# ENHANCING TRUST IN NIGERIAN C2C E-COMMERCE: A REPUTATION-BASED FRAUD DETECTION SYSTEM

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**Abstract**

The rapid advancement of internet technology has ushered in a new era of opportunities across various domains including economics, social dynamics, and cultural interactions. Its influence resonates globally, permeating nations, communities, institutions, and individuals alike. This digital evolution has given rise to a spectrum of novel concepts such as e-commerce, e-banking, e-governance, and e-learning. Among these, e-commerce stands out as a pivotal arena of industrial innovation. It has emerged as a significant driver of economic prosperity in developed regions like Europe, America, and parts of Asia since the early 21st century. Notably, its growth trajectory in Nigeria and several other African nations including South Africa, Kenya, and Egypt has been striking. The surge of e-commerce in Nigeria can be attributed to remarkable strides in internet and telecommunication services. Platforms like Konga.com, Jumia.com.ng, and Dealdey.com are emblematic of this burgeoning landscape. Online shopping is steadily gaining traction among Nigerian consumers, offering a convenient alternative to traditional retail channels. Consumer-to-consumer (C2C) e-commerce, which predates the internet, has found renewed vigor in the digital age. While large websites now facilitate this model, its essence lies in direct peer-to-peer transactions. In C2C e-commerce, individuals assume dual roles as both sellers and buyers, engendering a seamless marketplace. This framework fosters healthy competition and simplifies the acquisition of otherwise hard-to-find products and services. However, alongside its transformative potential, e-commerce also grapples with challenges, foremost among them being the specter of fraud. According to the Nigerian Inter-Bank Settlement System (NIBSS) data for 2014, there were 1,461 reported instances of electronic fraud, resulting in substantial losses amounting to 6.216 billion naira (N6.216b).

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## 1.0 Introduction

Globally, there has been a rapid improvement in the area of internet technology and this has presented diverse opportunities in aspects of economy, social and cultural activities. The Internet continues to have great impacts on nations, communities, institutions and individuals. Today, there are inventions of new ideas like ecommerce, e-banking, e-governance, e-learning, and so on. The Internet technology is generating interesting opportunities, most especially, in the area of industrial innovation. Electronic commerce, also known as e-commerce, is one of such opportunities. E-commerce has been confirmed to be a genuine source of economic growth in some developed countries such as Europe, America and parts of Asia since the turn of the 21st century while it is also experiencing a rapid growth in Nigeria and some other African countries such as South Africa, Kenya and Egypt. Ecommerce in Nigeria has been growing as a result of vast improvements in the use of the Internet and telecommunication services. Some of these e-commerce websites include Konga.com, Jumia.com.ng, Dealdey.com, Yudala.com, Kaymu.com, Olx.com, Jiji.com and efritin.com. Shopping online is gradually becoming widely acceptable to Nigerian consumers as it saves the stress of patronizing traditional retailers and time as well. Consumer-toconsumer (C2C) e-commerce is the oldest form of e-commerce known. It was used well before the Internet appeared; although it can and is now supported by large websites (Makelainen, 2006). Consumer-to-consumer e-commerce differs from other e-commerce models such as business-to-business e-commerce or business-to-consumer ecommerce as they enable users to deal directly with each other, that is, to buy or to sell from each other. In C2C ecommerce, every user can be a seller and at the same time be a buyer. The goal of C2C is to enable sellers and buyers to find each other effortlessly. The buyers and the sellers benefit in two crucial commerce areas, they benefit from competition for product and services and they can easily find products and services that are otherwise difficult to locate (Sonja, 2013). Despite the positive impact of ecommerce, there are also some negative impacts which ecommerce has also imposed; one of these negative impacts include loss due to fraud. Fraud is one of the major problems faced by many e-commerce platforms. According to data from the Nigerian Inter-Bank Settlement System (NIBSS) (NIBSS, 2016), the year 2014 saw one thousand, four hundred and sixty-one (1,461) reported cases of electronic fraud, with actual losses grossing six billion, two hundred and sixteen million naira (N6. 216b).

In 2015, about nine hundred and forty-Six (946) attempted e-fraud cases were also recorded by banks, Other Financial Institutions (OFIs) and Mobile Payment Operators (MPOs), resulting in an estimated loss of five billion naira (N5b).In 2016, over one hundred and thirty-two million (N132m) was lost in the e-commerce sector alone which was higher than the previous years. According to the data from NIBSS over the years, it is evident that the fraud recorded in previous years are always less than the later years, and this justifies that fraud is also on the high increase just as the Internet is growing wider.

Fraud occurrences across different e-commerce platforms may differ from each other depending on the ecommerce model operated in the concerned environment, meanwhile, some may be generic. For this reason, the way fraud will be addressed on business-to-business platforms may differ from the way it will be addressed in business-toconsumer platforms. Resnick *et al*., (2000)noted that there is a gap between notions of trust in business-to-business or business-to-consumer online businesses as compared with consumer-to-consumer online businesses. Consumer-toconsumer online businesses are more prone to fraudulent activities on the Internet compared to other forms of ecommerce, and as a result, there should be other relevant ways to relieve the risk of consumer-to-consumer ecommerce transactions (Resnick *et al*., 2000).Ismail (2014) also noted that there are differences between a consumerto-consumer and business-to-business e-commerce. This implies that business-to-consumer e-commerce methods cannot be utilised in consumer-to-consumer e-commerce.

The use of a reputation system on e-commerce platforms can help to detect fraud which will in turn minimise users falling victims of fraud. Reputation systems are one way of building trusts on the Internet as they help to offset the prominent effects of information-asymmetry problems on market efficiency by providing a meaningful history of the sellers (Withby*et al*., 2005).According to Rahimi and Bakkali (2014), reputation system can be defined as a system that "collects, distributes, and aggregates feedback about participants' past behavior." A reputation system is a technology that allows customers to rate a business or peer. It may allow for ratings and comments about hotels, restaurants, ecommerce sellers, contractors or peers in a sharing economy interaction. Reputation systems are also essential for peer-to-peer business activities as they allow individuals to establish a reputation to gain trust with potential clients. They aim to reduce the risk of engaging with potentially untrustworthy participants by providing a mechanism for establishing trustworthiness between mutually unknown online individuals, and they encourage honest behaviour and discourage rogue behaviour from participants. In the absence of reputation systems, there would be no explicit mechanism to distinguish between honest and fraudulent sellers and, due to high uncertainty in e-commerce platforms, fraudulent sellers would flourish by offering cheap products for an exorbitant price or not offering products at all. Existing Nigerian consumer-to-consumer e-commerce does not have a reputation system and the reputation systems used in other e-commerce models such as the business-to-consumer e-commerce may not be directly integrated on a consumer-to-consumer e-commerce model (Ismail, 2004). This paper proposes a reputation system for consumer-to-consumer e-commerce models and addresses the problem of cold-start which is faced by reputation systems.

Reputation systems have the potential of improving the quality of online markets by identifying fraudulent users and consequently, dealing with these users can be prevented (Indu*et al*, 2016). The reputation system in this study will serve as a fraud detection system for Nigerian consumer-to-consumer e-commerce platforms which can subsequently help buyers to detect and avoid fraudulent sellers.

## 2.0 Related Works

Due to the importance of having reliable and effective reputation systems in e-commerce marketplaces, trust and reputation modeling have become an active area of research. As a result, over the past several years, a variety of proposed approaches have emerged. In the literatures, a number of reputation systems have been proposed to address fraud in e-commerce platforms (IFCC, 2001), (Josang and Ismail, 2002), (Li *et al*., 2014), (Cornier and Tran, 2009), (Tadelus, 2016), and (Chang and Chang, 2012). This subsection concisely discusses the metrics and algorithms used for developing the reputation system.

IFCC(2001) proposed an implementation algorithm for a reputation system, which is based on seller-buyer closeness degree for e-commerce, in order to address the problem of fraudulent activities against honest parties to obtain illegal profit in e-commerce. The reputation system was also used to address the problem of trustworthiness. The algorithm proposed made use of six metrics which are: social network metric, feedback score metric, number of transactions, transaction price, time decay and seller-buyer closeness degree. Even though the model can be used to detect fraudulent sellers and products and thereby reducing the fraudulent activities in e-commerce platforms, the proposed model cannot handle the problem of cold-start in reputation systems.

Josang and Ismail (2002) proposed a computational reputation model for C2C e-commerce platform and integrated five-buyer reputation indicators, which are transactions amount, seller ratings, buyer operations, chargeback ratio and real name authentication so as to solve credit card problem considering buyer's reputation model. In their study, they made use of Analytic Hierarchy Process to distribute the weights of the various indicators which would be used in obtaining numeric value of buyer's reputation; sellers can use these values in

choosing appropriate buyers to deal with. The kind of model proposed in this study may not be suitable for the existing Nigerian C2C e-commerce model since the sellers do not choose the buyers to transact with.

Li *et al*. (2014) proposed a multi-attribute reputation management (MARM) support tool to assist users in choosing sellers when using auction sites. In their study, actual transaction data collected from eBay were used to demonstrate the effectiveness of their method. Their results showed that MARM was able to select more suitable sellers than other methods. In their model, four feature factors, namely: similarity of commodity category, value of each trade, time decay and credibility of the feedback giver, were used to synthesize an overall reputation of a trader. The proposed modelcan be time-consuming and may even be prohibited by C2C e-commerce sites as there is the need for the MARM model tools to download a database of transaction histories before it can be effectively used.

Cormier and Tran (2009) proposed a dynamic computational model of reputation for B2C e-commerce. They,firstly,introduced conceptions associated with trust and reputation and the mathematical formula of trust for B2C e-commerce were given. Then, a dynamic computation model of reputation was further proposed based on the conception of trust and the relationship between trust and reputation. Though, they made use of a mathematical model, their model is mainly for a B2C e-commerce and hence, cannot fit into a C2C kind of e-commerce.

Tadelis (2016) considered the problem of building online fraud detection in e-commerce websites. Increasing use of the Internet, online shopping and online auction have gained more importance. At the same time, criminals are also taking the benefits to perform undesired activities so as to gain illegal profit. Hence, fraud-detection moderation systems are commonly applied in practice to detect and prevent such illegal and fraudulent activities. This study proposed an online probity model framework which takes online feature selection, coefficient bounds from human knowledge and multiple instances learning into account simultaneously. By observing a real-world online auction, fraud detection data will show that this model can potentially detect more frauds and significantly reduce customer's complaints compared to several base line models and the human-tuned rule-based system.

Chang and Chang (2012) opined that trust and reputation modeling systems are central to the success of decentralised e-commerce systems, where autonomous agents are relied upon to conduct commercial transactions. However, the subjective and social-based qualities that are inherent in trust and reputation introduce many complexities into the development of a reliable model. They proposed the use of two new parameters in trust and reputation modeling: agent lifetime and total transaction count. They developed a model that employs these parameters to calculate an agent's seniority, then apply this information when selecting agents for soliciting and ranking reputation information. Existing reputation systems in literatures relied only on ratings provided by registered users; and this often resulted in cold-start problem.

## 3.0 Proposed Model

A reputation model was formulated by expressing the reputation process with appropriate mathematical variables, symbols and functions using the template approach to form a mathematical model. The mathematical model formulated was used as the reputation computation engine.

The proposed reputation model was implemented in a workable e-commerce system using web development tools. The development tools used in this work are PHP, MySql, HTML, CSS, and Javascript, Ajax and JQuery. The combination of PHP, MySQL, JavaScript (sometimes aided by the required jQuery or other frameworks), CSS, and HTML5 was used to produce dynamic web content for the online research instrument. PHP is a scripting language for coding the functionalities of a system and outputting HTML (the contents users view) to the user's web browser.

It is also used to query the database and pull information from it. PHP was chosen in order to handle all the main work on the web server while MySQL managed all the data, and the combination of CSS and JavaScript was used to handle the Web page presentation. JavaScript communicates with the PHP code on the Web server whenever it needs to update events for example date and time (either on the server or on the web page). The HTML5 tags were then used for rendering the Web pages for the browser to be able to function and allow users to use the Web page. Figure 1 shows the process flow of the proposed system.
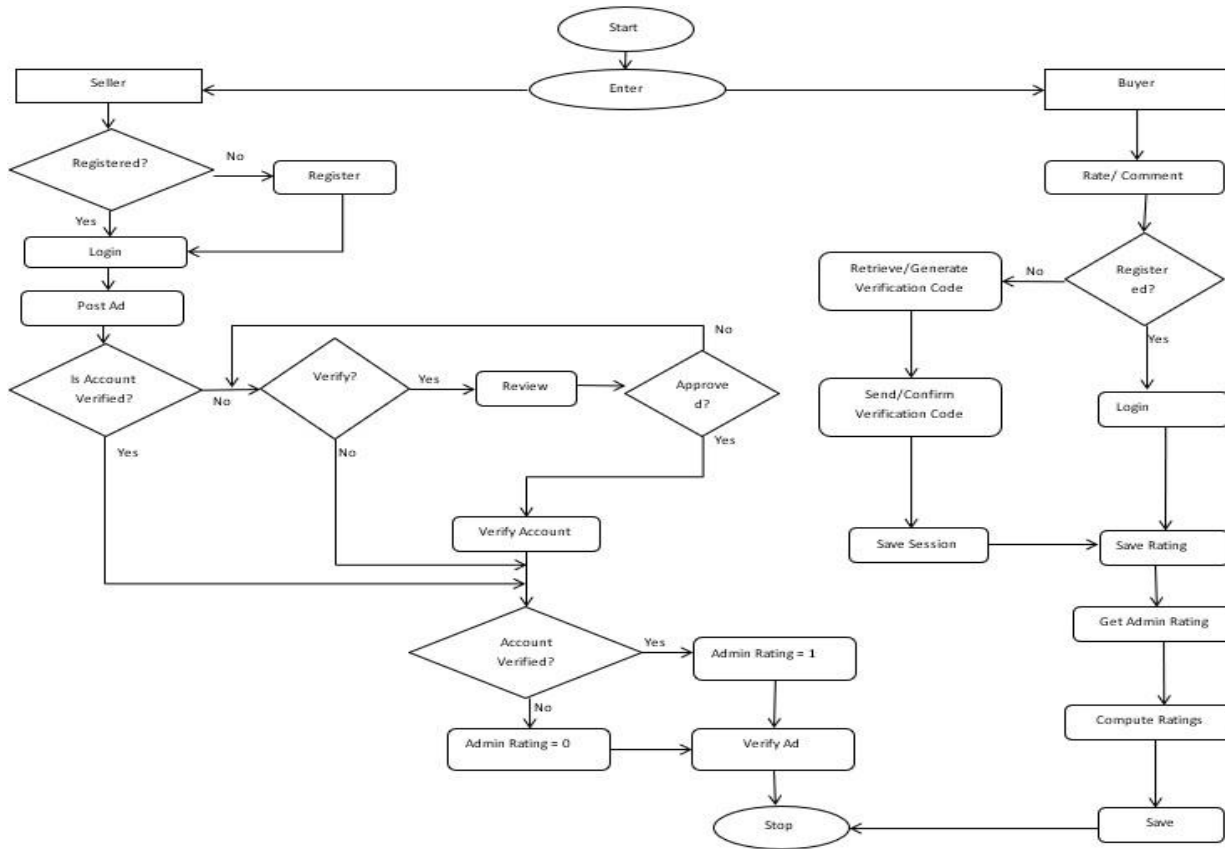


**Figure 1: Process Flow of the Proposed Model 3.1 Mathematical Model**
A mathematical model, which was used for computing the overall reputation score, was proposed for the reputation system. Existing reputation systems have provided different models for computing the overall reputation score. Some of the models for a reputation system model includes simple summation or average ratings, Bayesian systems, discrete trust models, belief models, fuzzy models and flow models.
In this study, the simple summation or average ratings model were adapted and modified to derive the proposed mathematical model in Equation 3.1. This equation is attached to each seller, which means that the displayed overall reputation score of a seller display one if his or her product has the same as the overall reputation score of the same seller for another product.

$$R_s = \frac{1}{N_i + 1}\sum_{i=0}^{\infty}(R_i + D_i) * 100\% \qquad (3.1)$$

Where:
$R_s$ = the Overall Reputation Score
$N_i$ = the Total Number of Registered and Non-registered users who provided ratings
$R_i$ = the User Ratings provided by the Registered and Non-registered Users $\{1, 0\}$ $D_i$ = the Decision Maker Rating $\{1, 0\}$

### 3.1.1 Overall reputation score

The overall reputation score (($R_s$), which is calculated in percentage (%), ranges from 0% - 100%. The minimum overall reputation score of sellers is 0% while the maximum is 100%. Once a new seller activates his or her account, the overall reputation score of the seller at that point will be 100%, and this is done in order to address the cold start problem which is a challenge in existing reputation systems. Cold start problem is simply the unavailability of rating score for sellers who are new in the system, or sellers who lack ratings from buyers. In this scenario, buyers find it hard to make decision as the seller does not have any initial ratings.

This is why the proposed model put into consideration account verification which will be done using the product the seller intends to sell. In a case where the seller does not verify his or her account, the overall reputation score of such seller will be 0%, account verification is not compulsory, sellers can still make use of the system for selling even without verifying their account.

### 3.1.2 Decision maker rating

This decision maker rating ($D_i$) can either be 1 or 0, and it is automatically provided by the system if the seller's account is verified or not verified, respectively. The verification of accounts is done by the administrator using the products details uploaded by the seller and the code generated by the system; the seller is supposed to follow the procedure for account verification after uploading the product details for sale. The decision maker rating can also be termed initial ratings; for a verified account, the decision maker rating is 1 while, for a non-verified account, the decision maker rating is 0. This decision maker rating ($D_i$) is used in Equation 3.1 to compute the overall reputation score ($R_s$).

### 3.1.3 User ratings

User ratings ($R_i$), can either be 1 or 0 for upvote or downvote rating respectively. The user ratings are provided by both the registered and non-registered users of the system. A user can only provide a rating for a user regarding a product; however, these ratings can be changed as they are not permanently fixed. In other words, if a user provides an upvote rating 1 for a seller regarding a product and if the same user comes back to provide a down vote rating 0 for the same seller in respect to the same product, the previous upvote rating 1 will be overwritten by the new downvote rating 0; this will be plugged into Equation 3.1 and the overall reputation score ($R_s$) will be updated.

### 3.1.4 Total number of ratings

The total number of ratings ($N_i$) is the sum of the registered and non-registered users who provided ratings for a seller. The total number (($N_i$) is added to 1 which is a constant in the Equation 3.1. The 1 represents the decision maker which is also the administrator and it is constant. The total number of ratings ($N_i$) is added to 1 and used to divide all through the summation of user ratings ($R_i$) and decision maker rating ($D_i$) in order to get the average reputation score which then multiplied by 100%; the result will be the overall reputation score of such a seller.

### 3.2 System design

The design of the proposed model was carried out using the Unified Modeling Language (UML) tools such as use case diagram, activity diagram and class diagram. UML is a standard visual modeling language used for modeling business processes and other similar processes. It is used for analyzing, designing and implementing software-based systems. UML is a common language that business analysts, software architects and developers use to describe, specify, design and document existing and new business processes, likewise the structure and behavior of artifacts of software systems.

**Use Case Diagram of the Proposed Model**

The use case diagram of the developed system consists of three actors and their respective use cases. The actors include the sellers, buyers, and administrators as shown in Figure 2. The sellers are required to register by filling the required details before they can be allowed to upload their products on the system; after uploading their products, the system administrator approves or rejects the ad after thoroughly examining the details. The sellers are also optionally expected to verify their account by verifying one of their products on the platform which the administrator approves or rejects. The buyers may register or may not register on the system before searching products and viewing product/seller details. However, it is required of the buyers to log into the system using their email and password or All-Time Passcode (ATP) which can be generated on the platform using their phone numbers before ratings and feedback can be submitted.
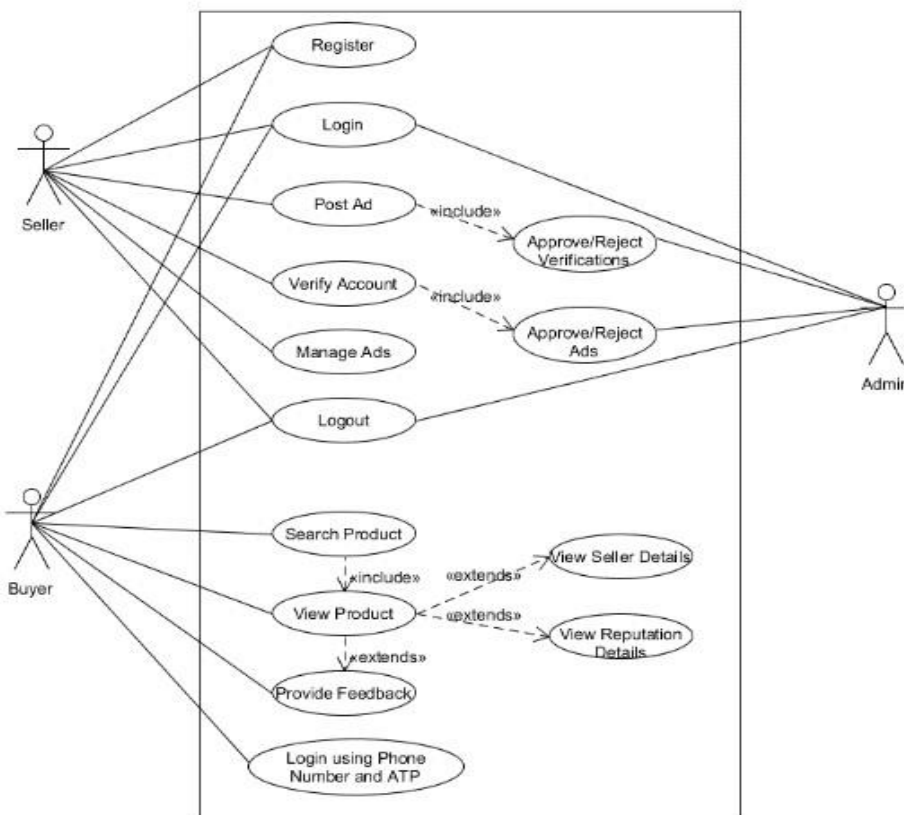


**Figure 2: Use Case diagram of the Proposed System Activity Diagram of the Proposed Model**

An activity diagram has been used to describe the various activities in the proposed model as shown in Figure 3. The three actors in the model, that is, those expected to carry out activities on the system are the sellers, buyers and the supposed system administrators. The sellers are the registered users and the buyers can be registered or nonregistered users of the e-commerce store. The administrators are the ones who manage the approval and rejection of products posted by sellers; they also manage the approval and rejection of account verifications and provision of decision maker ratings for sellers. A buyer may log in and may not log in, create account, browse or search for products, provide ratings and feedback. If a buyer decides to search or browse for products, and the buyer finds the desired products, the buyer can then view the product(s).

Upon viewing the product(s), the product information is displayed and the seller information is also shown. The seller reputation and feedback given by other buyer are also available in order to guide the buyer in making decisions. The buyer can then go ahead to contact the seller and at the end, the buyer is expected to also provide

ratings and feedback based on the outcome of the interaction. Before the buyer is able to provide rating and feedback, the buyer needs to either register or log in if he or she already has an account.

If the buyer does not intend to register on the platform, he or she can still provide ratings and feedback by obtaining an All-Time Passcode (ATP) using his or her phone number. Another important activity in the model is the process by which ratings are used for reputation determination. When sellers register and upload their products, account verification procedure, which is not compulsory, is used in determining the decision maker rating for sellers, the subsequent ratings provided by buyers are also by the reputation engine in determining the overall reputation score of the seller. The system administrator also approves or rejects products posted by the seller before it publicly appears on the website; the administrator also determines if the seller's account verification will be approved or rejected.
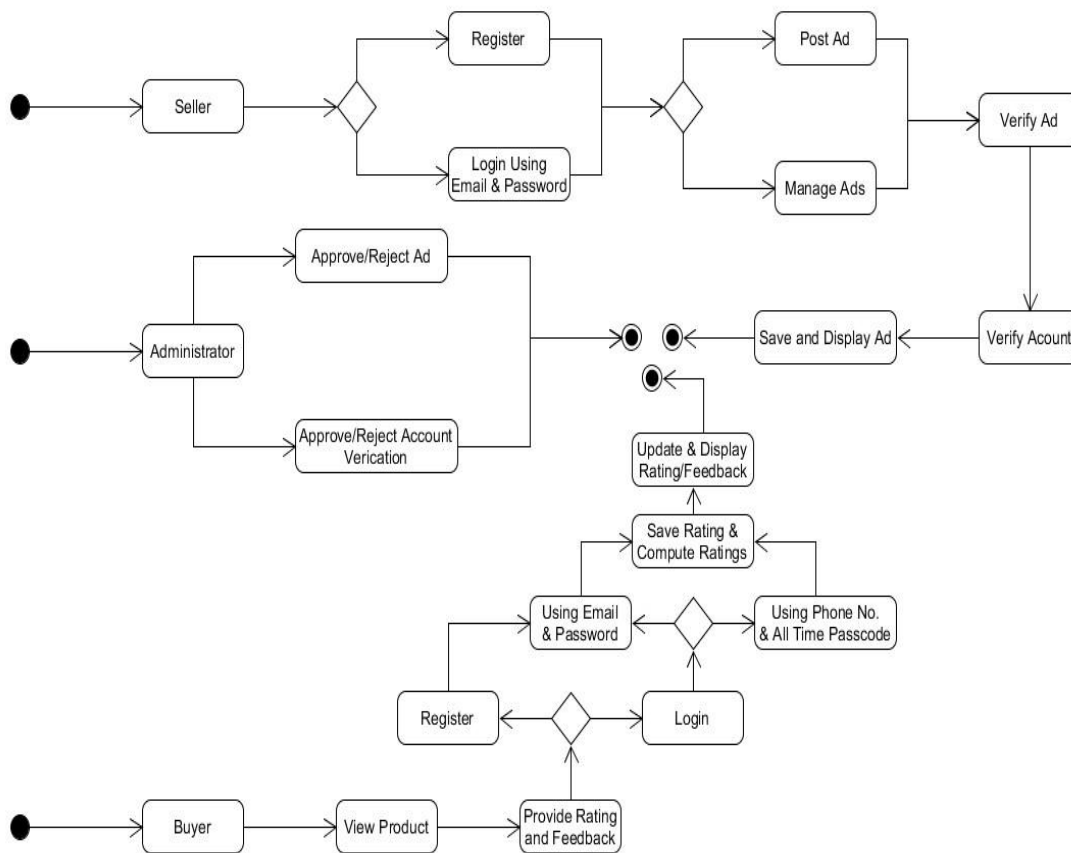


**Figure 3: Activity diagram of the Proposed System Class Diagram of the Proposed Model**

A class diagram is a UML diagram that shows the structure of a designed system at the level of classes and interfaces. Class diagrams also show the features, constraints and relationships of the system. They describe the object and information structures that are to be used by the system internally and in communication with its users. Figure 4 shows the class diagram of the proposed model.
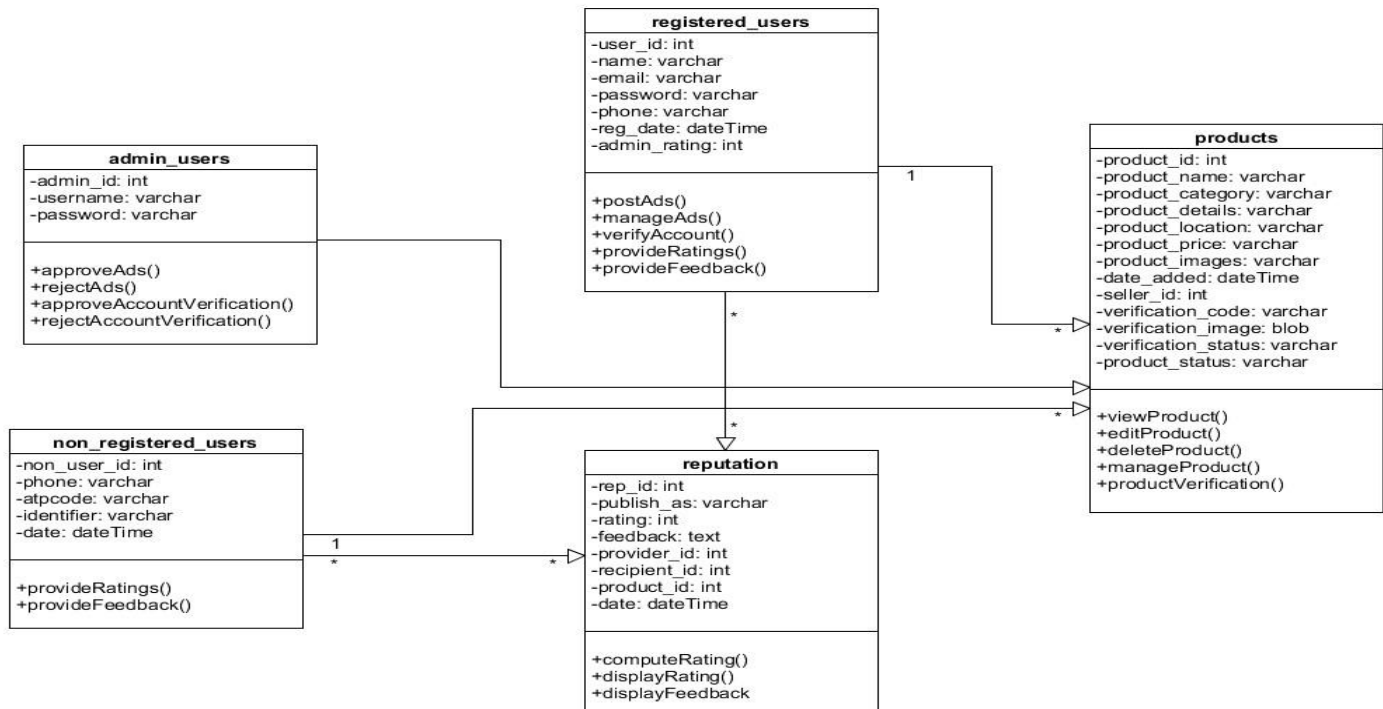
**Figure 4: Class diagram of the Proposed System**

## 4.0 Result and Discussion

This section presents the results of the implementation of the proposed model into a workable system. The workable system is a consumer-to-consumer e-commerce website with a reputation system.

Figure 5 shows the homepage view of the system; this is the page where both sellers and buyers get to see general information about the contents of the e-commerce store. Figure 6 shows the log-in page on the system; this is the page where already registered users either buyers or sellers get to provide their details to the system so as to access relevant information about their accounts and perform other activities. Figure 7 shows the account creation or registration page for visitors either as sellers or buyers on the system. This is the page where they get to provide their details for the system for it to create accounts for them. Although this account creation is not compulsory for buyers, it is compulsory for sellers before they can have access to post their products for sale.
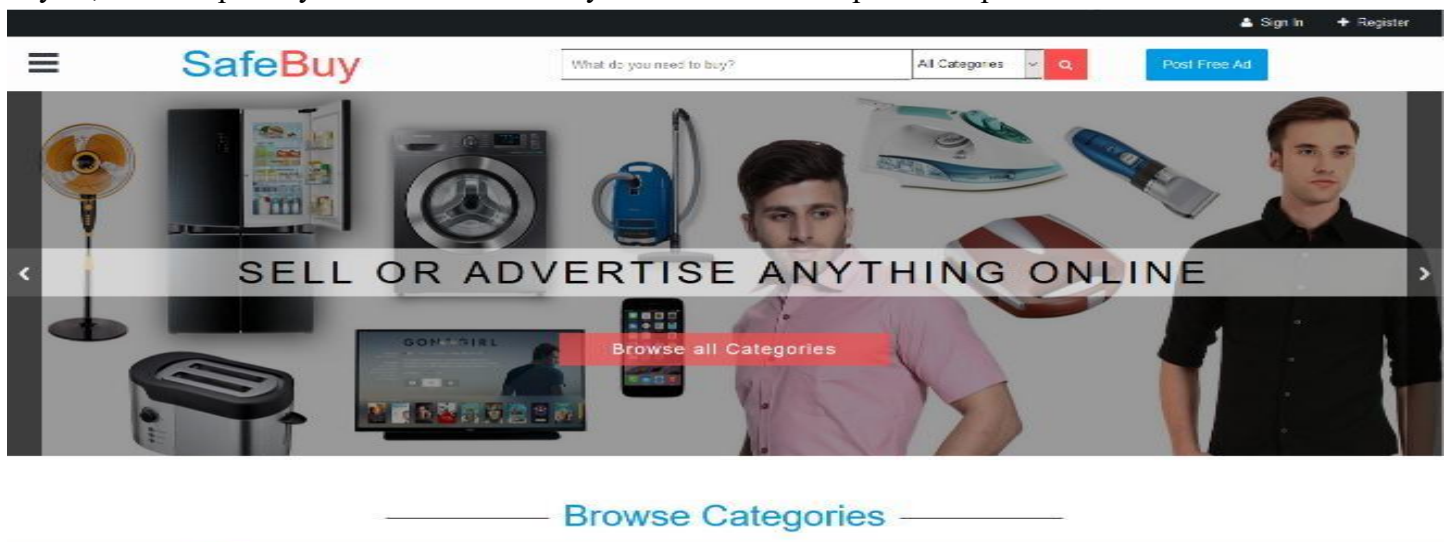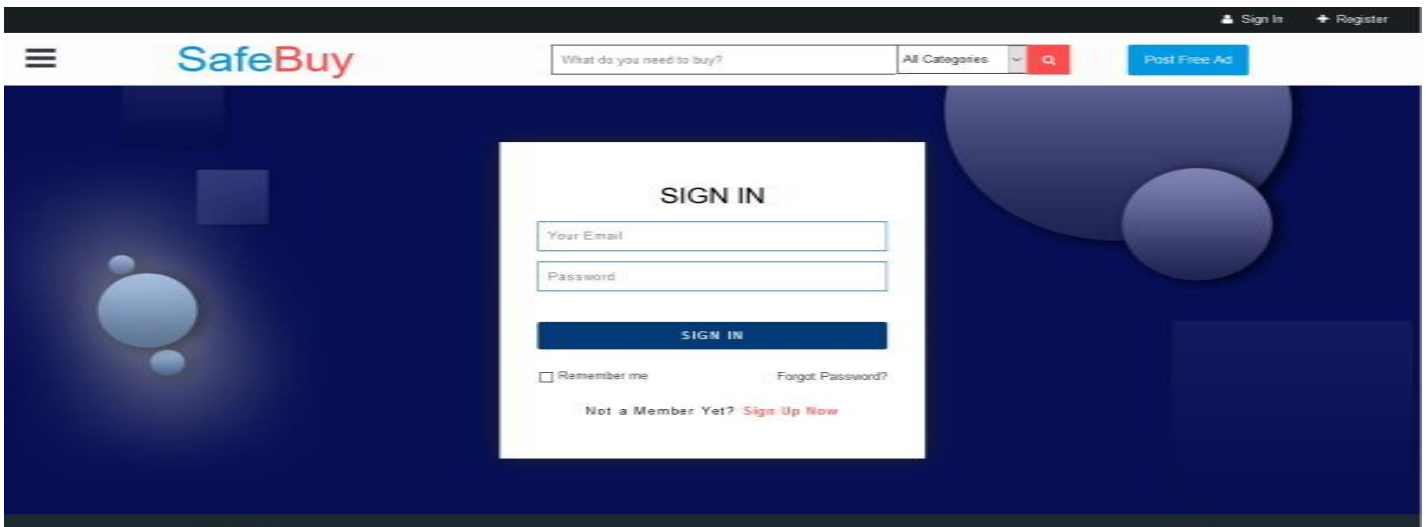
**Figure 6: Sign-In Page of the Reputation System**



**Figure 7: Sign up/registration/account creation page of the Reputation System**

Figure 8 shows the post an ad page which is where the seller fills in the details of the product for sale and upload the product's images as well. The seller is expected to have an account and log in before this page can be accessed. Figure 9 shows the verification page where the non-verified sellers are expected to upload their product having the unique code generated upon submission of their product for sale. This page is only available for sellers who have not verified their accounts and wish to verify them.

Figure 10 shows the product information page. This is the page where the shoppers/customers/visitors get to see more information about the product(s) being sold on the website (system); it also shows the details of the seller which includes the name, the contact details and the reputation of the seller. This is the same page where buyers can provide feedback after interacting with the seller and also view other buyers' feedbacks as well. This page is presented by the system when an item is selected.

Lastly, Figure 11 shows the authentication page where non-registered users can enter their phone number and get an All-Time Passcode (ATP) in order to enable them to provide ratings and feedbacks for the seller after interacting with the seller. This same page can also be used by buyers who have accounts to log in and provide their ratings and feedbacks as well.
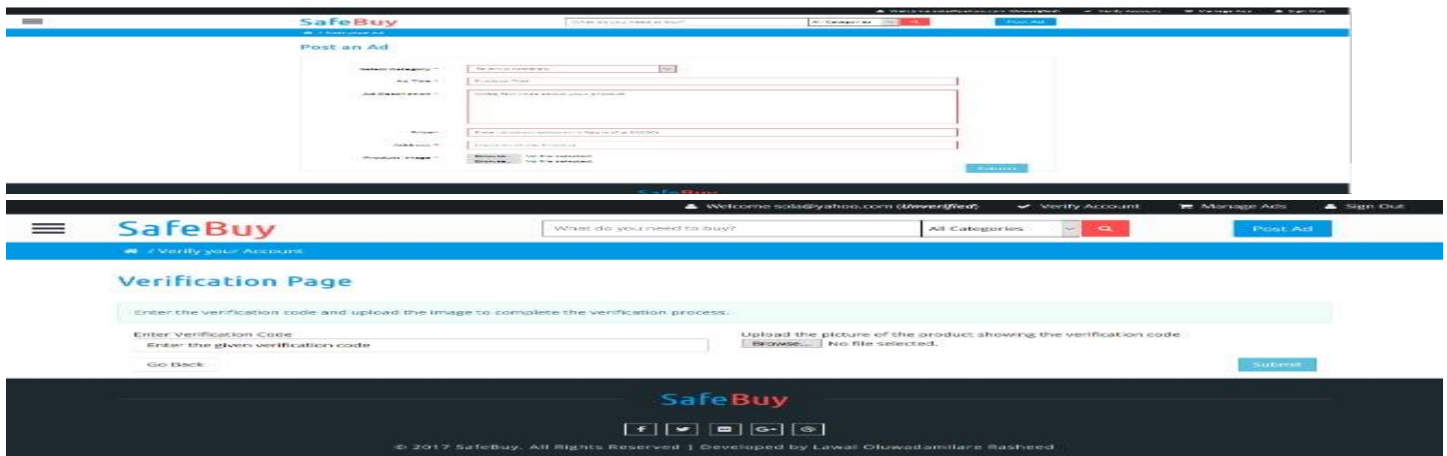
**Figure 9: Verification page of the Reputation System**



**Figure 10: Product information of the Reputation System**



**Figure 11: Authentication page of the Reputation System**

The seller's profile and seller's reputation page, as shown in Figure 12, shows the more detailed information of the seller's profile and seller's reputation. The seller's profile section shows the name of the seller and the logo which is the "Admin seal" as it shows that the seller is verified. The date in which the seller registered on the platform is also shown; this can help buyers make decisions based on how new or old the seller is on the platform. The final part shows "Last seen" which is the date the seller logged in last, and this can help the buyer to know how recent the buyer logged in to the system either to monitor his product(s) or do other things.

The seller's reputation section,as shown in Figure 12, shows the account status of the seller, which is either "Verified" or "Non-verified". The overall rating represented by stars shows the rating of the seller which were provided by the administrator, registered users and non-registered users. The reputation score is also show in percentage; this is calculated by using the proposed mathematical model presented in this research. The next item there shows the total number of registered and non-registered users who provided the ratings. The button "Read Feedbacks" when clicked will display the comments provided by the registered and non-registered users as shown in the feedback comment pop-up page. This is as shown in Figure 13. Although, this is not compulsory for every

user who provides ratings, it helps prospective buyers to know the mind of the raters. The "thumbs up" icon shows positive feedbacks while the "thumbs down" icon shows a negative feedback and the numbers beneath the both of them shows total number of people who provided the feedbacks.



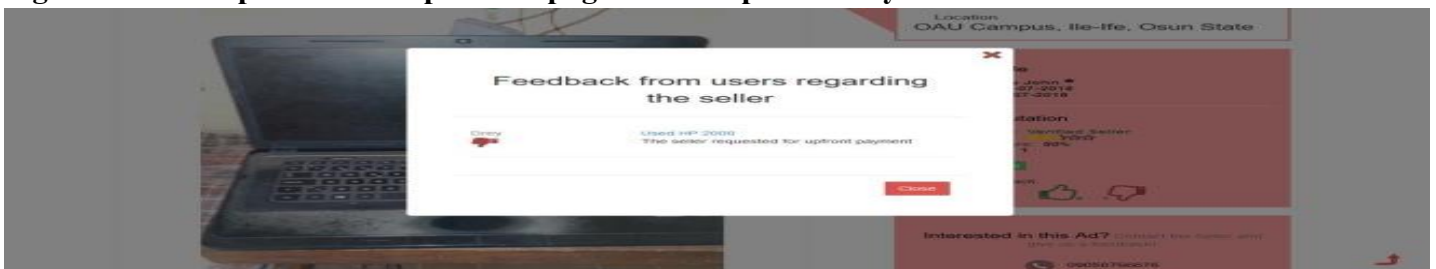**Figure 12: Seller profile and reputation page of the Reputation System**



**Figure 13: Feedback comment pop-up page of the Reputation System 5.0 Conclusion**

In this paper, a reputation system, which can serve as a fraud detection system on Nigerian consumer-toconsumer e-commerce platforms, was proposed. The proposed mathematical model serves as the reputation computation engine for the proposed reputation system. The reputation system developed was designed and implemented to serve as a fraud detection system that can help buyers on a Nigerian consumer-to-consumer ecommerce system to make decisions as to whether to transact with a seller or not. This can thus be said to imply that the proposed reputation system can help minimize fraud since buyers can access the history and behaviours of sellers before engaging the sellers compared to the existing C2C systems that do not have reputation systems. This study also addresses the cold-start problem which is one of the problems of a reputation system by proposing decision maker ratings and non-registered users' ratings.

Future work can be done on automating the account verification process of sellers, which is manuallycarried out by the system administrator in this paper. Another area to look into is the automatic detection of fake reviews and feedback which this study did not address.

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