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Money Laundering Detection System with Intelligent Agents

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ABSTRACT

Over the years, people acquire money illegally from public treasury and launder it by depositing it as clean money into the banking system. Hence, the laundered money is integrated back into the financial system concealing the illicit sources. Money laundering is a major challenge and a threat to both financial institutions and government. This research is aimed at developing an Enhanced Multi-agent Money Laundering Detection System for monitoring cash flows in individual and corporate accounts in deposit money banks and other financial institutions, so as to detect illicit fund movement. In an effort to checkmate money laundering, threshold is used by financial institutions to check the volume of money an individual or company can transact in a single transaction. This is defective as the transaction can be broken into pieces to avoid being detected. The existing Money Laundering detection systems lack intelligence on detecting money laundering when it evades the stated threshold. This work aims at developing an Enhanced Multi-Agent Money Laundering Detection System with time frequency analysis. The system was designed to monitor financial institutions monetary transactions to detect money laundering activities. The intelligent agent system was designed to perform some tasks autonomously, which means that the system can act independently of humans. A set of autonomous type of behaviours for the agent class, including reactive, proactive, and cooperative behaviour was designed. Both autonomous and semi-autonomous agents rely on data (customer daily transaction history) which is the agent's perception or awareness of its environment. Various kinds of intelligence are supported by this kind of data. Business rules form an important part of the knowledge base for software agents to perform delegated tasks. Also the system uses time frequency analysis to detect money laundering which involves multiple account or multiple transactions. Object-Oriented Analysis and Design Methodology (OOADM) was adopted in this research work. The software was developed using Hypertext Markup Language (HTML), Hypertext Preprocessor (PHP), My Structured Query Language (MySQL), Cascaded Style Sheet (CSS), Java Script, Dream weaver, and Fireworks. The software performance was tested using accuracy in money laundering detection as the key performance index (KPI). In the software test carried out 97% accuracy in detecting money laundering was achieved.

Keywords: Bank verification Number (BVN), Cyber security, Cyber crime, Money laundering, Intelligent agents, Time-frequency analysis

INTRODUCTION

Money Laundering is the practice of integrating the proceeds of criminal enterprises into the legitimate mainstream of the financial system [1]. It is a technique designed to make illicit acquisition appear legitimate, usually by disguising the property's illegal origin. Money laundering reveals a practice whereby funds obtained from illegal transactions are transferred into secret accounts to shield their detection and possible sanctions [2]. According to International Monetary Fund (IMF), estimated aggregate size of money laundering in the world could be between 2 and 5 percent of global gross domestic product (GDP) [3]. Today, money laundering has become more and more sophisticated and a trait to national peace. Most of the money laundered is used to finance terrorism, religious crises, overthrowing of government, etc. This criminal activity poses a serious threat not only to financial institutions but also to nations and can result to existential trait. Most countries have established anti money laundering agencies and banks and other international financial institutions and financial agents have been implementing Anti Money Laundering solutions. However, most of the existing commercial solutions are not effective enough as they concentrated on transaction threshold. Those solutions need a lot of customization to directly implement Anti Money Laundering rules, regulations and procedures, and therefore

are not full-fledged solutions, especially for detecting and analyzing suspicious transaction. As pointed out earlier, Money Laundering is a threat for countries and nations, and it is highly risky to financial institutions as it could damage the national economy of a country. Governments, financial regulatory bodies and financial institutions require implementing processes and procedures to prevent or detect money laundering from their illegal activities that money launderers are involved in. To do this, key players have understood the critical significance of national financial stability and international security by using Anti Money Laundering (AML) mechanisms to track and prevent money laundering. The challenges of implementing anti money laundering in financial institutions are large due to the growing volume of daily transaction data, nature of money laundering and heterogeneity and diversified place of data. In order to tackle such challenges solution developers have tried a lot but have not succeeded in generating software architecture and developing solutions. Indeed, the volume of financial institutions and transactions has increased manifold and managing money laundering under such circumstances needs to be supported by automated tools.

The rise of information technology has help in so many ways to ease the financial transaction system, and it has been important for financial and banking systems, changing the structure of such institutions. Innovations in banking sector are improving the ease of internet payments and transactions and have majorly impacted the services provided by financial institutions. New technologies are used to create a faster, safer, and more convenient online environment for their services [4]. However, with the advancement in technology comes an increase in cybercrime prevalent in today's digital age. Criminals' exploitation of unsuspecting individuals and organizations is on the increase. Money laundering is one significant aspect of cybercrimes which aid fraudsters to legitimize their illicitly gained funds. Cybercrime, the use of a computer as an instrument to further illegal ends, such as committing fraud, trafficking in child pornography and intellectual property, stealing identities, or violating privacy. Cybercrime, especially through the Internet, has grown in importance as the computer has become central to commerce, entertainment, and government [5]. New technologies create new criminal opportunities but few new types of crime. What distinguishes cybercrime from traditional criminal activity? Obviously, one difference is the use of the digital computer, but technology alone is insufficient for any distinction that might exist between different realms of criminal activity. Criminals do not need a computer to commit fraud, traffic in child pornography and intellectual property, steal an identity, or violate someone's privacy. All those activities existed before the "cyber" prefix became ubiquitous. Cybercrime, especially involving the Internet, represents an extension of existing criminal behaviour alongside some novel illegal activities. Most cybercrime is an attack on information about individuals, corporations, or governments. Although the attacks do not take place on a physical body, they do take place on the personal or corporate virtual body, which is the set of informational attributes that define people and institutions on the Internet. In other words, in the digital age our virtual identities are essential elements of everyday life: we are a bundle of numbers and identifiers in multiple computer databases owned by governments and corporations. Cybercrime highlights the centrality of networked computers in our lives, as well as the fragility of such seemingly solid facts as individual identity [5].

RELATED WORKS

The review carried uncovers knowledge based anti-money laundering, ontology based expert system for suspicious transaction, money laundering detection using synthetic data, fast detecting suspicious money laundering and an investigation into data mining approaches for anti-money laundering. [6], defined a multi-agent system designed to help financial institutions in this task by developing agent architecture, and characterize the different types of agents, considering the distinct roles they play in the process. In the system, they defined a set of entities (agents) with autonomy to perform specific tasks and to engage in communication with others in order to accomplish a certain set of goals. Also the multi-agent system was the basis of the new decision making process and it can initiate learning of new rules and parameters that will serve as valuable resources for the agents defined. [7], proposed a solution for curbing digital fraud in the finance industry. According to them, Fraud detection is a reactive process, and it usually incurs a cost to save the system from an ongoing malicious activity. They proposed the use of an Intimation Rule Based (IRB) alert generation algorithm. These IRB alerts are classified based on severity levels. The solution uses a richer domain knowledge base and rule-based reasoning. The work proposed an ontology-based financial fraud detection and deterrence model. [2], presented knowledge-based anti-money laundering software agent bank application first developed to control money laundering and is currently in use among financial institutions to handle complex financial transactions and services, including Money laundering. Knowledge based AML which can be used by intelligent agents in a single bank. The result shows AML platform that focuses on internal data monitoring in a bank, but incapable of monitoring multi-bank transactions and this is the weakness for the research. [8], proposed a deep learning strategy to create synthetic data that facilitates the simulation of money laundering schemes using an agent-based model. The applied generative adversary neural network (GAN) methodology that creates synthetic data that is statistically significant to simulate money laundering situations in a network of non-banking correspondents. The agent-based models allow a technical explanation of how they carry out money laundering among non-bank correspondents without generating any alert or suspicious activities. [9], proposed the use of a Bayesian network based on rules from the State Bank of Pakistan and regulations of Pakistan to

measure the suspected behavior of customers by assigning them a score. Then, the deviation is computed between the assigned score and the historical behavior of the customer. Once the deviation is significant from defined rules and regulations of normal behavior, the transaction is marked as suspicious and requires further investigation to explain the difference in behavior. The Bayesian network does not allow us to model complicated structures, such as money laundering typologies, but it provides an easy to understand visualization of money laundering occurrences. [10], in his paper proposed a method focused on the relationship between financial accounts based on the social network analysis performed. The paper builds on the assumption that for illegal activities to happen, the interaction between multiple social actors is required. Therefore, the relationships between actors are analyzed by assigning individual weights to actors based on geographical, transactional, and economic factors. It concludes that social network analysis is indeed valuable when defining risk profiles and when detection suspicious patterns and transactions. The research also mentioned the increase in informative power when analyzing multiple networks. Ontology Based Expert-System for Suspicious Transactions Detection was proposed by [7], and it is essential for development of AML software. Because computer science researchers adopt similar standards in their fields of study, the ontology of AML has become sharable and reusable. This has led to the development of expert system AML in which the knowledge based and rules based modeling is integrated to detect suspicious transaction detection. Both suspicious and non-suspicious transactions are the input for the system and the system does not automatically validate suspicious transactions before applying the rules to detect it. Validation of suspicious transactions is the weakness of this research. In proposed framework the suspicious transactions are validated using incidence identification and surveillance of ML processes in individual transactions.

Research from [11] proposes a combination of clustering and classification techniques to detect investment transactions. The paper researches customer behavior in investment activities, seemingly to be fairly complicated to the many factors involved as fund prices, market climate, currency exchange rates, and the political environment. The paper examines two investment values: subscription value, being the value wherefore existing shareholders can participate in company rights offerings. The second value, the redemption value, is the price wherefore an issuing company could buyback securities before the maturity date - the end date of a security. In order to reflect the relationship, the paper uses the following parameters: the proportion of redemption value of the subscription value and the proportion of redemption value of the total value of investors' shares. Using these parameters, the paper tries to cluster groups to detect suspicious transactions. The paper also emphasizes the importance of automation in detection monitoring, since the volume of financial transactions that have to be investigated by financial institutions is increasing. [11], provide promising results of the detection of suspicious transactions using clustering but on the other hand the model requires validation on larger datasets to draw better conclusions. [12], use Decision Trees to identify rules of money laundering based on customer profiles of a commercial bank in China. It concludes that Decision Trees are useful to generate anti-money laundering rules from customer profiles. A predictive method of Decision Trees is provided by [13] to discover money laundering patterns and rules. It states to identify suspicious transactions more effectively than rule-based methods. Le-Khac, Sammer and Kechadi introduced fast detection of suspicious money laundering [14]. In order to develop a new solution for international investment bank, they proposed a data mining-based solution for Anti-money laundering (AML). In this work they focused on heuristics approach to improve the performance for this solution. Getting money laundering pattern is one of the goals of this research and important to support AML software. Applying heuristics in suspicious screening process is done by changing the parameters as many times as possible to determine the suspicious group using clustering algorithm. Suspicious and non-suspicious groups are then fed into a neural network for training and their results are stored in a knowledge-base. The drawbacks of this work is classifying the transactions and taking only corporate data. But there exist ML cases from the individual transactions. So that the proposed framework recommended finding suspected transactions from both corporate and individual transactions.

PROBLEM STATEMENT

Money Laundering is a major challenge and a threat to both financial institutions and government. People steal money from public treasury and launder it to unknown destination. Most often the laundered money is integrated back into the financial system concealing the illicit sources. Most of the money laundered is used to finance terrorism. Terrorism today has become a global threat to the security of every individual. Terrorism clearly has a very real and direct impact on human rights, with devastating consequences for the enjoyment of the right to life, liberty and physical integrity of victims. In addition to these individual costs, terrorism can destabilize Governments, undermine civil society, jeopardize peace and security, and threaten social and economic development. An effective Anti-Money Laundering is necessary as it helps in uncovering evidence of criminal activity through identification of suspicious movements of financial assets and enabling the tracing of criminal proceeds to facilitate their preservation, recovery and ultimate return to rightful owner. As money laundering is getting more and more sophisticated making it difficult for financial institutions to detect this criminal activity, financial institutions and governments require equally sophisticated systems that are adoptive

and flexible to be able to continue detecting money laundering activities. Most of the existing system has some defects which include:

1. Threshold is used to check the volume of money an individual or company can transact in a single transaction. This is defective as the transaction can be broken into pieces to avoid being detected.
2. There is no automatic reporting system as banks are only mandated to report transactions that exceed the set threshold to the Anti – Money Laundering Agencies. Often banks can renegade on this due to personal interest.
3. The Existing Anti-Money Laundry systems can only monitor one financial institution at a time.
4. The frequency of transactions is not tracked with the existing system.

PROPOSED METHOD

The methodology employed in this research was the Object-Oriented Analysis and Design Methodology (OOADM). It uses a formal methodical approach to the analysis and design of information system. An object-oriented methodology is a strategy for software design and development using objects (classes, encapsulation, inheritance, and polymorphism). For effective implementation of this work, some web application languages was used to design the Enhanced Multi-Agent Money laundering detection System. These includes; Hypertext Markup Language (HTML), Hypertext Preprocessor (PHP), MySQL, Cascaded Style Sheet (CSS), Java Script, Dream weaver, and Fireworks. Dream weaver is an HTML-based application that is used to generate graphical user interfaces. The scripting language behind the development of the system is PHP and JavaScript. JavaScript is used to add functionality beyond standard HTML to a web page. It adds interactivity to website. MySQL is used together with PHP in website development and is open-source software. These are the materials needed to actualize the projects objectives.

SYSTEM DEVELOPMENT

The Enhanced multi-agent money laundering detection system was implemented using the PHP programming language. The PHP programming language was used because of it's enormous advantages of simplicity, easy programming, flexibility. PHP utilizes graphical user interface (GUI) and supports the adopted software methodologies for the research work. The new multi-agent money laundering detection system is an enhancement to an already existing technology. The objective of the design includes: To develop intelligent agents that will detect money laundering transactions; To use the intelligent agent developed to provide analysis of data we have in financial institutions to determine in real time suspicious money laundering transactions; To apply a time-frequency analysis of transaction data for suspicious activity detection; To leverage the Bank verification Number (BVN) availability to monitor transactions of same individual in different banks; To develop a money laundering detection system that detect money laundering transactions split into multiple transactions. The actors captured in the implemented system are the Banks and Financial Agents, The Customers and the AML Agencies. The use case diagram and the High level model will depict this as seen in figure 1 and figure 2 respectively.

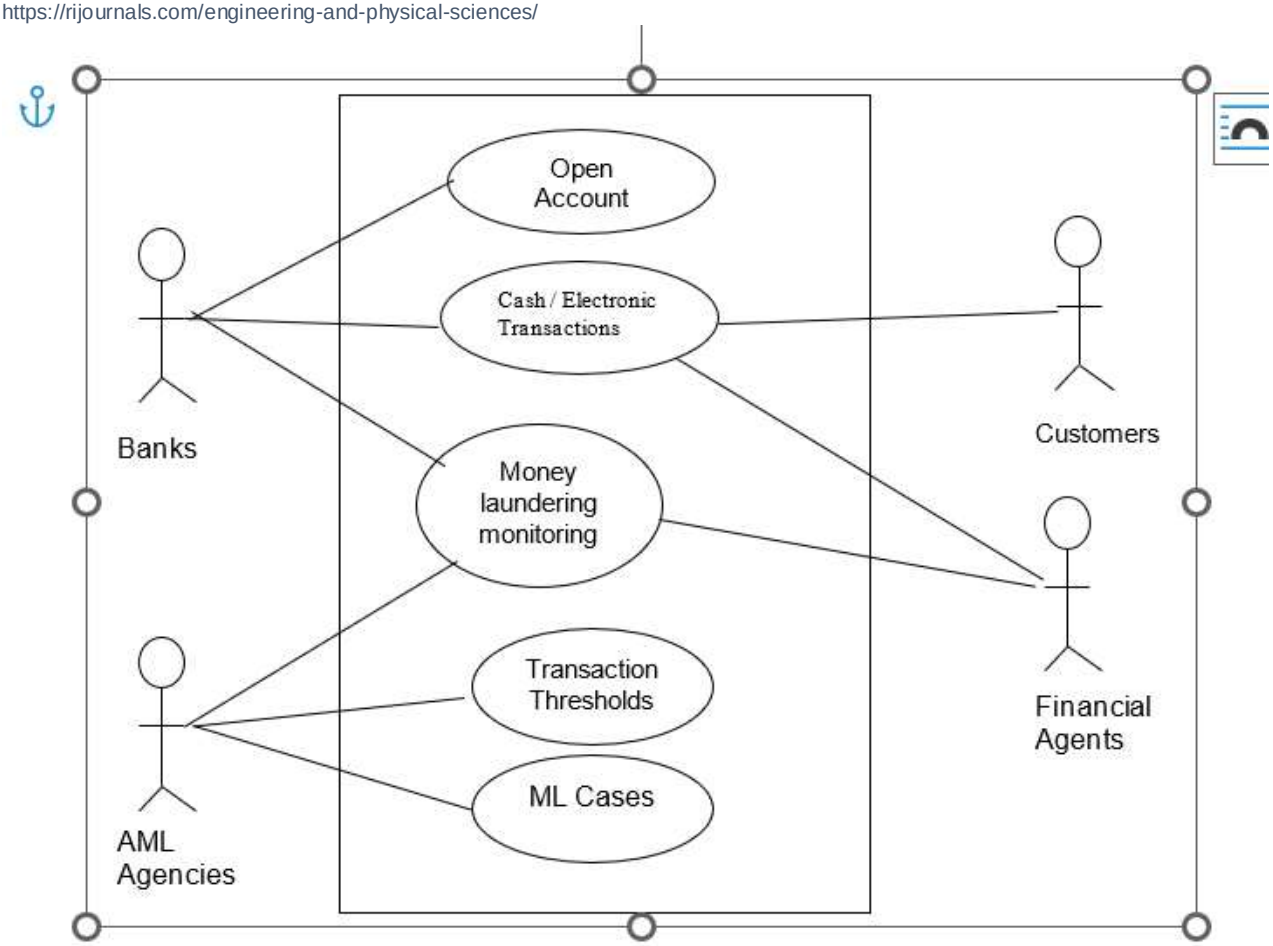

Figure 1: Use Case Diagram of the multi-agent money laundering detection system

The user requirements describe functions that are performed by the users on the system. The users of the proposed system are categorized into four levels namely Banks, financial agent, customers and AML Agencies. The activities of these users are described in figure 5.1 using use case diagrams.

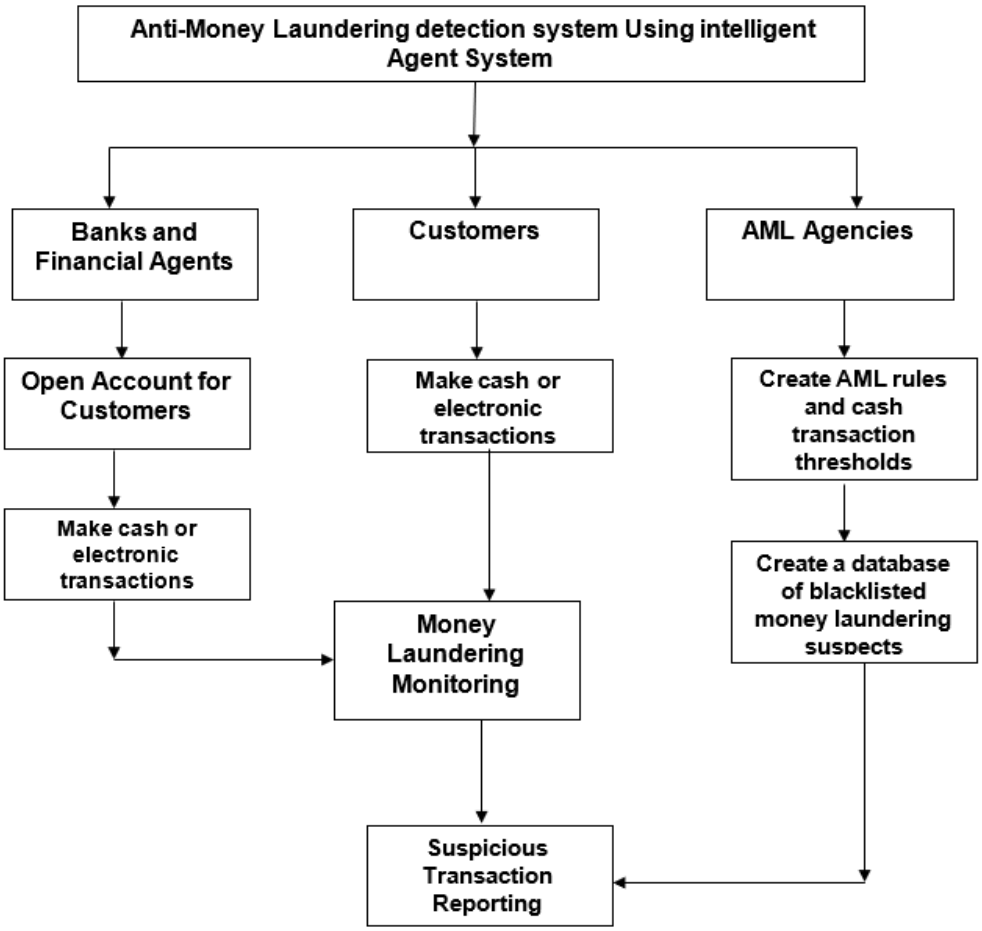

Figure 2: High Level Model of the Multi-agent money laundering detection System

The functionality of the proposed system as represented in the High Level Model in figure 5.2 is discussed in detail as follows;

1. The banks and financial institutions opens account for customers and equally process the customer's transaction.
2. The customers initiate transactions
3. The AML agencies creates rules for money laundering monitoring

SEQUENCE DIAGRAM

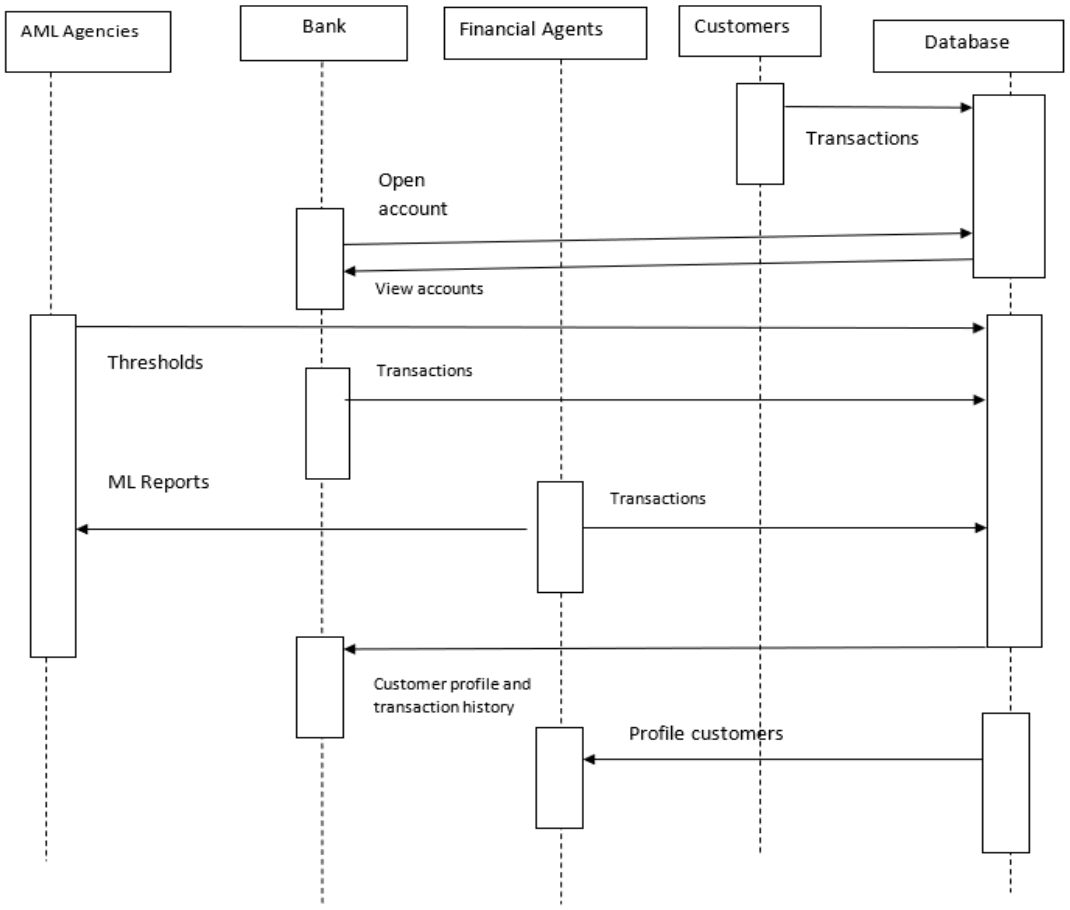

Figure 3: Sequence diagram of the multi-agent money laundering detection system

The sequence diagram of the multi-agent money laundering detection system depicts how objects interact with one another and in what order. It depicts the objects and classes involved in the system.

RESULTS

Test Results (Actual Test Result versus Expected Test Result)

The Enhanced Multi-agent money laundering detection system was able to monitor and perform real time alert and notification to accounts that had suspicious entries based on the rules set to monitor what would be considered as money laundering as the transactions happen. It also was able to log the information into a log file. The information on the log file is then made accessible to the user via an interface that the user can use to further analyze the data.

Table 1: Expected Result vs Actual Result

Module	Expected Test Result	Actual Test Result
Home Page	Expected to see the page containing links to other modules	The home page displayed platform and contains all the links to the various modules in the anti money laundering detection system
Log In Form	Expected to see the Log In form so that users can log in.	When clicked on log in, a form appeared where you can enter your username and password
New Account opening form	When clicked on the system, it is expected to display the form for entering new account opening details	When clicked on the button, the system displays the customer account opening form.
Transaction form	It is expected to allow customer to deposit or withdraw money	The customer was able to make money deposit or money withdrawal from his/her account
Intelligent Agent form	It is expected to use the set transaction limit for the day to detect money laundering	The intelligent agent was able to use threshold to determine is a transaction amount can be considered as money laundering
Time-Frequency Analysis form	It is expected to tract money laundering in multiple transaction over time	Time frequency analysis was able to extract all transactions by a single person within a time frame and use it to detect where money laundering has occurred using multiple transactions
Reporting form	Expected to generate money laundering alert	The reporting agent was able to forward an alert to the security agencies indicating that the transaction is classified as money laundering having exceeded the set threshold

Performance Evaluation

The performance scoring test was carried out using confusion matrix for the analysis of the multi-agent money laundering detection system. It reflects the data for money laundering detection in connection with the true positives, false negatives, false positives, and true negatives. The results of this research were that the money laundering precision rate for intelligent agents developed was 0.94. The data analysis recall rate stood at 0.86. The F1-score for time-frequency analysis was 0.97. The model successfully monitored 98% transactions of individuals with their various bank account. The accuracy of the model was improved from 92% to 97% by reason of detections in individuals accounts in other financial institutions. The result was generated for 900 transactions using confusion matrix.

CONCLUSION

The research had shown that applying the multi-agent to money laundering detection improved system performance from 92% accuracy to 97%. The time-frequency analysis was able to detect 98% individual transaction split into different bank accounts using the Bank verification Number (BVN).

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