U.S National Archives and Records Administration (2024), the blockchain is not for general data storage but for recording transactions. The term “blockchain “ can be broken into two, “block” and “chain”. A block is a list of transactions while a chain is a connection of blocks. The blockchain is immutable in nature. To be immutable means that transactions recorded cannot be changed easily. Blockchain technology promotes transparency and accountability.

**2.1.4 Non Fungible Token (NFT)**

According to U.S National Archives and Records Administration (2024), a Non Fungible Token (NFT) is a special type of digital item that represents a physical or digital asset. The term “non fungible” simply refers to the fact that these tokens are unique. These tokens have no inherent value and as such cannot be interchanged. Owing to the fact that an NFT is unique, it can be used in a variety of purposes. For example, it can be used to represent items in the real world that are also unique such as paintings. Whoever then possesses this token can be said to be the one and only owner of this asset. These tokens can be transferred to other users signifying a transfer of the assets represented by the tokens.

**2.2 LITERATURE REVIEW**

An approach for detection of fake products is proposed by Aadeesh et. Al. (2022) who also present a survey of different anti-counterfeiting methods. The system developed by them works by recording information about the product’s movement through the supply chain on the blockchain. This record can be checked for verification purposes. They also compare methods such as RFID, barcodes and magnetic strips for anti-counterfeiting purposes.

Al Balushi et. Al. (2024) present a study on factors affecting purchase of non-deceptive counterfeit products. They identified a list of behavioral factors, all of which except integrity, contributes to attitudes of consumers in purchasing products.

Cornelier (2022) carried out a study of the effects of consuming adulterated alcohol as well as proposed some remedies to be used in curbing the issue.

Dilipkumar et. al. (2024) present another blockchain based approach to solving the issue of counterfeit products. Products are assigned QR codes which users can scan using any scanner of their choice. Scanning this QR code references the blockchain for verifying the authenticity of the product containing he code.

George (2018) presents a concise guide to understanding poisons. Although intended for forensic investigators, it contains insights on multiple life threatening toxic substances.

Kishan et. Al. (2023) proposed a system for identification of fake products using blockchain technology. The method used by their system is one in which every personnel in the supply chain records their involvements with the product. This will serve to create a unique record that can be used to verify the product’s authenticity by inspecting the supply chain that led to its delivery.

Klantschnig et. al. (2024) try to analyze the problem of sale of fake pharmaceutical products in Nigeria and trace its roots to colonial times as well as identify national crises in the pharmaceutical sector of the country, as the modern driver of this threat.

National Archives and Reports Administration (2024) of the United States released a report which contained a brief report on NFTs as well as its underlying technology, the blockchain.

Natchapol (2022) presents an NFT-based approach for detection of counterfeit products.

**2.3 SUMMARY OF LITERATURE REVIEW AND KNOWLEDGE GAP**

While some of the reviewed literature focused on analyzing the issue of product counterfeiting, others presented viable solutions to these problems, mostly using a blockchain based solution. Some of the existing systems focused on creating tamper-free records of the supply chain which could be checked later for verification purposes. However, this will pose strain on the part of the users of the system as they have to manually inspect these supply records to ascertain the authenticity of the product. The proposed system aims to fix this gap by developing an intuitive NFT based solution. It also fixes certain other problems which are in some of these systems. One example of such is presented in the literature review where the authors attempted to create an NFT-based solution, just like the proposed system. However, that system, just like every other system reviewed, does not disable the QR code upon delivery. Disabling the QR code would mean to make it such that it cannot be scanned again or used for verification activities. For the system aforementioned, their QR codes can be reused for fraudulent counterfeiting since they have already been verified, but are still active. This is another gap that the proposed system aims to fix.

**CHAPTER THREE: METHODOLOGY AND SYSTEM ANALYSIS**

**3.1 Methodology Adopted**

For the development of the proposed system, the Scrum Development Methodology (Regan, 2017) was followed, alongside Object Oriented Analysis and Design (OOAD) Methodology for the design. Scrum is a methodology that is gaining popularity fast among developers (Regan, 2017).

In scrum methodology, the whole software development project is broken into intervals of fixed durations, called Sprints. A set of prioritized requirements called user stories are focused on to s sprint. In cross-functional teams, tasks are assigned based on each participant’s capabilities.At the end of iteration , as over minded people.

At the end of the development sprint, a review of the system using alpha / end-to-end testing was performed.. Aloha testing is simply an end-to-end testing of a system to ensure that it meets the business requirements stated, thus, providing business value.

**3.2 Analysis of Existing Systems**

Some of the existing systems for the identification of fake products using blockchain technology, rely on a supply chain record keeping. When the manufacturer makes a product, he/she prepares a special code which could be a string of arbitrary length. This code serves to identify the product. Other noteworthy information about the product are added to the blockchain as well. A QR code is prepared as well such that once scanned, it will serve to verify the product through these uploaded details.

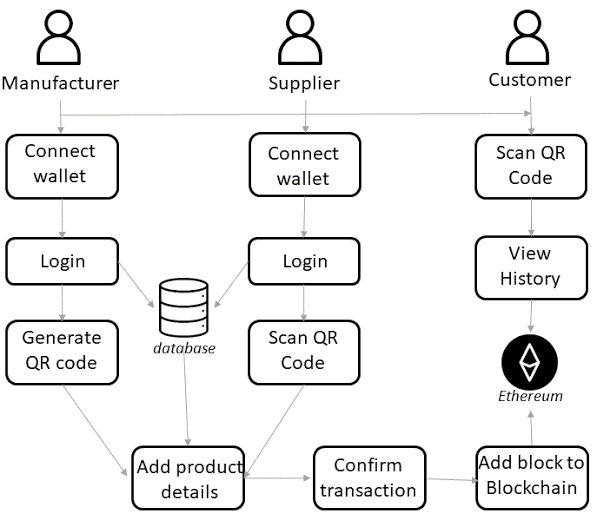
For each party in the supply chain who this product gets to (e.g. a retailer who resells the product) extra information will be added about that party to the blockchain records. The party themselves are usually tasked with scanning the QR code and adding the information themselves. For example, a supplier who receives the product will have to add details about the product’s location, how much it was sold/bought for at that point or who it was sold to. This way of having every party in the supply chain record their activity with the product will see to the creation of an immutable record of the product’s movement from factory to each/every supplier or reseller.

Users who purchase this product then have to scan the QR code provided. This will reveal to them all the supply chain records of the product. An inspection of this record will reveal the authenticity of a product. Any fake product that was randomly introduced into the supply chain will not have a valid supply chain record. Another purpose of scanning the QR code is to compare the unique identifier contained in the QR code with the company’s records on the blockchain.

Blockchain technology is utilized for records keeping because it is immutable in nature. Data that is stored cannot be changed or deleted. Thus, it ensures that the records cannot be tampered with, once created.

**3.2.1 Data Flow of Existing System**

The data flow of the existing system can be depicted using the following diagram. This diagram depicts the process of the product manufacturers storing information about the product on the blockchain that can be used for verification later on, as well as creating QR codes that can be scanned to initiate the verification process. It also depicts the process of suppliers adding extra information to blockchain about the product. This blockchain records can then be inspected by users in verifying the authenticity of the product.



**figure 3.1 - diagram depicting existing systems**

**3.2.2 Weaknesses of The Existing System**

* **Stressful User Experience** In using such systems to detect the authenticity of products, it places a burden on users to manually inspect the supply chain records or history of the product. Users may prefer a system where they simply scan the QR code and the job of verifying the product’s authenticity is completely handled by the system.
* **Error Prone** given that the system relies on the users to access the supply chain records, there is a chance for human error where a user assumes that a fishy record is actually authentic and goes ahead to consume the product.
* No mechanism for ascertaining if a product has already been verified before or not. An already verified product signifies an already used product. Without any provision for checking for this, QR codes of verified and trusted products could be reused in fake products packages.
* **depends on the integrity of humans** firstly, users having to use a non-proprietary QR code scanner poses a risk on its own already. For instance, an intentional QR code scanner developer could make the app such that the QR code scan convinces the user that the product is authentic, when in reality, it is not. This could be done by redirecting the user to a phished version of the authentic company website with fake details to convince them. Secondly, it depends on the integrity of human parties in the supply chain to enter accurate details or not manipulate the whole process somehow. Lastly, it relies on the consumer to have a premonition on how to detect fake products by looking at the supply chain records.

**3.3 Analysis of the Proposed System**

The proposed system attempts to solve the issues inherent in existing systems by the following approach. Firstly, QR codes will be made to be once-scan only. This means that if a QR code has been scanned before, it will be deemed used. Thus, attempting to use this QR code again will simply tell the user that the product containing the code has been purchased before. Users will also be encouraged to always scan their QR codes on purchase.

The proposed system will also make use of physical measures as well as technical measures. The QR code will be printed directly on the non-transparent bottle rather than on the external packaging. This will serve to guard against fraudsters who replace the insides of an authentic packaging (containing valid QR codes) with harmful adulterated content. The bottle cover will be sealed so that in case someone tries to replace the bottle contents, he/she will have to break this seal. Users will be alerted that a broken seal signifies adulterated content and should not be purchased.

Another key idea contained in the proposed system is the use of Non Fungible Tokens (NFTs) to indicate ownership of products. On verifying a product purchase (by scanning the QR code), a unique NFT is transferred to the wallet address of the user, thus signifying him/her as the authentic owner of the product. Non Fungible Tokens (NFT) also play a key role in the verification of purchased products. When these NFTs are created, their identifiers are stored on the system’s storage as well as embedded inside a QR code. This QR code will be printed on the bottle of purchased products. On scanning this QR code, the proposed system will check the code that is embedded inside. If this code does not exists on the system’s storage or the system sees that it has been used before, the user is warned not to consume it. Otherwise, it is denoted as safe for consumption.

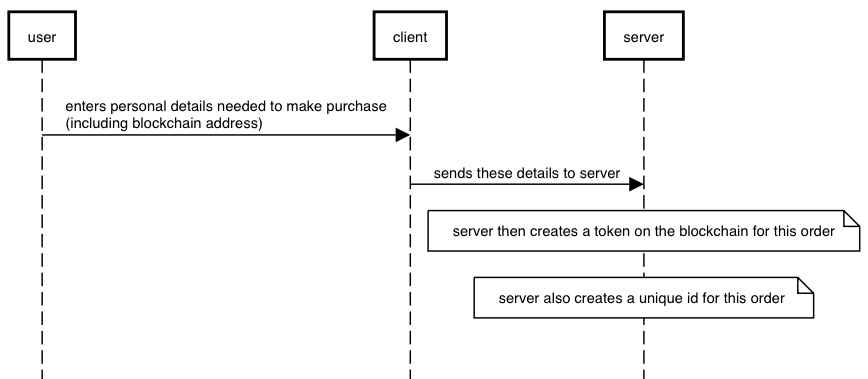
**3.3.1 Advantages of the Proposed System**

* **improved user experience** the proposed system works by checking an embedded code and does not require the user to look at any supply chain records. This will reduce the load on the part of the user in using the system.
* **secure** the use of physical methods in conjunction with technical methods will see to the improved security of users. Methods such as the once-read nature of the QR codes, NFTs for ownership certification, imprinting on the non-transparent bottles and sealing of bottle covers will help reduce the risk of counterfeits.

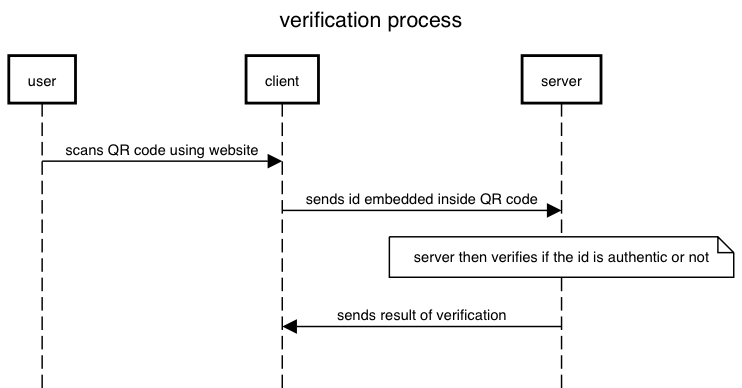
**3.4 High Level model of the Proposed System**

The proposed system can be understood from different perspectives. One of such perspectives is it having a client-server architecture. In this context, a client refers to the web browser through which the users access the system’s website. On the other hand, the word server refers to the software that responds to requests from browsers who try to access the system’s services. It responds usually by giving them webpages to display or performing certain actions and responding with the result of these actions. It is the part of the system which users cannot see but handles all the hard work of the system. For example, when a user clicks on the button to order a product, it is the server that actually handles all the processes required for ordering a product, after which the user sees the confirmation on the website (the content of this confirmation is based on the response which the server will send). Following from this, the server is the part of the proposed system that will utilize the blockchain, and handle all the operations required by the system.

The order creation and verification processes are both represented in the following sequence diagrams.



**fig. 3.2 - sequence diagram showing process of order creation**

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**fig. 3.3 - sequence diagram showing process of verification**

**CHAPTER FOUR: SYSTEM DESIGN AND IMPLEMENTATION**

**4.1 Objectives of the Design**

The aim of the design was to develop an effective system for the detection of fake products. The objectives of the design thus, were the following:

* design a suitable overall architecture for the software
* design modules that should be within this architecture

The design of the system was done in accordance to some well-known and accepted software design best practices such as Encapsulation, Single Responsibility Principle and high cohesion.

* **encapsulation** is a design principle that is all about information hiding. It involves hiding complex programming behind simple interfaces so that all the user of the module needs to know about, is the interface.
* **Single Responsibility Principle** put simply, this principle states that a particular module should do one thins and one thing only. For example, a class that has methods for dealing with NFT cannot have methods for handling storage as well
* **high cohesion** this relates to the practice whereby every method or variable f a class is actually needed and related to every other method or variable

**4.2 Control Center / Main Menu**

This the main control center of the system can be seen from two perspectives.

1. From the perspective of the admin of the application, the main control center is the Server program. Starting this program is akin to starting the entire system. This is because all the other parts of the system are joined or integrated by this server. It determines when to use different modules, based on requests from browsers
2. From the perspective of the users of the application, the landing page which is the first page they’ll see on opening the company website is the main control center of the application. Every other action that will be performed with the system stems or starts from this page.

**4.3 System Specification**

**4.3.1. Database Design and Structure**

The word “database” refers to data that is stored and is structured or organized for easy retrieval and manipulation. For this project, the design and structure of the database was determined by analyzing the data needed for all the system’s operations.

The following is a depiction of the structure of data stored and maintained by the system.

|  |  |  |
| --- | --- | --- |
| **field name** | **description** | **data type** |
| id | this field is the primary key | string |
| wallet\_address | the wallet address of users which is collected alongside other personal details. After verification, the token signifying ownership will go to this address | strung |
| token\_id | this is the identifier for the Non Fungible Token that is created for each order | string |
| is\_used | this is used to denote if this purchase has already been verified or not. Once a purchase has been verified, this field is set to true so that the QR code cannot be used again. | Boolean |

**4.3.2. Program Module Specification**

The following modules are what make up the proposed system.:

* Server. - this module contains codes for the server and it’s endpoints.
* NFTHandler - this provides the blockchain functionality required by the system. The system currently uses NFT(Non-fungible tokens) for its blockchain-related operations.
* StorageHandler- this handles all data storage, retrieval and manipulation activities required by the system.

**4.3.3 Algorithms**

initialize StorageHandler

initialize NFTHandler

start server

on request to server:

if request is for homepage

return home page to user

else if request is to process an order

create an id for this order

create an Non Fungible Token for this order

store the NFT, the user’s wallet address and the id for this order

else if request is to verify a purchase

get order id that is in QR code

if id exists in system store and has not been used before

get user wallet address from system store

transfer Non Fungible Token to user wallet address

mark this is as used

return response to user that product is authentic

else

tell user that product is not safe

**4.4 System Implementation**

**4.4.1 Proposed System Requirements**

**4.4.1.1 Hardware Requirements**

RAM: Minimum 4GB

Internet Connectivity Support

**4.4.1.2 Software Requirements**

Supported OS - windows, Mac OS, linux

Programming Language: Python

**4.4.2 Program Development**

Some Languages and framework used in the development of the system are:

* **Python** A popular programming language known for its simplicity in syntax and extensive use in data science.
* **Flask** This is a framework that is used to create web servers. It is written in the Python programming language and comes with a good modules and tools for carrying out the programming of web server.
* **HTML (HyperText Markup Language)** - HTML is a special markup language that is used on the web for defining the structure of a webpage. It is The markup language that is used to talk to the browser. It tells your browser what elements should be in your web page, as well as where to put each element (e.g. images, videos, text) that you see.
* **CSS (Cascading Style Sheet)** - While HTML documents tell the browser the structure of elements to be contained in a webpage, CSS is a language that is used to show your browser how to beautify or style your website e.g. how to color each element, how to size elements, where exactly to position elements e.t.c
* **JS (JavaScript)** - The role of JavaScript in a website is to “program” a website or define the behavior of the website. Pop-ops, drop-downs, form validation and general dynamic behavior are all due to the use of JavaScript in a website.

**4.4.2.1 Choice of Programming Environment**

The Python programming language was chosen for undertaking this project. One reason it was picked was due to its simplicity in expressing algorithms. Python could be written in an IDE(Integrated Development Environment) or using a simple code editor (then run using the terminal). External API (Application Programming Interface) was also used. These APIs provided the QR code functionality as well as the blockchain functionality required by the application. Python comes with module that allow one to easily make http requests. Thus, for API that could only be connected to using http requests, this could be done easily.

**4.4.3. Documentation**

A documentation is a guide that explains how to use a system to potential users of the system. There are different types of documentations for different purposes. For this system, the following types of documentation are provided

- **Code Documentation**

The code was documented using inline comments where seemed s fit

- **API (Application Programming Interface) Documentation**

The API documentation is as follows:

|  |  |
| --- | --- |
| ENDPOINT | ROLE |
| /home | accessing this endpoint will display the homepage to the user |
| /process-order | this endpoint is used by the system to initiate all the required process once a user orders a product |
| /verify | this endpoint is accessed anytime a QR code is scanned. It handles the verification process |
| /scan-page | accessing this page opens a QR code scanner that can be used for scanning QR codes of products |

**CHAPTER FIVE : SUMMARY, CONCLUSION AND RECOMMENDATION**

**5.1 Summary**

This project was concerned with developing a system for the detection of fake products. A brief overview of counterfeit products, types and their effects was presented. Related literature on the concept of fake products and their detection with blockchain based solutions was considered. Existing systems and their shortcomings were also identified alongside likely solutions which the proposed system offers, The design and development of the proposed system was also expatiated upon.

**5.2 Conclusion**

The proposed system thus developed in this project, which proffers innovative solutions to some shortcomings in existing fake product detection systems will see to improve safety of consumers. These consumers tend to be potential victims of consumption of counterfeit drugs. However, with the advent of such a system as is proposed and the methods proposed by this project, purchase of counterfeit products will be reduced. Thus will increase revenue to organizations, protect organization reputation and increase the safety of consumers.

**5.3 Recommendations**

**5.3.1 Application Areas**

The proposed system finds application in consumable product producing companies, particularly those whose product comes in a sealable bottle. Such companies include but are not limited to the following:

* In pharmaceutical companies the use of such a system will ensure that safer drugs are produced such that will increase the health of everyday people, as well as reduce mortality rates due to consumption of unsafe drugs.
* In food and beverage companies, the proposed system will find suitable application and see to improved health and safety of consumers of such products.

**5.3.2 Suggestions for further research**

* **Integration of other Technical methods** For instance, a blockchain solution combined with a machine learning solution will be more robust than the blockchain solution alone. Multiple solutions can be combined.
* **Non-technical methods** This could involve research into physical methods and systems that can aid in prevention of product counterfeiting. It could also delve into awareness and sensitization methods.

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**APPENDIX A: PROGRAM LISTING**

**Landing Page code**

<!DOCTYPE html>

<html lang="en">

<head>

<title>SmylerCM Company</title>

<meta charset="utf-8"/>

<!-- <meta name="viewport" content="width=device-width, initial-scale=1" /> -->

<link rel="stylesheet" href="static/style.css"/>

</head>

<body>

<header>

<a href="#" class="logo" >SmylerCM</a>

<ul class="navlist">

<li><a href="#">Home</a></li>

<li><a href="/generate">Place an Order</a></li>

<li><a href="http://wa.me/2347016270152">Contact Us</a></li>

</ul>

<div class="bx bx-menu" id="menu-icon"></div>

</header>

<section class="hero">

<div class="hero-text">

<h5>Try It Now!!</h5>

<h4>Amazing Product</h4>

<h1>SmylerCM</h1>

<p>lorem ipsum dolor sit amet consecteur adipiscing elit. lorem ipsum dolor sit amet consecteur adipiscing elit</p>

<a href="/scan">Verify a Purchase</a>

<a href="http://wa.me/2347016270152" class="ctaa">Contact Us</a>

</div>

<div class="hero-form">

<form action="/process-order" method="POST" id="form">

<h4>Order Our Product</h4>

<div class="input-group">

<label for="name">Your name</label>

<input name="name" id="name" type="text"/>

</div>

<div class="input-group">

<label for="wallet-address">Wallet Address</label>

<input name="wallet-address" required="true" id="wallet-address" placeholder="e.g. email address OR wallet public address" type="text"/>

</div>

<div class="input-group">

<label for="amount-purchase">Amount To Purchase</label>

<input name="amount-purchase" id="amount-purchase"type="number"/>

</div>

<div class="input-group">

<label for="phonenumber">Your phone number</label>

<input name="phonenumber" id="phonenumber" type="text" placeholder="e.g. 08037684536" maxlength="11"/>

</div>

<button type="submit" id="order-btn">Order Product</button>

</form>

</div>

</section>

<script src="static/script.js"></script>

<script src="static/eruda.js"></script>

<script>

eruda.init();

</script>

</body>

</html>

**Landing Page Styling**

\* {

margin: 0;

padding: 0;

box-sizing: border-box;

font-family: "Poppins", sans-serif;

list-style: none;

text-decoration: none;

}

:root {

--green: #4d9559;

}

.poppins{

font-family: "Poppins", sans-serif;

}

header {

position: fixed;

right: 0;

left: 0;

z-index: 1000;

inline-size: 100%;

display: flex;

justify-content: space-between;

align-items: center;

padding: 33px 9%;

background: transparent;

}

.logo {

font-size: 30px;

font-weight: 700;

color: white;

}

.navlist {

display: flex;

}

.navlist a {

color: white;

margin-inline-start: 60px;

font-size: 15px;

font-weight: 600;

border-block-end: 2px solid transparent;

transition: all .55s ease;

}

.navlist a:hover {

border-block-end: 2px solid white;

}

.menu-icon {

color: white;

font-size: 35px;

z-index: 1001;

cursor: pointer;

display: none;

}

.hero {

block-size: 100%;

inline-size: 100vw;

min-block-size: 100vh;

background: linear-gradient(245.59deg, #4d9559 0%, #38703d 28.53%, #133917 75.52%);

background-size: cover;

position: relative;

display: grid;

grid-template-columns: repeat(2, 1fr);

align-items: center;

gap: 2rem;

padding: 0 5%;

}

.hero-text h5 {

font-size: 15px;

font-weight: 400;

margin-block-end: 40px;

color: white;

}

.hero-text h1 {

font-family: "Permanent Marker", cursive;

font-size: 75px;

line-height: 1;

color: white;

margin: 0 0 41px;

}

.hero-text h4 {

font-size: 18px;

font-weight: 600;

color: white;

margin-block-end: 10px;

}

.hero-text p {

color: white;

font-size: 15px;

line-height: 1.9;

margin-bottom: 40px;

}

.hero-img {

inline-size: 300px;

block-size: auto;

}

.hero-text a {

display: inline-block;

color: white;

background: #4d9559;

border: 1px solid transparent;

padding: 12px 30px;

line-height: 1.4;

font-weight: 15px;

border-radius: 15px;

transition: all .55s ease;

}

.hero-text a:hover {

background: transparent;

border: 1px solid white;

transform: translate(8px);

}

.hero-text a.ctaa {

background: transparent;

border: 1px solid white;

margin-left: 20px;

}

#form {

inline-size: 100%;

background: white;

box-shadow: -2px 2px 5px 5px rgba(0,0,0,.35);

padding-inline: 30px;

padding-block: 30px;

border-radius: 1em;

display: flex;

flex-direction: column;

gap: 2em;

}

#form h4 {

text-align: center;

font-size: 20px;

}

.input-group {

display: flex;

flex-direction: column;

gap: 5px;

}

.input-group label, .input-group input {

color: rgba(0,0,0, .65);

font-size: 15px;

}

.input-group input {

border: none;

background: lightgrey;

padding-block: 5px;

padding-inline: 10px;

outline: none;

}

.input-group input:hover {

border-block-end: 2px solid black;

}

#order-btn {

background: darkorange;

border-radius: 1em;

padding-block: 1em;

inline-size: 100%;

color: white;

font-weight: bold;

font-size: 15px;

text-align: center;

}

**APPENDIX B : SAMPLE OUTPUTS**