

# Predictive Analytics for Inventory Optimization in Manufacturing

B R S Mendis

General Sir John Kotelawala Defense University

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**Abstract**—Accurate demand forecasting is important in the biscuit manufacturing business to optimize inventory management, maintain operational efficiency and reduce costs. Currently, the scenario subjected company has produced over 50 products under different brand names as well as SKUs. To get demand forecasting, they rely on the manual methods conducted by the sales and administration and marketing departments. These manual methods are performed using tools like excel, they are prone to errors, data duplication, and inefficiencies which are leading to unreliable forecasts and dependencies on individuals. To address these challenges, this project aims to develop predictive analytics forecasting models. To build this model, machine learning techniques will be employed such as Random Forest, Time series and Regression which will be used to analyze historical sales data to identify the trends and patterns, capture complex relationships and find external factors influencing demand. Model creation will enhance the accuracy of demand, inventory management, and improve the decision-making process of the company. The future outcome of this project, the company will be able to meet customer demands in a better manner, reduce inventory costs, and maintain a competitive edge in the market.

**Keywords**—Demand forecasting, Biscuit manufacturing, Inventory management, Machine learning.

## I. Introduction

The biscuit manufacturing industry is a dynamic sector characterized by a diverse range of products and intense market competition. Companies under this industrial category provide a wide range of products under different brand names and SKUs (Stock Keeping Units). So, the biscuit manufacturing industry is considered as a competitive environment in the Sri Lanka as well as the world, in such competitive environment, the accurate demand forecasting is crucial to maintain an efficient inventory management, to optimize production process, and controlling the costs. Two of the principal production costs involved are depreciation of the production line and wastage arising from product which is out of specification. [1] Forecasting demand involves predicting future product demand based on historical data, market trends and patterns, and other factors influencing. Accurate demand helps the companies to align their production schedules as well as distribution channels with anticipated demand, this reduces the risk of overstock and helps to enhance customer satisfaction. The company I focus on is a privately held mass production enterprise specializing in the manufacturing of biscuits, and along with some other categories such as agricultural and cereal products and milk products. However, 60% of the company's production, and sales and distribution are rooted in the biscuit manufacturing sector, which maintains the company's stability and growth. With a workforce of over 1000 employees, the company caters for both local and international markets, producing and distributing biscuits under various brand names. The company's end customers are sales representatives and outlet bases, who purchase and distribute the products to consumers worldwide. Sales are considered as the primary driver of this company's profit and wealth. In this context, accurate demand forecasting has become important, as it directly influences the sales outcomes and overall business performance. The demand forecasting process requires handling sensitive data to predict future market needs accurately, ensuring that the company can meet the customer demand efficiently and sustain in the competitive global market. Currently, the company manufactures over fifty different biscuit products, each associated with a distinct brand and SKUs. To forecast demand for these products producing, the company relies on manual methods prepared by sales and administration, and marketing departments. These methods are conducted with the help of tools like excel spreadsheets, where the data collected from a system stored and entered in a blank space, manipulated, and analyzed to generate forecast. As this practice is a traditional and manual practice, it will produce challenges that undermine the accuracy and reliability of the forecast obtained. The limitation of the current forecasting methods highlighted the urgent need for a more robust and automated approach. The inefficiency associated with manual forecasting will not only affect the accuracy of demand predictions but also lead to an increment of operational costs and reduced agility in response to market changes. As the industry continues changing consumer preferences, market competitions and market conditions, the company must adopt advanced forecasting techniques to stay competitive, strong, and stable and meet the customer demands effectively. To overcome these challenges, this study aims to develop predictive analytics forecasting models that leverage machine learning techniques to obtain an accurate demand forecast. Machine learning (ML) is used to teach machines how to handle data more efficiently. Machine Learning relies on different algorithms to solve data problems. [2] Utilizing advanced data analysis methods, such as time series analysis, machine learning algorithms, data preprocessing and feature engineering and some clustering techniques, the model will automate the forecasting process, thereby will help to minimize the human errors and improve the demand predictions.

## II. Methodology

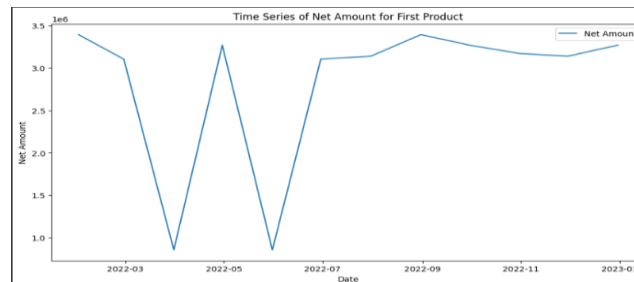
The research methodology is designed to provide a comprehensive approach to develop an accurate and dependable forecasting model for the biscuit manufacturing company. The methodology comes with machine learning algorithms with robust data collection and evaluation process to ensure that the predictive analytic conduct is effective or not compared with the current manual

forecasting methods. In that case, we apply machine learning. With the abundance of datasets available, the demand for machine learning is on the rise. Many industries apply machine learning to extract relevant data. The purpose of machine learning is to learn from data. [2].

A. Approach and techniques: The machine learning model will train with historical sales data and other relevant variables, with the aim of developing the model that can predict accurately the future demand across various products, brands, and SKUs. The key steps of the study are data processing, model training, validation, and evaluation. Data preprocessing is a method of cleaning and organizing the data to ensure the quality of data and its consistency; while doing preprocessing, we can have feature engineering to create meaningful input variables for the model. Once the data is preprocessed and prepared, the machine learning models can be trained on a portion of data, while having other portions remaining for validation and testing. The model's performance is calculated using some metrics to measure the accuracy and reliability of the model. Finally, the models will be compared against the other models to identify the best approaching model for the company's requirements.

### III. Results

Exploratory data analysis – Time series of net amount.



The graph shows a time series with the net amount for the product over the time from early 2022 to early 2023. The Y-axis shows the net amount in millions from 0.8 to 3.5 million, and X-axis shows the month timeline. The blue line depicts the significance of fluctuations in net amount over the year, with peaks and troughs. The most significant variances shown in the months of March to July 2022, in April and June 2022 where the graph dips reach close to 1 million. After July 2022, the net amount stayed at a higher place. As for the future forecast the net amount for the month of January 2023 will be around 3 million with minor fluctuations and illustrates a slight upwards trend in next following months.

Future predicted net amount values.

```
[9] from statsmodels.tsa.holtwinters import ExponentialSmoothing
# Assuming you want to forecast for the next 3 months (adjust as needed)
forecast_horizon = 3

# Create and fit the model with adjusted seasonal_periods and initialization_method
model = ExponentialSmoothing(
    time_series_data.iloc[:, 0], # Using the first product's data (adjust as needed)
    trend="add",
    seasonal="add",
    seasonal_periods=3, # Reduced to 3 (e.g., quarterly seasonality)
    initialization_method="none" # Using the legacy initialization method
)
model_fit = model.fit()

# Get future predictions
future_predictions = model_fit.forecast(steps=forecast_horizon)

# Display the predictions
print("Future Predicted Values:")
print(future_predictions)

Future Predicted Values:
2023-01-31    3.195409e+06
2023-02-28    2.975843e+06
2023-03-31    2.822326e+06
Freq: ME, dtype: float64
```

### IV. Discussion

The findings underscore the limitations of manual forecasting methods currently used within the organization. By leveraging predictive analytics, businesses can reduce human errors, adapt to changing market trends, and respond quickly to demand fluctuations. The variation in forecast accuracy across products suggests the need for tailored models rather than a one-size-fits-all approach. Moreover, incorporating external factors like seasonal trends, promotions, and regional preferences could further enhance forecasting precision. Future improvements should focus on integrating machine learning algorithms and real-time data to continuously refine demand predictions.

### V. Conclusion

This project aims to improve the demand for forecasting accuracy and analyze the performance of the OREO product line and provide insight into better decision making. The analysis revealed a forecasting gap, with actual sales of prediction exceeding 45.99%, emphasizing the need for forecasting model. The product named OREO blueberry 240g\*4 shows a high performance and strong demand in the market while OREO real choc and nuts 400g\*36 shows a low performance and sales. Some products show reliable forecasts, others had high error rates. Product performance was categorized as high, medium and low based on total sales, revealing a strong market. The forecasted summary on the predicted sales and demand shows a high demand for OREO coffee 400g\*36 and OREO valentine 200g\*25, and OREO oat krunch dark choc 400g\*4 with high net amounts in millions. The errors

metrics such as MAE, MSE, and RMSE showed a variability in forecast reliability across the products. Overall, the project shows the importance of having advanced predictive analytics and data-driven strategies to improve allocation of resources, maximize sales and forecast future data.

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