

# Fraud Detection System for Effective Healthcare Administration in Nigeria using Apache Hive and Big Data Analytics: Reflection on the National Health Insurance Scheme

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**Abstract**—Nigerian researchers have shown that the lack of adequate mechanisms for fraud detection has impaired both providers and beneficiaries of this scheme. This work develops a fraud detection program for Nigeria's National Health Insurance Scheme (NHIS).

Nigeria's National Health Insurance Scheme (NHIS) and Health Maintenance Organizations (HMOs) are the subjects of this study. The study was conducted using available data from NHIS-registered healthcare facilities and HMOs. Unified Modeling Language (UML) tools were used to create the framework. The framework was built with Apache Derby DB, Hadoop Distributed File System (HDFS), and Apache MapReduce as the big data processing platform.

Using Apache Hive and Big Data Analytics, a system for detecting healthcare fraud is developed. This system used data from the Nigerian National Health Insurance Scheme (NHIS), which was broken down into three categories: enrolment, referral, and claim data. The analysis of current healthcare investigative methods is conducted, and a new framework is proposed.

**Keywords**—Big Data, Fraud, Detection Apache Hive Deep Learning, NHIS, Healthcare Insurance.

## I. INTRODUCTION

Big data often refers to data sets that are too large for popular computing tools to collect, compile, handle, and process in a reasonable time. Big data analytics is the process of collecting, storing, and processing large, complex datasets, which may include structured and unstructured data, streaming and batch data, and sizes ranging from terabytes to zeta bytes, to identify patterns and other useful information [20]. Big data analytics [15] can be used for information management, which needs to be able to gather large amounts of digital data for analysis, interpretation, and the creation of knowledge that could help find illegal behaviour.

The use of big data tools would make it easier to spot inconsistencies that indicate fraudulent activity. Big data analytics could lead to the discovery of a "big arrest" with this transferable skill. Crime refers to a broad variety of unethical activities and actions involving fraud or falsification with the intent to deceive. Any criminal act marked by deception, concealment, or breach of confidence is referred to as a crime [12]. These actions do not require the use of weapons or actual violence. Parties and entities

commit criminal acts to procure income, goods, or services; to escape payments or lack of services, or to acquire private or corporate benefits. In other words, a crime is a malicious infringement against the public that society wants to prohibit and that is punishable by fines, incarceration, and/or death if convicted. There's no such thing as a crime only if it is described as such in the country's legal system [23], [7]. In this study, since the words crime and fraud are synonymous, they would be used interchangeably.

Fraud has a deleterious effect on businesses in many ways, including but not limited to physical, operational, and psychological. Although the financial damage caused by theft is significant, the total burden on a company can be immense. The damage to one's integrity, credibility, and customer relationships may be severe. Fraud has a significant impact on society, both in terms of its financial costs and the deterioration in victims' quality of living as a result of this. Since fraud can be committed by either internal or external employees, it is critical to have an appropriate crime prevention system in place to protect the organization's properties and image. It is as ancient as humanity, and it happens in varying degrees of seriousness. Society, on the other hand, will help to prevent and reduce violence. Several more crime-fighting agencies and programs are focused on societal and neighbourhood efforts.

The scope of criminal activity can be seen in all facets of life [12]. Deliberate deceit or misrepresentation to obtain certain shabby benefits in the form of healthcare spending is a crime in this field [7]. This can include things like giving people false and deliberately misleading claims, filing false bills or reports, lying about certificates or training, and delivering needless medical services or drug prescriptions, both of which deplete the healthcare system's funds. This makes it difficult for the healthcare sector to provide high-quality, safe care to legitimate customers, and it has prompted calls for a more robust crime-fighting scheme to eliminate drug activity and thereby improve the quality and lower the cost of healthcare services. It has been designated as a "high-risk" area in several countries, including the UK, Romania, Nigeria, and others, due to the vast number of cases registered, investigated, and prosecuted [7].

Healthcare fraud includes false providers, organized crime, extortion of patients, and patients who reap the benefits of their eligibility for health insurance proceeds. It

is classified into three categories: health insurance fraud, drug fraud, and medical fraud.

The majority of evidence on healthcare crime comes from health insurance fraud, which occurs when a company or individual defrauds an employer or a public healthcare agency due to the confidentiality of medical health records. In this article, an analysis of current healthcare fraud detection methods is conducted and a new framework is proposed to enhance effective healthcare administration in Nigeria.

The following are a few examples of the types of fraud being investigated by the NHIS;

#### For Staff

- Obtaining employment through the use of forged qualification certificates and references;
- Claiming for un-worked hours;
- Working while on sick leave;
- Claiming unpaid travel and other expenses;
- Managers acquiring goods and services for their use;
- Creating ghosts employees

#### For Ghosts Patients Contractors

- Creating ghost patients;
- Making claims for services rendered by ghost employees, such as the production of false prescriptions;
- Claiming services that were not provided (enhanced services);
- Creating bogus prescriptions for self-medication;
- Accepting bribes to register foreign visitors.

#### Other Service Providers

- Pharmacists claiming for medication that was not dispensed;
- Pharmacists claiming for services that were not rendered;
- Failure to declare prescription charges collected;
- Claims for ghost patients – (dentists and opticians)
- Dentists claiming more Units of Dental Activity than are provided;
- Opticians claiming NHIS allowances for individuals who are not entitled

#### For Patients

- Changing prescriptions to obtain more medication;
- Obtaining multiple registrations with GPs to obtain more medication;
- Overseas visitors using false documents to obtain NHIS services; and
- Patients selling their medication.

## II. REVIEW OF RELATED LITERATURE

Three forms of fraud are involved in the healthcare insurance system: the healthcare service manager, the healthcare client or claimant, and the policy user. While the bulk of service providers are trustworthy and ethical, a few unethical ones could cause significant harm to the healthcare system. This necessitates an investigation into certain

incidents to find perpetrators, thus prompting the use of a proper analytics tool [7], [17].

New technologies have made it easier to produce, capture, and store high-dimensional and complex data. A medical database is used to store a huge amount of data generated by medical technology. The number of records in a database, the number of fields or attributes associated with a record, and the complexity of the data itself all contribute to the growing size of medical databases [16].

The author describes the volume of data used in the payment process for a healthcare benefits plan that helps veterans and the disabled in the United States pay for medications [7]. The risk of fraud cannot be underestimated in such a dynamic system with many key players. Simultaneously, the accuracy of medical records must be maintained to prevent false claims [23].

Owing to these shortcomings in managing the magnitude, pace, range, quality, and complexity of data in the healthcare industry, traditional research approaches are ineffective [13], [6], [11], [3], and [2].

### A. Approaches to investigating Healthcare Related Fraud

Cluster mapping was proposed for the spatial examination of alleged fraud [13]. The focus of the research was on different forms of fraud perpetrated by a major authority. Some health insurance frauds, as pointed out, involve more than one party collusion or subversive fraudulent activities [6].

The authors use the knee-point k-means algorithm to create a data mining strategy for detecting fraud in health insurance schemes [11]. The National Health Insurance Scheme (NHIS) was used as a case study. The research reflects on the use of certain computer-based approaches as an aid to reduce healthcare providers with healthcare insurance fraud.

The act of engaging with the intent of obtaining a fraudulent result from an insurance process was analysed in a study on hybrid methods for fraud identification in health insurance [9]. To identify false representations, the approach used the benefits of supervised and unsupervised learning approaches. Similarly, a study of the advantages of big data analytics and the key approaches to be applied to cases of fraud in the Romanian public healthcare sector was introduced [19].

The authors introduced a model for solving real-time crime in cloud-based health insurance [5]. To identify possible frauds, this method employs a fraud management solution. The approach was built on a large amount of historical evidence, mathematical simulations that predicted the future, and social media analytics. Server modules such as applications and online servers are used to provide the services.

The authors developed a tool to identify and forecast possible frauds using big data, Hadoop, and analytics tools, which resulted in the identification of claim anomalies [7]. The approach was built on a large amount of historical

evidence from a variety of insurance companies and hospitals in a single geographic region. The work identifies the open-source predictive modelling framework's efficacy and performance. The study was also able to identify records that were incorrect or dubious.

A data mining-based fraud prevention method for health insurance fraud In the field of health insurance, this technique uses Evolving Clustering Method and Support Vector Machine for fraud detection[15].

Using supervised and unsupervised data mining methods, a model for identifying healthcare fraud and abuse was created [18], [14]. We considered the future definition of fraud in our study to report the real fraud. We obtained information on fraud from a variety of sources. Since the anticipated data is so huge, this study has used big data analytics tools to develop the Healthcare fraud detection System.

### *B. Overview of Health Insurance Scheme*

The case of this study is the Nigerian National Insurance Health Scheme. The National Health Insurance Scheme (NHIS) is a body corporate founded by the Federal Government of Nigeria under Act 35 of the 1999 Constitution to improve the health of all Nigerians at a reasonable cost. The aim of the National Health Insurance Scheme (NHIS) is to provide social health insurance in Nigeria, where contributors' health care services are paid from a common pool of funds contributed by Scheme participants [1].

It is a pre-payment contract in which participants pay a set fee regularly. The money is pooled, allowing Health Maintenance Organizations (HMOs) to provide for those that need medical care. It's primarily a risk-sharing agreement that can help with resource mobilization and equity. It is, without a doubt, the most widely used form of healthcare financing in the world. HMOs' private health insurance is also controlled by the NHIS. A link to the online HMOs list should be available from HMOs. Medical coverage is. Health insurance is a social security scheme that ensures the availability of needed health care to people in exchange for daily token payments.

However, like many other similar projects, NHIS has been characterized by poor service delivery, ineptitude, corruption, and lack of accountability, despite huge government financial intervention, thereby leading to stakeholder service quality concerns and disappointments [8]. These pressures have never been as profound as they now appear thereby, requiring scholarly attention.

### *C. How the National Health Insurance Scheme of Nigeria Operates*

This scheme is in charge of registering health maintenance organizations (HMO) and health care

providers in the country. It issues them with the right guidelines for the scheme and also determines after negotiation, capitation, and other payments due to the health maintenance organizations and health care providers. HMOs are tasked with receiving funds, providing payments to care providers for service rendered, and providing quality control. They may be privately or publicly operated. Primary care services are provided by registered private and public hospitals and clinics. Enrollees must enrol with a health maintenance organization, after which they must choose primary health care providers, and coordinate their access to secondary and tertiary care. The providers submit a claim to HMO, which is checked and approved to compensate participating providers for services rendered to beneficiaries [10].

## III. MATERIALS AND METHODS

### *A. Data Collection*

The data was gathered from the National Health Insurance Scheme (NHIS). The majority of the data was collected manually in paper form by NHIS via HMOs and deposited in file folders, making data gathering one of the most challenging tasks in this project. This was achieved by record analysis and observation, with data obtained from publications and NHIS repositories in both cases. Enrollment, update, referral, and claims data were separated into four groups.

The data are in the following formats: CSV, PDF, audio, excel, and images. The following are some of the data's attributes: Enrollment Information: Name, Gender, Date of Birth, Address, Gender, Next of Kin, Mobile, Fixed Telephone Number, Email address, Mobile, National ID number, Employer NHIS number, Date of NHIS registration, Nationality, Allergies, Posting Location, Photograph, Genotype, Blood group, Patient's name, Expiration date, NHIS number, Primary provider Claim: primary provider's name, and NHIS number, drug medication sheet, secondary provider's name and NHIS number, Detection code, date of treatment, care provided, amount billed, co-payment collected.

### *B. Analysis of the System*

The researchers have proposed the design and implementation of a healthcare fraud detection system. They have adopted the Use Case Diagram in the analysis of the proposed system. For the study, the use case diagram was used to depict user interactions as illustrated in Figure 1.

### *C. Design of the System*

To design the model of the scheme, two (2) separate types of diagrams were used: Use Case Diagram, a Unified Modelling Language (UML) used to analyse various systems, and Apache Hive Architecture and Flow Model. These were used to convert the existing model into a responsive model to help in the implementation of the healthcare system.

#### *a) Use Case Diagram*

Figure 1 illustrates the system's Use Case Diagram. It features eight (8) use cases (login/logout, upload data, analyse claims, analyse enrollment, analyse referral, analyse update, pre-process data, and report) and four (4) key

players (financial manager, data manager, contributory manager, and admin officer). These are discussed as follows:

*Login/Logout:* Security is essential for the system because it is designed to be used in a web-based environment. All users must have valid user credentials to access the system. The user must have these credentials before entering the device, and the system must agree that they are legitimate.

*Upload Data:* There are two ways to upload data to the system. The current data is first digitized and uploaded to the server, which is handled by the data manager. The data is uploaded via automated systems in the second process.

*Analyse: Claims.* This is the method of analysing claims that have been filed for reimbursement. There were two types of outcomes: dishonest and non-fraudulent.

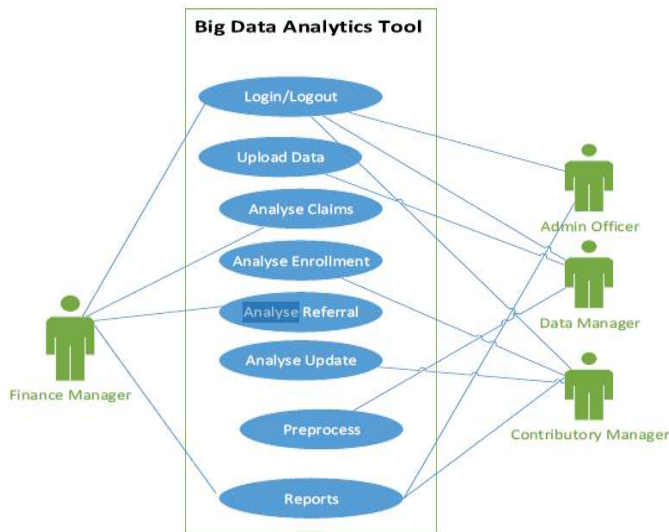


Figure 1: Use Case Diagram for the System

*Analyse Enrolment:* This is the method of analysing enrolment results for new registrations. There were two types of outcomes: fraudulent and non-fraudulent.

*Analyse Update:* This is the process of analysing updated data submitted for things like adding a dependent, changing the primary facility or HMO, and so on. There were two types of outcomes: dishonest and non-fraudulent.

*Analyse Referral:* This is the process of processing referral requests for patients to be referred to higher facilities. There were two types of outcomes: fraudulent and non-fraudulent.

*Data pre-processing (pre-processing):* The cleaning of data before it is sent for processing.

*Reports:* These are the reports generated after the evidence has been processed.

*b) Apache Hive Architecture and Model Flow Diagram*

In this study, the problem was solved by using Apache Hive and a conceptual framework for a deep learning algorithm (deep belief network). Apache Hive is a distributed and parallel data processing framework that runs on top of Hadoop. Figure 2 shows the Apache Hive diagram depicting the static features of the proposed flow of the model. This diagram depicts the various interactions between model components, analytics, and the results to be obtained, as well as the relationships between them. Figure

2 shows how real-world data is collected and loaded into a large data warehouse (Apache Derby DB) using the Hadoop Distributed File System (HDFS), which stores data and supports Hive Query Language. The MapReduce framework contained provides algorithms for distributed data processing that will be implemented. The architecture's multiple layers represent attributes of the data being processed from one layer to the next, simplifying the examination of fraudulent claims. An Advanced analytics diagram was used to create the pictorial representation of this model. As a test platform, the researchers used the Nigerian Health Insurance Scheme (NHIS).

IV. RESULTS

This research examined how the big data framework can be used to extract data, from the National Health Insurance Scheme (NHIS) to detect fraud. The Big Data framework considered is Apache Hive, which runs on Hadoop. The Hadoop Distributed File System (HDFS) implementation is used to store data. The MapReduce framework is used to deal with very huge data sets. The design of the system is shown in Figure 2.

The Hive Architecture and flow model used the MapReduce framework shown in Figure 2. Hive supports queries expressed in SQL-like declarative language-HiveQL. Hadoop is an open-source distributed computing platform for big data applications that implements data processing and storage in decentralized clusters of data centres. YARN is a Hadoop resource management tool that enables the parallel processing of data deposited across multiple HDFS collections. Figure 2 depicts the system in its conceptual form [21], [4]. The model took into account a large amount of data from this industry.

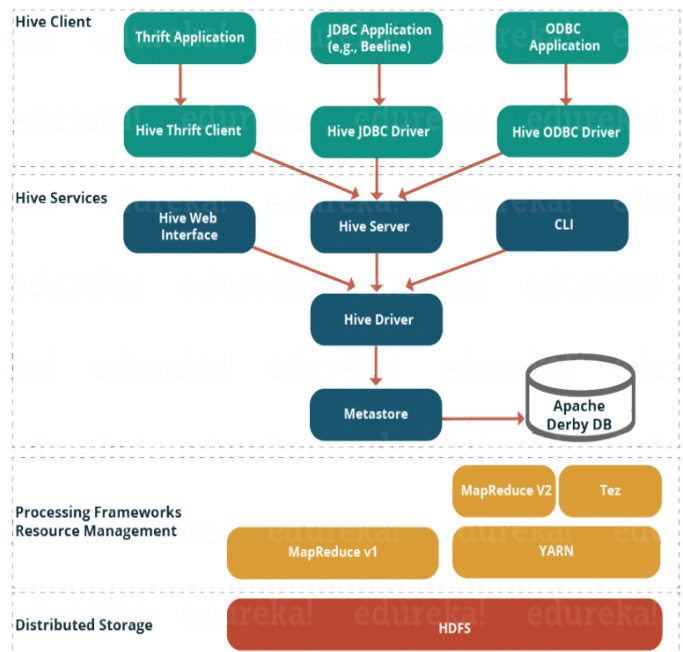


Figure 2: Hive Architecture and Flow Model

V. DISCUSSION

The system's implementation was created using Java Enterprise Edition technology. It is web-based and can be remotely accessed. A front end is created using Java Server

Pages while the application logic is built using Enterprise Java Beans. The backend is split into two parts: input storage is handled by Apache Derby DB, and output storage is handled by Hadoop Distributed File System (HDFS), which also supports Hive Query Language. The input storage (Apache Derby DB) accepts data in different formats (e.g., pdf, jpeg, png, gif, CSV and excel) as inputs and processes them to produce a report for the stakeholders which is stored in SQL-like declarative language-HiveQL. To make the processing of this data easier, the vast input in the various formats is first broken into smaller units using the Mining Algorithm, which is implemented in the MapReduce Framework. Through major modules, the system extracts the data stored in these forms.

The combined hybrid framework in deep learning algorithm makes it easier to identify incorrect or fraudulent information in submitted healthcare repositories and shows how hospital and other healthcare data can help detect healthcare insurance fraud[18];[13],[9], and [22].

The Hive Architecture can be divided into the following components:

*Hive Clients:* As a result of this study, Hive used JDBC, Thrift, and ODBC drivers to support applications written in a variety of languages such as Java, C++, Python, and others.

*Hive Services:* To execute requests, Apache Hive offers a variety of utilities such as the CLI, Web Interface, and others.

*Hadoop Framework:* This is indeed the result of combining MapReduce and Hadoop's Distributed File System (HDFS). It allows distributed parallel processing of large volumes of data through low-cost industrial sector servers that store and process the data. It can manage any kind of data from distressed networks, including unstructured data, application logs, images, audio files, communications files, and emails, independent of format files.

*Resource Management and Processing Framework:* Internally, Hive executes queries using the Hadoop MapReduce framework as the binding legal engine (Figure 3). The collected data must be converted into a homogeneous data set (this process is linked to edge detection, regularization, and feature extraction algorithms).

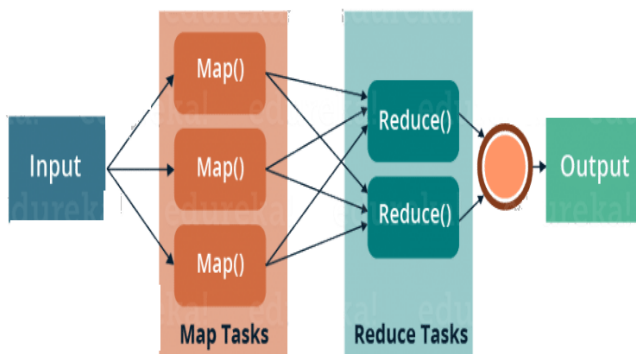


Figure 3: MapReduce framework

*Data Visualization:* Visualization allows users to communicate with the data, makes visual patterns visible, and makes these results fast and concisely.

*Analysis:* This component helps to create new features from the data attributes to increase the deep learning method's accuracy. The extracting features aim to identify the least possible amount of descriptors possible.

*Other Components:* This is followed by the development of the investigation report. Payment is made if the report shows no evidence of fraud, if it does; the audit is brought to the review panel for legal proceedings (injunction, litigation in a criminal court, and fund recuperation). The investigation came to an end at this stage, and everything is stored in the archive. Those who violate the law may be subject to monetary fines (charges, recovery of funds related to public trust or private sacraments), as well as industry regulations (such as termination of rights and protections, or prohibitions against providing services to NHIS service users).

## VI. CONCLUSION

In conclusion, this paper developed a system for the detection of healthcare fraudulent activities by using data from the National Health Insurance Scheme (NHIS.) The system was designed using Use Case Diagram, a Unified Modeling Language (UML), and implemented using Apache Hive. The system was able to detect several fraudulent activities; providers, insurers, and beneficiaries. This includes self-referral, collaboration with providers, and double billing. Verification of enrollees, ghost policyholders, duplicate billing, upcoding, and other issues Using Apache Hive and Big Data Analytics, a system for detecting healthcare fraud for NHIS is developed.

This research focuses on a specific aspect of big data analytics in Healthcare in NHIS, which had historically been inaccessible. As a result, the system can be usefully explored further to establish relics for future research in the fields of big data analytics and healthcare fraud detection. Based on the observations, interpretation, and review, It is suggested that this study be researched further. As a result, future research may use this framework, which has not yet been implemented. The application of this method to a healthcare case study will be the subject. Finally, this system when implemented by the National Health Insurance Scheme (NHIS) will no doubt be an asset to the Scheme.

## VII. LIMITATIONS

The study looks at the methods that are already in use and identifies where they fall short when dealing with big, structured and unstructured data. The process of finding and choosing materials was incredibly time-consuming and labour-intensive. However, it is manageable because carefully chosen articles that meet the extraction and analysis of data sets criteria were made.

## VIII. FUTURE WORKS

- i. There was limited access to data in NHIS, about incidences of fraud, further study can be conducted to determine the level of impact of fraud on the NHIS service users and the government.

- ii. The proposed framework can be further implemented as a fraud detection management system to effectively support the NHIS

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