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Research Article

Ensemble Technique on Predictive Analysis and Fraud Orders Detection using Supervised Machine Learning Algorithms in Supply Chain Management

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Abstract

Background: In this research article, the researcher developed a predictive model on fraud orders detection using ensemble approach of supervised machine learning algorithms in supply chain management. Fraud orders are the significant research issues in business industries with respect to supply chain management and logistics management activities it creates a misleading statistic and disrupting the entire business process. The researcher pointed out some of the significant research issues on fraud orders detection in supply chain management.

Method: The researcher used the ensemble techniques on predictive model which are based on different supervised machine learning algorithms. This research article intended to the comparative research study on different supervised machine learning algorithms and its accuracy level such as Logistic Regression 0.69, Random Forest Classifier 0.89, K-Neighbours Classifier 0.74, Gaussian-NB0.67, Decision Tree Classifier 0.88. This predictive model is verified at 89% accuracy level and can be capable to handle imbalance training datasets and predict the sales and orders are in category of fraud or not.

Results: The researcher handled the imbalance datasets with accuracy level of 89% to identify the orders are in category of fraud or not. The researcher used the sales and orders datasets from Kaggle and refined the data with data pre-process process. During the data analysis process the data are passed through the different supervised machine learning algorithms and finally the researcher found that Random Forest Classifier given the 89% accuracy level to classify those orders are in category of fraud or not. One of closer predictive

model-based Decision Tree Classifier which is also given the 88% accuracy level and very close to Random Forest Classifier.

Conclusion: Finally, the researcher concluded that the ensemble approach of predictive model is based on Logistic Regression, Random Forest Classifier, K-Neighbours Classifier, Gaussian-NB, Decision Tree Classifier on Fraud Orders Detection Using Supervised Machine Learning Algorithms in Supply Chain Management. This predictive model is verifying at 89% accuracy level to classify whether the orders are in category of fraud or not. The researcher assure that the predictive model would be benefited for the industries in supply chain management and logistics management to identify the sales and orders are fraud or not and enhanced the business process and operational activities.

Keywords: *Logistics, SCM, Machine Learning, Ensemble*

Introduction

In an area where time and resources can make or break a company line, speculative analytics is no longer just a useful bonus feature to have in logistics; it is a necessity. The modern procurement market demands more than ever: businesses across the supply chain are now expected to easily adapt shipping patterns, predict customer behaviour, provide timely delivery through highly efficient routes, and reduce the risk of inventory errors and miscalculations.

So, what exactly is predictive analytics, and why is it so important to logistics and supply chain? Predictability models use historical and trading data to identify risk patterns and opportunities within a particular set of circumstances, which helps guide decision-makers and anticipate future events. The guesswork solution can serve a wide range of different needs but brings a larger amount if it is designed for a specific type of work and is based on a set of rules and restrictions for that particular function. How can you ensure effective procurement management? This is an open question for many suppliers, distributors, manufacturers and retailers. Today, amid the changing market power of commodities, changing operating systems, the ever-increasing demand, businesses are wondering how to make their purchases less vulnerable to disruption. Machine learning captures the answer to many well-known challenges and emerging procurement challenges. Use machine learning cases in the supply chain are many. The benefits of machine learning and AI can be applied to all aspects of the supply chain including procurement, manufacturing, asset management, inventory, shipping and customer processing.

Logistics management is the backbone of the country's economy and development. Improving the efficiency of the commodity sector is important for the country's economy because it increases economic growth, increases exports to global supply chains, and creates jobs. The high cost of entry into India is due to a number of factors, including poor policy environment, lack of multi-modal transport system and thus greater reliance on road transport, weak storage infrastructure, the presence of multiple stakeholders in all transport and a number of storages, road infrastructure and infrastructure, road infrastructure and infrastructure. and a lack of technology in transport / storage and distribution operations (NITIE.2020).

Lıterature Revıew

Saeid Sadeghi et.al., (2020) said in today's competitive markets, the development of information technology, rising customer expectations, global trade, and other modern

competitive priorities have forced organizations to change. Therefore, competition between businesses is replaced by competition between businesses and their supply chains. which can help organizations overcome their problem [1]. Mahya Seyedan and Fereshteh Mafakheri (2020) emphasized that big data analytics (BDA) in asset management (SCM) is receiving increasing attention. We differentiate these algorithms and their application to transaction management in time series forecasts, interactions, K-closest neighbours, neural networks, regression analysis, vector support mechanisms, and vector regression support [2].

Raul Valverde and Kraus Cornelia (2014) argue that large amounts of data and the inability to analyse themselves make counterfeit activities invisible in procurement management processes such as procurement, warehouse management and asset management. This research study showed that the analysed data analysis complied with Benford's theory and that the parameters maintained by the parameter with Dynamic SQL provide an excellent tool for analysing data in the transaction list to detect possible fraud [3]. Iman Ghaleh khondabi et. al (2020) stated that the descriptive analysis, classification, and material testing. In terms of both information technology development and data acquisition, many companies use large amounts of data in their supply chains, have focused more on the use of big data in forecasting analysis, rather than on the other three types of data analysis: descriptive analysis, diagnostic analysis, and randomized analysis [4].

Nenad Stefanovic (2014) analysed that today’s business climate requires supply chains to work rather than function, requiring a new approach that incorporates data analytics. This paper introduces a sales performance management model that includes process model, performance measurement, data mining models, and web portal technology in a unique model [5]. Global competition will eventually suffer from these high travel costs. Cost of order processing, shipping costs, handling and storage costs, storage costs, acquisition costs, handling costs, administration costs, and packing costs are the main costs of inventory costs. Travel costs are rising in various industries lie among the fastest growing sectors in the world economy (NITIE.2020) [6].

Uthaya sankar Sivarajah et.al., (2017) stated that Big Data (BD), with its ability to access valuable information for an advanced decision-making process, has recently attracted great interest from both educators and practitioners. The analytics process, including the deployment and use of BDA tools, is seen by organizations as a tool to improve efficiency despite strategic strengths, drive revenue streams and gain competitive advantage over business competitors [7].TN Varma and Danish Ali Khan (2014) emphasized that the growing growth of Information Technology (IT) and communication technology in Supply

Chain Management (SCM) plays a key role in increasing network flow decisions to provide organizational competition, high service level development , depreciation, purchasing costs and electronic risk reduction (ie-risk) [8].

Tahereh Pourhabibia, et.al., (2020) Methods for detecting Graph-based anomaly (GBAD) are among the most popular methods used to analyse connection patterns on communication networks and to identify suspicious methods, challenges that require significant research efforts to increase the reliability of this approach. In addition, we offer recommendations for addressing these challenges [9]. Dino Knolla et.al., (2016) said the manufacturing industry is being severely affected by global trade patterns and the increasing power of product life cycles leading to global procurement networks. Using machine learning, general knowledge of management processes can be extracted and used to predict future conditions [10]. Urenna Nwagwu et, the correct method of obtaining information was adopted by the predictable learning environment Several phases of learning-based learning have been used to create a predictive learning platform for multiple learning but with minimal emphasis on classifiers working to adapt to meet the time of a trained model [11].

Xuan V. Pham et.a., (2020) argued the use of forecasting statistics in Supply Chain Management (SCM). However, most of them focus exclusively on certain other activities in procurement management, including Procurement, Demand Management, Logistics and Transportation, or only technical aspects. The purpose of this paper is twofold: first, it aims to provide a detailed description of the outstanding asset management functions (SCMF) that work through forecasting analysis; and second, to highlight practical methods, algorithms, or models in SCM with a comparative review of the machine learning method for predictive analysis [12]. Petri HeloORCID Icon & Yuqiuge Hao (2021) working on the development and evolution of information technology, competition has improved significantly around the world. This research study provides an overview of the concept of AI and SCM. It also focuses on timely and critical analysis of AI-driven procurement and consumer-driven research. In this experimental study, emerging business models based on AI for companies of different cases are analysed [13].

Ilie-Zudor et. al (2020) explores how existing components and objective-driven research have been integrated to find a solution that has been developed in a global network of truck loads [14]. Felipe, C. M et. al., (2016) In addition to providing a comprehensive overview of today's data, the findings show that today's methods and techniques may have a process of transparency that can occur in a large, unidentified network where assets, reporting lags and incomplete data exist, but processes are sensitive to policy changes. insufficient. The methods

presented in the paper were found to be valuable in improving process efficiency, transparency and planning in asset operations [16]. Pierre Benaddi (2020) According to the 2020 MHI Annual Industrial Survey, the number of supply chain managers using predictive analytics has grown from 17% in 2017 to 30% in 2019. statistics plan to do so by 2025 [15].

Garver, M. S. (2019) given strong belief among companies that forecasts have the potential to completely transform transactions. Its introduction helps commodity and supply companies meet the growing demand. In fact, the retail industry has identified speculative figures that have had a significant impact on sales over the past decade [19]. The organization that oversees performance is already widely accepted among industry decision-makers. Indeed, a study conducted by the Supply Chain Management Council found that 93% of exporters and 98% of foreign firms felt that data-driven decision-making was essential to delivering procurement services, and 71% of them believed that big data improved quality and performance [18].

Carrión, G. C et.al., (2016) For these purposes, the details of the relevant texts were collected and reviewed. Accordingly, this article will introduce the details, algorithms, and models used in the analytics of its prediction and performance, the tax results of SCM, which include all the elements necessary for the effective operation of SCMF [18]. Hair, JF, and Sarstedt, M. (2021) Many companies have benefited from performing analytics of workflow, resource sharing, decision making, etc. cloud service to measure their business by relying on business-based speculation models to drive their workflow through a cost-effective decision-making process to improve their forecasting and accountability skills with real-time analytics [19]. Dr Sourabh Singha Roy and Prachuab Trinikorn (2021) discussed fraud increases in sales orders and the perception of fraud is needed to reduce the risk with help of machine learning predictive model in current business Industries [20].

Problem Statement And Research Objectıves

Businesses can improve their supply chain management through machine learning that enables them to withstand any disruption. The global commodity market is facing uncertainty, volatility, and a lack of visibility. According to a recent Supply Chain Complexity survey conducted by Körber, only one in 10 businesses can keep up with its procurement challenges. In addition to growing customer expectations, visibility, and operational difficulties, companies now face unique challenges: travel problems, remote work, shortages due to unexpected demand increases, fraud orders etc. According to McKinsey, there are 5 major sources of exposure to epidemics. Also, the use of machine

learning software acts as a pre-service plan on how supply chain professionals should begin to address major procurement issues. The researcher stated some of the key objectives on ensemble technique on predictive analysis and fraud orders detection using supervised machine learning algorithms in supply chain management which are as:

1. To identify the key attributes of supply chain management
2. To study the different predictive model and its accuracy on fraud orders detection using supervised machine learning algorithms.

Research Desıgn And Methodology

During the thorough analysis of datasets on ensemble technique on predictive analysis and fraud orders detection using supervised machine learning algorithms in supply chain management the researcher found that sales and orders datasets are having some outlier's data which would create a misleading statistic for the predictive model. The researcher identifies the Supply Chain Management datasets and analyzes those 180519 entries are having which are represented the overall data representation, the data considering for the training and testing to the predictive model on Supply Chain Management on fraud orders detection classifications.

The researcher used the data set with 180519 entries where 144415 for training dataset and 36104 entries for testing dataset for classifier to classify the data in terms of 80:20 ratio. The entire datasets are represented as follows:

1. Let the complete datasets be represented D={D1 ,D2, D3, D4…….D180519},
2. Let the training datasets be presented as Train={D1 ,D2, D3, D4……D36104},
3. Let the test data be represented as Test={D36105 ,D36106, D36107…….D180519},

The splitting of dataset is based on the random manner, system automatically divided the two different datasets in terms of ration 80:20 manner which is one of the standard mapping parameters to train and test the dataset in machine learning model.

Dataset Description: Sales and Orders

Range Index: 180519 entries, 0 to 180518

Data columns/Features (total 53 columns):

Source of Data : Kaggle

Table 1.1: Nature of Sales and Orders Dataset

S. No. Description -Dataset	Status/Type of Data
1 Days for shipping (real)	null int64
2 Days for shipment (scheduled)	null int64
3 Benefit per order	null float64

4	Sales per customer	null	float64
5	Delivery Status	null	object
6	Late_delivery_risk	null	int64
7	Category Id	null	int64
8	Category Name	null	object
9	Customer City	null	object
10	Customer Country	null	object
11	Customer Email	null	object
12	Customer Fname	null	object
13	Customer Id	null	int64
14	Customer Lname	null	object
15	Customer Password	null	object
16	Customer Segment	null	object
17	Customer State	null	object
18	Customer Street	null	object
19	Customer Zipcode	null	float64
20	Department Id	null	int64
21	Department Name	null	object
22	Latitude	null	float64
23	Longitude	null	float64
24	Market	null	object
25	Order City	null	object
26	Order Country	null	object
27	Order Customer Id	null	int64
28	order date (DateOrders)	null	object
29	Order Id	null	int64
30	Order Item Cardprod Id	null	int64
31	Order Item Discount	null	float64
32	Order Item Discount Rate	null	float64
33	Order Item Id	null	int64
34	Order Item Product Price	null	float64
35	Order Item Profit Ratio	null	float64
36	Order Item Quantity	null	int64
37	Sales	null	float64
38	Order Item Total	null	float64
39	Order Profit Per Order	null	float64
40	Order Region	null	object
41	Order State	null	object
42	Order Status	null	object
43	Order Zipcode	null	float64
44	Product Card Id	null	int64
45	Product Category Id	null	int64

46 Product Description	null float64
47 Product Image	null object
48 Product Name	null object
49 Product Price	null float64
50 Product Status	null int64
51 shipping date (DateOrders)	null object
52 Shipping Mode	null object

In this research study the researcher used the 53 attributes/features of orders and sales dataset which are describe ethe complete structure of dataset. During this research study the researcher eliminated some attributes such product_id, order_id, sales_id and other attributes which are not playing a significant role towards this research study.

Research Desıgn and Methodology

In this research study the researcher used the different machine learning algorithms to build the optimum accuracy of predictive model on cardiovascular-disease using ensemble techniques - supervised classification algorithms in health care industries. The researcher used and explored the decision tree classifiers, random forest, K-neighborhood and support vector machine classifiers to find out which predictive model is more efficient for the accuracy point of view to predict cardiovascular-diseases problem in patients on the basis of their patient's previous cases history.

5.1. DECISION TREE CLASSIFIER

Decision trees use multiple algorithms to decide to split a node into two or more sub-nodes. The creation of sub-nodes increases the homogeneity of resultant sub-nodes. The decision tree splits the nodes on all available variables and then selects the split which results in most homogeneous sub-nodes.

$E(T,X)=\sum_{c\in X} P(c)E(c)$…….(1)

T=Target Variables whereas X= Features/ Independent Variables

Decision trees are used for handling non-linear data sets effectively. The decision tree tool is used in real life in many areas, such as engineering, civil planning, law, and business. Decision trees can be divided into two types: categorical variable and continuous variable decision trees. For the next node, the algorithm again compares the attribute value with the other sub-nodes and move further. It continues the process until it reaches the leaf node of the tree. The complete process can be better understood using the below algorithm:

Algorithm:

Step-1: Begin the tree with the root node, says S, which contains the complete dataset.

Step-2: Find the best attribute in the dataset using Attribute Selection Measure (ASM).

Step-3: Divide the S into subsets that contains possible values for the best attributes.

Step-4: Generate the decision tree node, which contains the best attribute.

Step-5: Recursively make new decision trees using the subsets of the dataset created in step -3. Continue this process until a stage is reached where you cannot further classify the nodes and called the final node as a leaf node.

5.2. RANDOM FOREST CLASSIFIERS

Random forest is a supervised learning algorithms which is used for both classification as well as regression. It is mainly used for classification problems. As the researcher emphasized that forest is made up of trees and more trees means more robust forest. Random forest algorithms create decision tree on the data samples and then get the prediction on each of them and finally select the best solutions by means of voting. It is an ensemble method which is better than a single decision tree because it reduces the over fitting by averaging the result.

Algorithm:

Step-1: First start the selection of random samples from a given dataset.

Step-2: Next, this algorithm will construct a decision tree for every sample then it will get the prediction result from every decision tree.

Stept-3: In this step, voting will be performed for every predicted results.

Step-4: At last, select the most voted prediction result as the final prediction result.

5.3. K-NEAREST NEIGHBORS CLASSIFIER

It is an algorithm which classifies a new data point based on its proximity to other data point groups. Higher the proximity of new data point from one group, higher is the likelihood of it getting classified into that group. Distance between data points is measured by distance metrics like Euclidean distance, Manhattan distance, Murkowski distance, mahalanobis distance, tangential distance, cosine distance and many more.

For the data points X and Y with n features

X=(x1, x2, x3, x4, ……xn) and Y=(y1, y2, y3, y4,…….yn)

$D(X,Y) = (\sum_{1=1}^{n}(|xi - yi|)^{p})^{1/p}$ …….(2)

For data points X and Y with n features

Using the distance metrics, it is easy to create neighborhood of n closest neighborhood to the new data point. to get the class of the new data point, we look at the class groups which have more data points in the created neighborhood and the class groups which are closer to our

new data point compared to other groups in the neighborhood, based on these two factors we determine the class of our new data point.

5.4 LOGISTICS REGRESSION

The logistics regression/classifier is base the sigmoid function which values are ranges in between 0 and 1, but never exactly at those limits

F(x)=1/(1+e^-z)

Y= e^(b0 + b1*x) / (1 + e^(b0 + b1*x))

Where Y is predicted the output or target variable, b0 is the bias or intercept term and b1 is the coefficient for the single value (x), each feature of the input data is associated b coefficient that are earned from the training datasets.

5.5 GAUSSIAN NB Model:

In this research paper the researchers used the Gaussian Model which is useful in statistical probabilistic modelling based on normal distribution data obtained explicitly. A Machine Learning (ML) algorithm is also involved to measure the similarities between seen and unseen data points, and to predict the value for unseen point from training data.

Gaussian model: $f(x) = ae^{-\frac{1}{2}(\frac{x-\mu}{\sigma})^2}$

To optimize the result the researcher used the Gaussian process model. It can provide the assessing the partitions of data by considering each component for probabilistic method.

Results and Dıscussıon

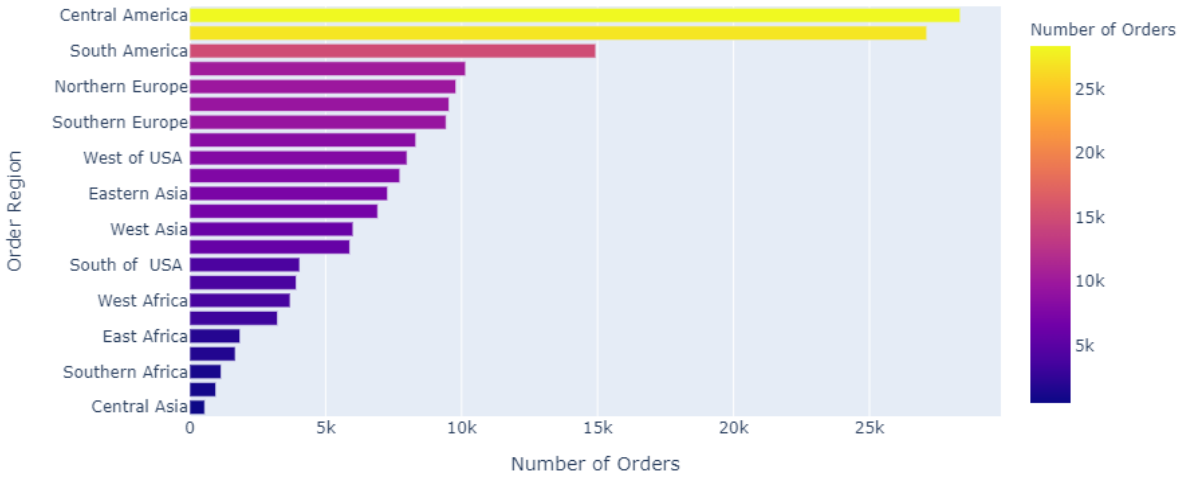

Fig.1.1: Statistical analysis of number of orders and region

The data analysis report shows that Central America, northern Europe, south Europe and South America are having the maximum orders whereas central Asia, south Africa, East

Africa are the least orders. The fraud orders cases of found in the region which are having maximum orders. During this process supply chain management provides a significant role for smooth functioning. To provides the prevention from the fraud orders , the researcher strongly recommended for this predictive model which is having 89% accuracy level(Fig.1.1).

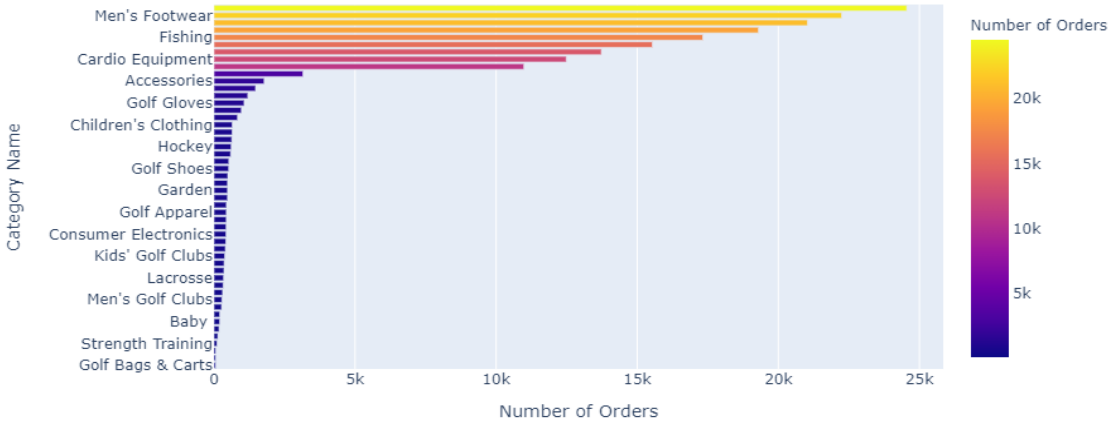

Fig.1.2: Statistical analysis of number of orders and products category name

The above data analysis report shows the number of orders and different category of products, the statistical analysis report showing that number of orders are increased for the category of Men's Footwear, Fishing, Cardio Equipment. The number of fraud cases are increased in high orders of sales of different categories of products. To control the cases of fraud orders detection this predictive model playing a significant role and approved accuracy level 89% with different ensemble approach of machine learning algorithms (Fig 1.2).

Table 1.2: Forecasting: Predicting on orders is Fraud or Not

S. No	Predictive Model	Accuracy
1	Logistic Regression	0.6906918386309326
2	Random Forest Classifier	0.8929085277657611
3	K-Neighbors Classifier	0.7423094244520747
4	Gaussian-NB	0.6718960851534189
5	Decision Tree Classifier	0.8857624272160016

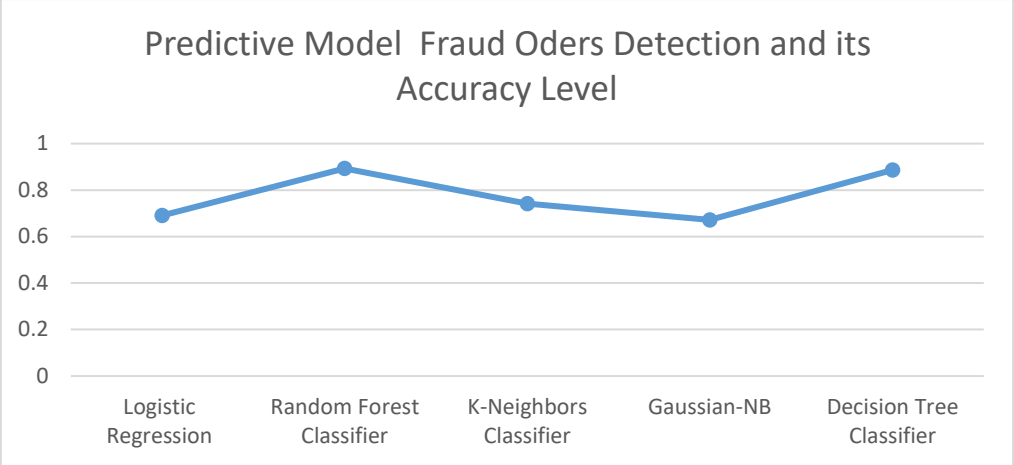

Fig.1.3: Predictive model fraud detection and its accuracy level

The above data analysis report is based on ensemble approach of different categories of supervised machine learning techniques which are produced the different accuracy level of prediction such as Logistic Regression 0.69, Random Forest Classifier 0.89, K-Neighbors Classifier 0.74, Gaussian-NB0.67, Decision Tree Classifier 0.88. The predictive analysis report shows that Random Forest Classifier produced the highest level of accuracy to predict the fraud orders detection at 89% , the second predictive model which is based on Decision Tree Classifier produced the second highest level of accuracy to identify the fraud orders detection at 88% . Finally, the researcher concluded that the predictive model which is based on Random Forest Classifier is having the highest level of accuracy to predict the fraud orders detection in supply chain management. The researcher assured that the predictive model would be benefited for the business industries to identify the fraud orders detection and enhance the business process for smooth functioning (Fig. 1.3).

Summary And Conclusıon

In the current competitive environment, service providers have a problem handling large amounts of data in order to achieve integrated, efficient, effective, and fast acquisitions. Thus, the explosive growth in volume and diversity of data across the supply chain has created the need to build technologies that can intelligently and quickly analyse large amounts of data (Saeid Sadeghi et.al., 2020). This is because the analysis of speculation on obtaining fraud orders has a variety of applications in SCM, including customer analysis, practice analysis, fraud detection orders and demand forecasting. In this research article the researcher developed a predictive model for fraudulent acquisition orders using an integrated approach to machine learning algorithms and the important use in supply chain predictions to suggest the fragmentation of these systems, identify gaps, and provide insight into future research.

Finally, the researcher used the different supervised machine learning algorithms and found the accuracy of predictive model such as Logistic Regression 0.69, Random Forest Classifier 0.89, K-Neighbours Classifier 0.74, Gaussian-NB0.67, Decision Tree Classifier 0.88. This predictive model is approved at 89% accuracy level to predict the sales and orders are in category of fraud or not, at this level the researcher is given assurance to implement in business industries to control the sales and orders services in supply chain management system (SCM).

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