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A Product Backorder Predicting System for Supply Chain Management

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ABSTRACT: The aim of the study was to predict backorders in the supply chain. The research was a comparative study of Logistic Regression, Random Forest, Boost ,Adaboost and the Ensembled Model of Random forest and XGBoost .The paper detrmined the best model to classify products with the highest likelihood of becoming back order. This would enable the company to reduce lead time and provide customer satisfaction. This will give the company time to meet client expectations and improve the supply chain. Out of all the models the ensembled model of Random Forest and XGBoost performed best with an AUC of 0.96.

KEYWORDS: Back-order, Back-Order Prediction, Supply Chain, Machine Learning

I. INTRODUCTION

It's crucial to always have enough inventory in order to satisfy client demand, however if inventory is constantly expanded in an effort to boost availability, this may result in greater storage costs and drained capital, which means there may be periods when the product is unavailable. Backorders occur when a customer orders a product that is not in stock, temporarily out of stock, or not being produced in sufficient quantities and chooses to wait until it is available and guaranteed to be delivered [1]. If backorders are not resolved quickly, the business may lose customers to competitors, which will affect revenue, share market price, etc. There is a considerable risk that the business may lose a customer to a rival if the backorders are not promptly resolved, which will also have an effect on earnings, reputation, share market price, etc. The various levels of supply chain management may be under extreme strain when steps are taken to fulfill or minimize backorders. Increased labor, production, transportation, and warehouse expenses may result from actions taken to fulfill or reduce backorders. Even if not all of these back orders may be prevented entirely, anticipating them and taking preventive action in advance may shorten lead times and lower costs.

This study suggested a comparative study of Logistic Regression, Random Forest, XGBoost ,Adaboost and Ensembled Model of Random forest and XGBoost to find backorder trends before customers order. This will enable the company to adjust to reduce customer service delays and provide accurate dates. Predictive analytics gives the company time to meet client expectations and result in improved performance. Back Order Prediction uses machine learning to predict product backorders which will reduce costs. According to the research[2], parts with the highest likelihood of scarcity may offer a significant opportunity to improve organization performance.

II. RELATED WORK

Research was done for Danish craft beer companies, on backorder prediction using machine learning [3]. According to the study, the demand for craft beers significantly increased. They needed strategies to deal with the circumstance in which they cannot meet the demand based on experience. A precise backorder forecasting was required for the producers because of the limited production capacity. Based on producers' historical data, a machine learning prediction method was utilized to forecast upcoming backorders. A comparative study of Random Forest, XGBoost , Light Gradient Boosting Machine and BB was carried out. After calibration, the LGBM model was the best performing model with an AUC score of 0.95

Furthermore, research was carried out on supply chain backorders using distributed random forest (DRF) and gradient boosting machine learning algorithms [4]. Due to its ambiguity and inflexibility, machine learning algorithm prediction is unsuitable for many businesses decision processes. To handle complex real-time data caused by automated or human error, a range technique was used to create many tiers of predictive features. Adjustable

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range gives decision-makers freedom. To explain, tree-based machine learning was chosen. The machine learning models we increased by 20%.

Additionally, research was done using machine learning techniques the focus of the study was on supply chain risk management through managing backorders [5]. The aim of the study was to predict product backorder using machine learning in the area of business decision-making while allowing the authority to make decisions some degree of flexibility, enhancing the process's clarity, and maintaining higher accuracy. The LGBM model, calibrated using the Isotonic Regression approach, performed the best, with an AUC score of 0.95 compared to the RF, XGB, LGBM, and BB models. According to the study, a product's inventory supply, the number of units that can be supplied, the current demand (sales), and a precise forecast of the future demand can all have a significant impact on how well backorders are forecasted. The use of resampling methods to manage unequal data is the weakness in this work.

III. METHODOLOGY

The problem, was a binary classification problem. The aim is to classify whether will go to back order or not.

Data

The Dataset was found on Kaggle “Can you Predict back Orders”. The dataset has a total of 23 features, including the objective variable and 15 numerical features. The features are shown below:

- SKU - product ID
- national inv: Component inventory.
- Lead time: Product transit time, or how long it takes a shipment to reach its destination after being picked up.
- in transit qty: Source-to-destination product quantity.
- Forecast columns: Projected product sales for 3,6,9 months.
- Sales quantity for 1,3,6, and 9 months.
- min bank: Recommended stock minimum.
- Pieces past due: Any overdue product parts.
- Product performance average over 6 and 12 months.
- deck risk,oe constraint,ppap risk,stop auto buy,rev stop: Product flags.
- target variable: went on backorder.

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Architecture

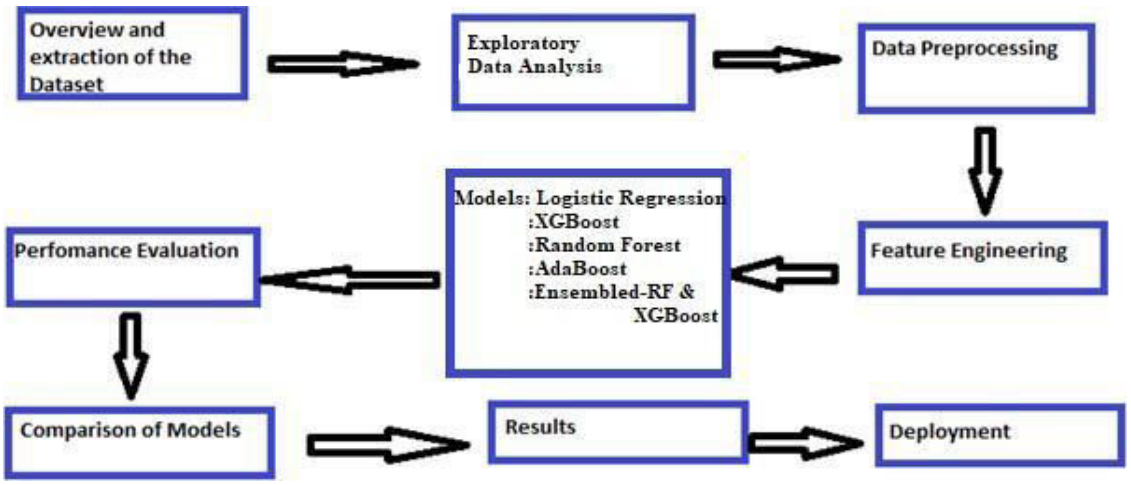
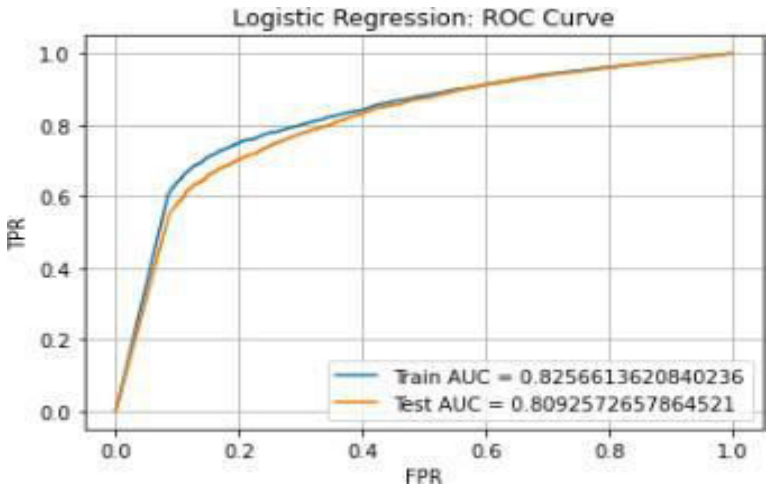


Figure 1:Architecture

IV. RESULTS

A comparative study was carried out of five models. The models were as follows: logistic regression, Random Forest, XGBoost, AdaBoost and an ensembled model of Random Forest and XGBoost. The aim was to find the best model in predicting product back order. The Receiver Operating Characteristic Curve (ROC AUC) Score was used to measure the performance of the models. The ensembled model was the best performing model with an AUC of 0.96. Below are the results of all the models:

a. LOGISTIC REGRESSION



ROC AUC: 0.81

The probability that a random positive sample will be positioned to the right of a random negative sample is 0.809 percent. Furthermore, this indicates the model's impressive aptitude for foreseeing class-specific backorders.

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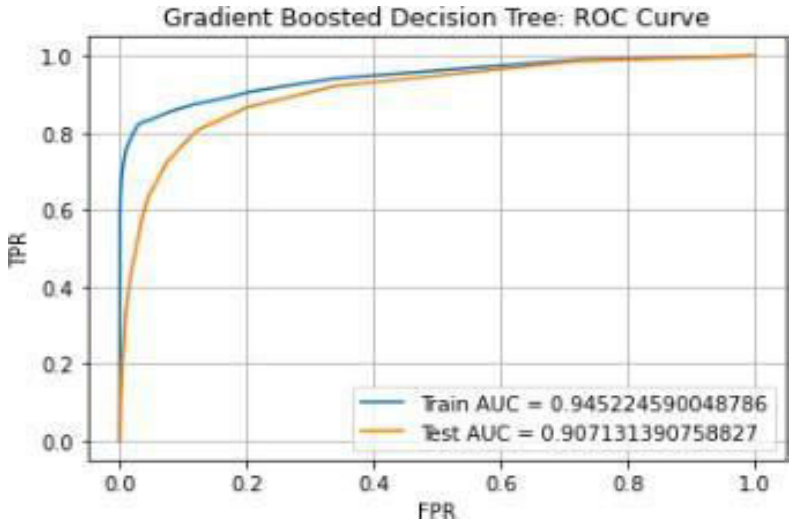
b. XGBOOST



ROC AUC is 0.907

Area under the curve equals 0.907%, which indicates that there is a high probability that a positive example will be placed to the right of a negative example. This displays the model's capability of foreseeing supply shortfalls and backorders.

c. ADABOOST

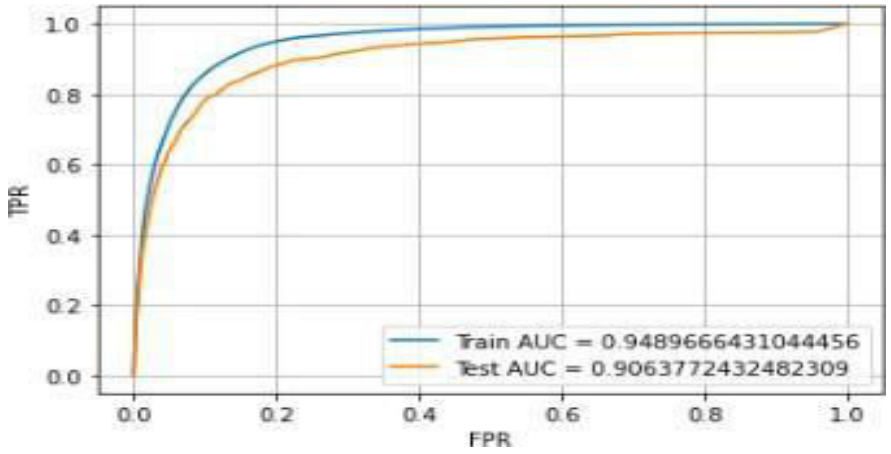


Figure 4:AdaBoost AUC

AUC is 0.906

The probability of a random positive example being placed to the right of a random negative example is 0.906. This indicates that the model is capable of accurately predicting backorders.

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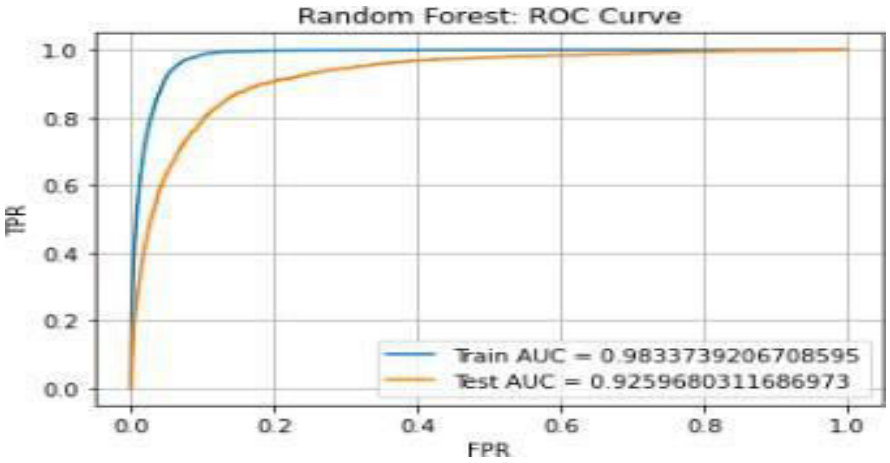
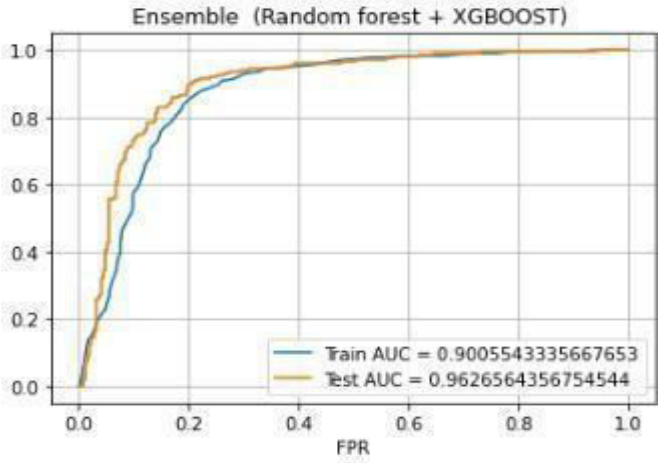
d. RANDOM FOREST



AUC: 0.926

There is a 0.926% chance that a randomly selected positive example will be put to the right of a randomly selected negative example. Proof that the model can accurately foresee future backorders.

e. ENSEMBLE MODEL: RANDOM FOREST AND XGBOOST



AUC 0.96

The probability of a positive example being put to the right of a negative example is 0.960 percent. As a result, it's clear that the model can reliably predict future backorders. This model has the highest AUC proving to be the best model.

f. Overall Comments

It was noted that the Ensembled Model had the best AUC of 0.96

V. CONCLUSION AND FUTURE WORK

- From the results, this paper recommends the ensembled model i.e. Random Forest and XGBoost. It had the Best AUC. This was an improvement from the other researches including Ntakolia et al (2021) which had an AUC of 0.95

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To the Production Manager

- It was noted that products with low stock where most likely to be back order
- Forecasted Sales i.e. Demand were highly correlated to the actual sale. Hence this shows the importance of demand forecasting in improving the earnings of the business.
- Demand forecasting was also noted to be important so that it help the manger avoid keeping few stock that what is required by the market which will result in back orders
- To help in managing the backorders, a predicting system was noted to be a necessary tool.

VI. FUTURE WORK

This research only covered features that were represented in the dataset. A consideration into taking into account issue that cannot be represented in the dataset can be done for example Economic environment.

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BIOGRAPHY

Kudzai Modester Sabata is a Master of Technology Honors Degree student in Software Engineering at Harare Institute of Technology (2022), in the School of Information Science and Technology and Department of Software Engineering. She has a Bachelor of Technology Honors Degree from Harare Institute of technology (2018).

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