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Development of an Accurate Demand Forecasting Model and Production Planning Strategies to Ensure Optimal Resource Utilization

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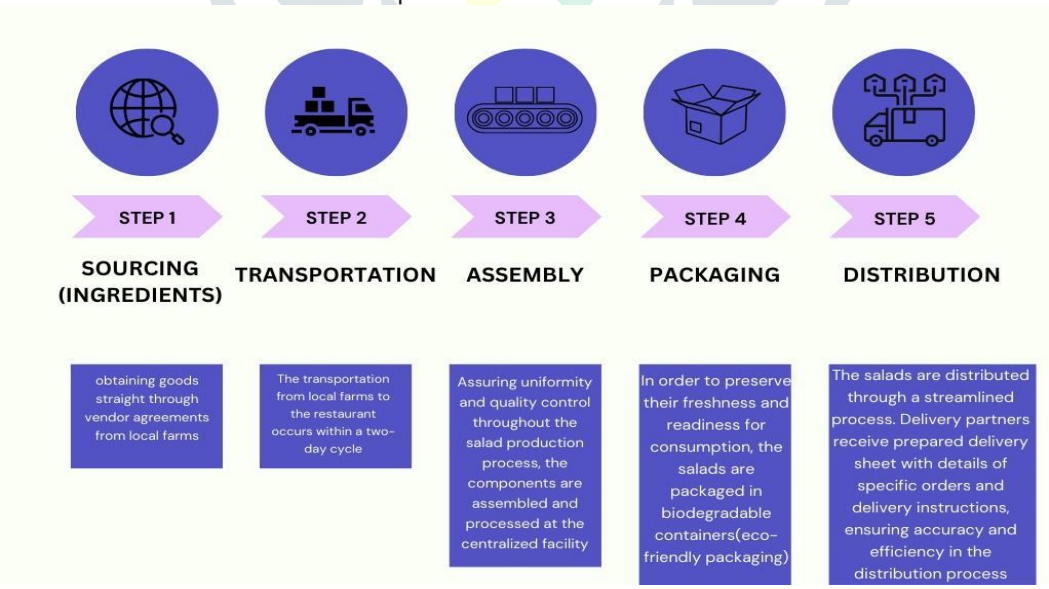
Abstract : *According to a research paper titled 'Causes of Food Loss and Waste: An Analysis Along the Food Supply Chain,' published by the CEMMPRE, Department of Mechanical Engineering, University of Coimbra in July 2018, it is projected that food production will increase by roughly 70% by 2050, yet approximately one-third of the food is lost or wasted. Hence, an accurate demand forecasting can improve production schedules, reduce surplus inventory, and lessen the chance of food wastage. This not only increases operating efficiency but also helps to achieve sustainability objectives by reducing food waste. This paper is to provide an accurate demand forecasting model and effective production planning techniques. With the help of historical data analysis, seasonal variations, and demand fluctuations, the project aims to solve the problems with demand prediction and production schedule planning.*

I. INTRODUCTION

The process of making salads is a well-planned chain that begins with obtaining premium, fresh ingredients from nearby farms and vendors. Then, at a centralized facility, these ingredients are processed, assembled, and packaged. After being assembled and packaged, the salads are delivered to distribution hubs or straight to the residences or workplaces of clients. Delivery partners are guided in ensuring timely and effective distribution via prepared delivery sheets. Given below is a flow chart of the whole process.



II. OBJECTIVES

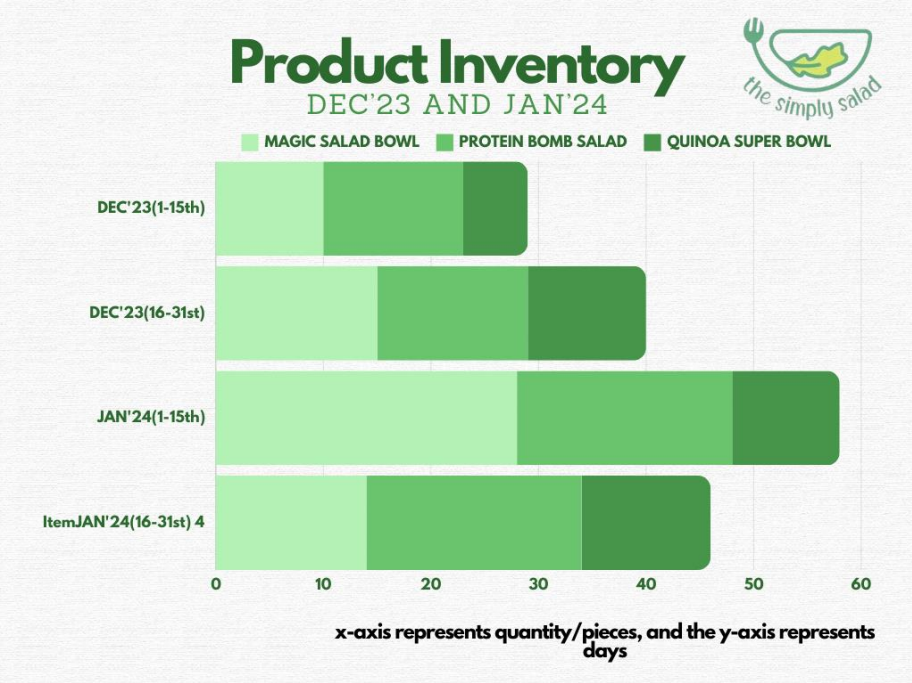
The Primary objectives of this project include:-

1. Develop a sustainable and accurate demand forecasting model tailored for the food industry.
2. Suggest production planning techniques into practice to reduce waste and maximize resource use.
3. Improve overall supply chain efficiency.

III. Problem Identification

The following are the problems identified:-

1. Inaccurate Demand Forecasting: The business frequently overestimated or underestimated client demand, leading to excess inventory or stock outs.Improper demand forecasting results in increased storage costs for surplus inventory or lost sales opportunities due to stockouts.



2. Manual Production Planning Processes: The majority of production planning is done by hand, which results in mistakes, hold-ups, and ineffective scheduling and resource allocation. Production expenses rise and resources are used less efficiently when production planning is done manually due to human mistake and inefficiency.

3. Lack of Integration between Sales & Production Department: If there is a significant spike in orders midday, there is a communication breakdown between the production and sales departments, which causes mismatches between the actual production output and the anticipated demand.

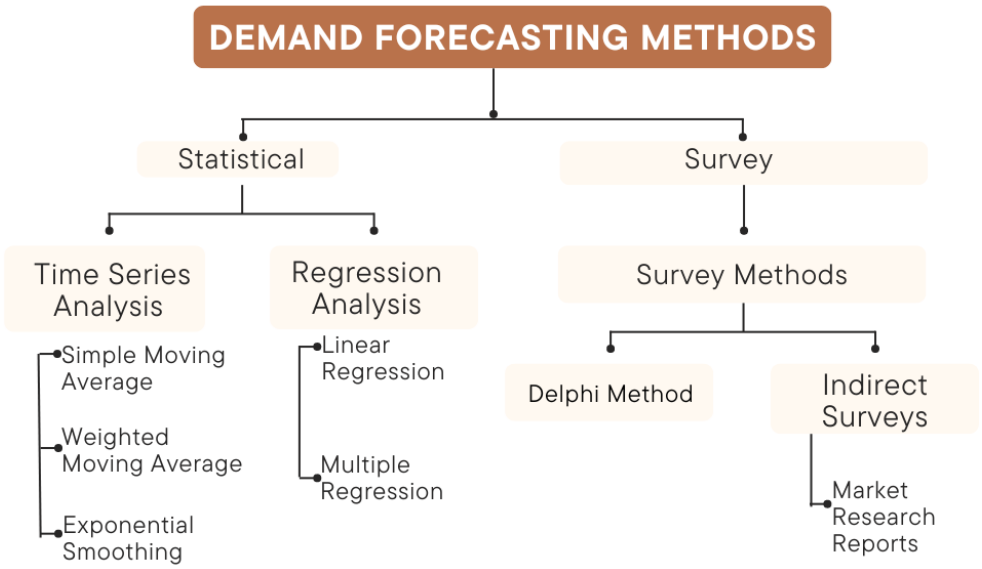
IV. Methodology

Steps to Follow to Find the Accurate Demand Forecasting Method:

1. Identifying Data for Forecast Testing
2. Implementing Data into Forecasting Methods
3. Obtaining Results and Analyzing Data
4. Visualizing Error Analysis: Graphical Representation of Results

V. Demand Forecasting Methods

To identify the best forecasting model, we will evaluate the results obtained from employing different techniques.



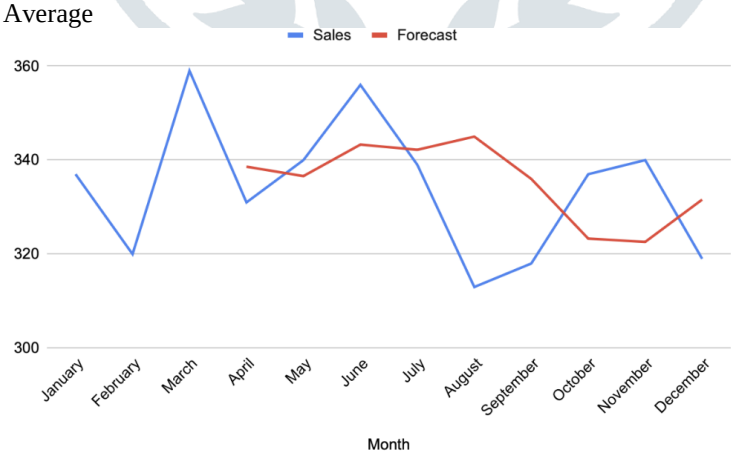
VI. Statistical Demand Forecasting

Here are the findings from the statistical demand forecasting method:

1. This method allows companies to forecast future sales by taking into consideration demand patterns. For example, if the sample data shows frequent spikes in demand, the trend-adjusted exponential smoothing method is suggested.
2. Continuous monitoring of demand projections helps to avoid underproduction or overproduction of items, which can result in inefficiencies and financial losses. Companies can efficiently fulfill consumer demand by altering production levels in response to predicted demand.
3. Enhances operational efficiency.
4. Enables to properly deploy resources and capitalize on market possibilities.

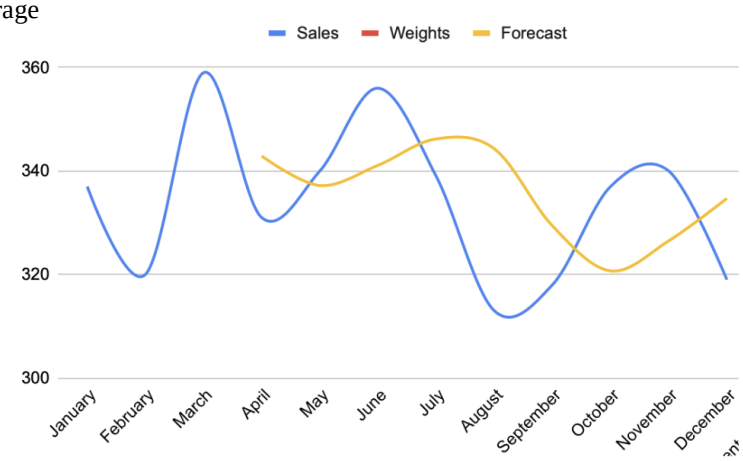
VII. Graphical Representation

1. 3 Months Moving Average



X-axis represents the months of the year
Y-axis represents the quantity of salad bowls

2. Weighted Moving Average



X-axis represents the months of the year
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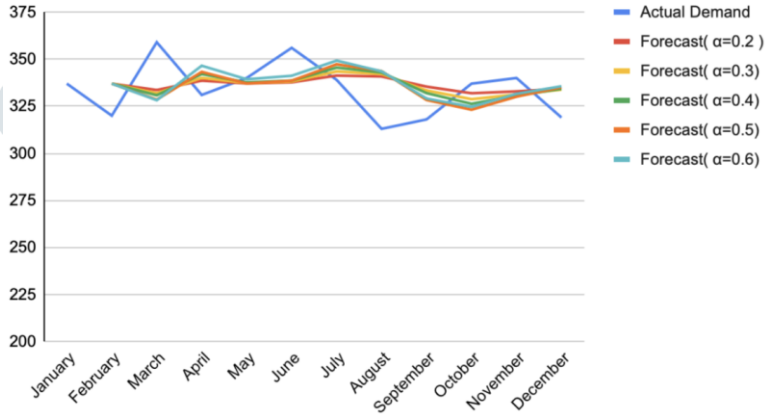
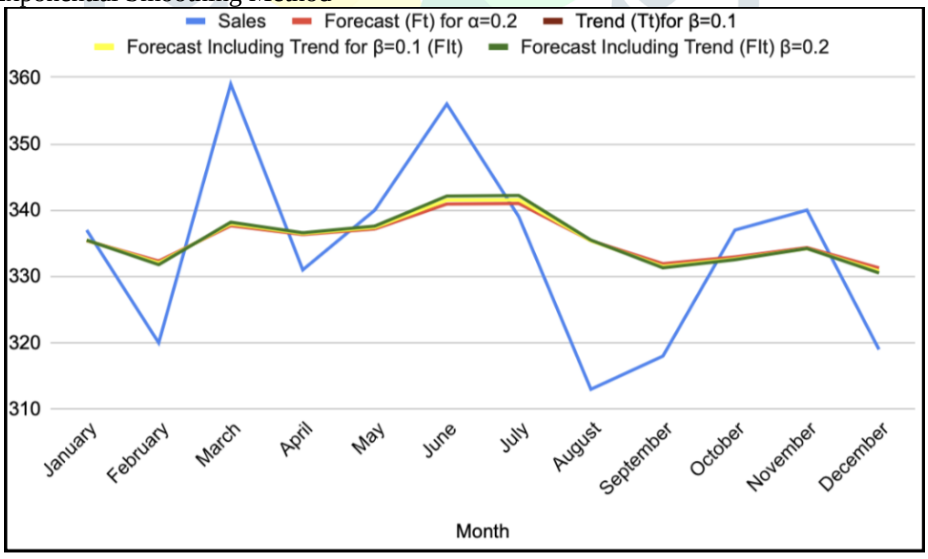
3. Exponential Smoothing Method



X-axis represents the months of the year
Y-axis represents the quantity of salad bowls

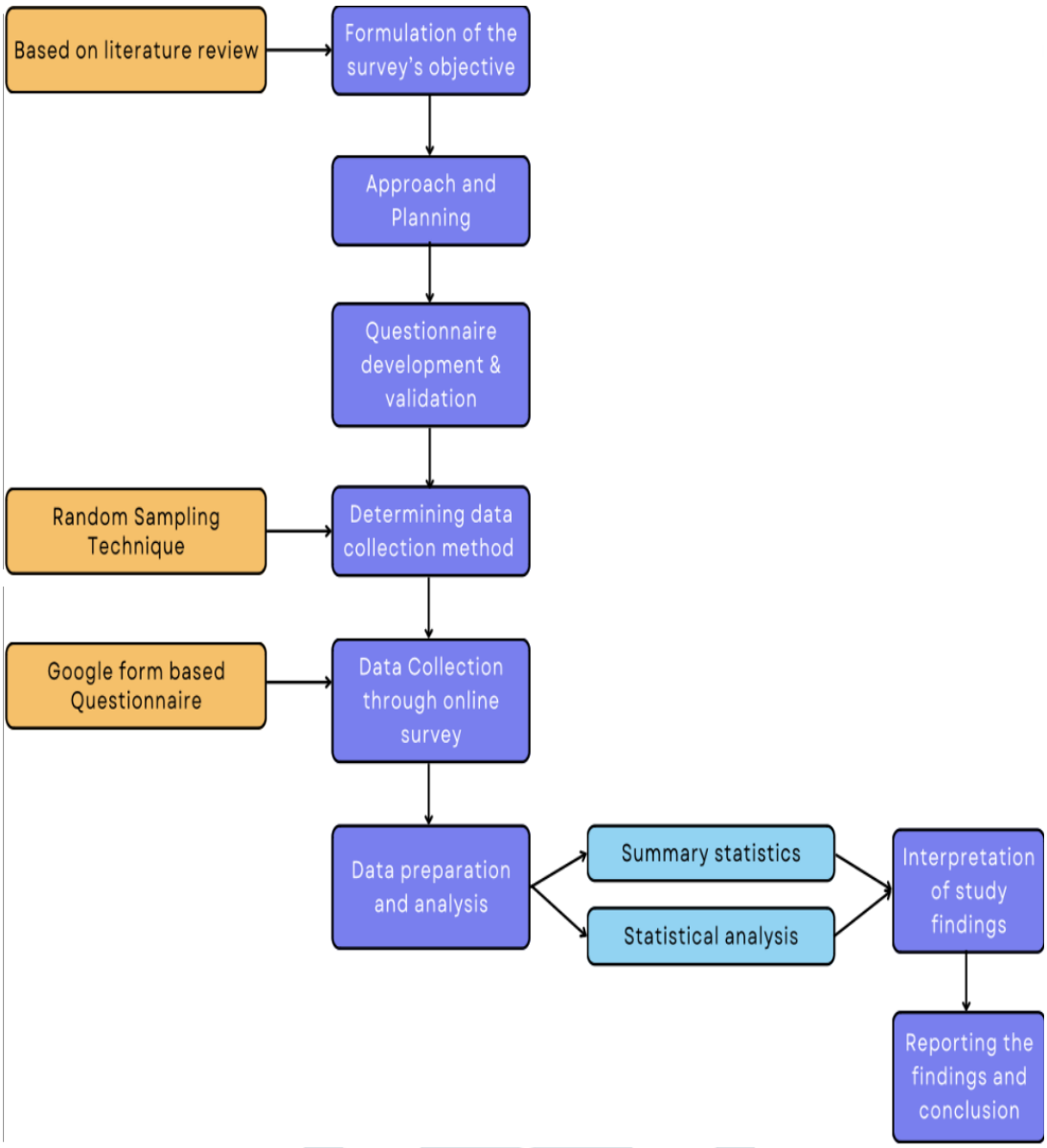
4. Trend Adjusted Exponential Smoothing Method



X-axis represents the months of the year
Y-axis represents the quantity of salad bowls

VIII. SURVEY METHODS

Consumer survey process is a methodical way to learn more about the preferences, actions, and perceptions of consumers. Given below is a flow chart followed to do a survey



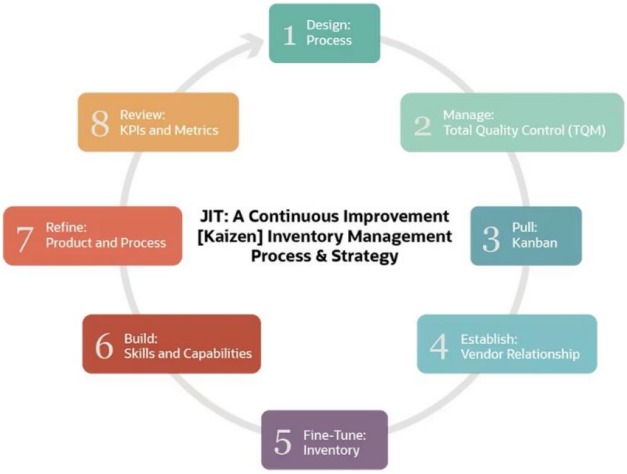
Objective of the survey: Forecast by segmenting the target market according to psychographic features (attitudes towards convenience, culinary adventurousness), lifestyle factors (like health consciousness and busy lifestyles), and demographic data (like age and income).

Designed Questionnaire: The questionnaire was created to segment the target market based on psychographic traits, lifestyle factors, and demographic information. Through this thorough approach, we hope to obtain insights into consumer behavior and preferences in order to enhance the product lines.

Sampling: Random sample method, This technique ensures that the sample accurately reflects the characteristics of the wider population while reducing bias.

IX. Production Planning Techniques

The Simply Salad forecasts demand, schedules production processes, and allocates resources using conventional production planning techniques. But these approaches frequently come with a number of drawbacks that reduce operational effectiveness and profitability. Hence to Improve the existing Production Planning we have to adopt these strategies



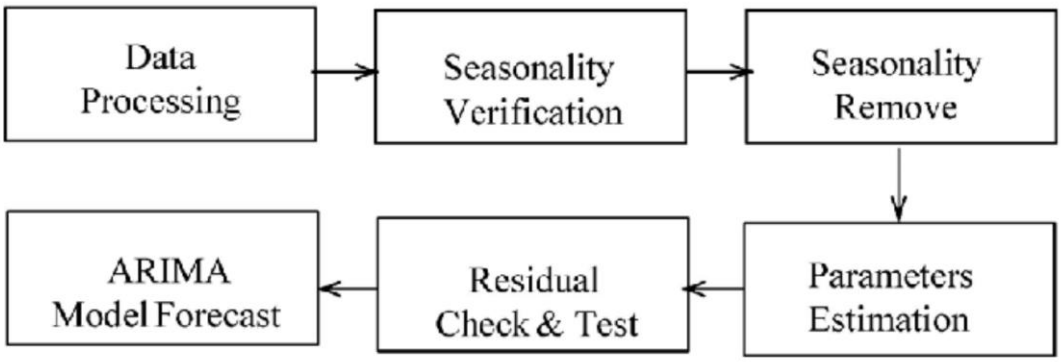
The following four steps, out of the eight listed for implementing Just-In-Time (JIT) processes, are crucial for effective production planning at The Simply Salad:

1. Manage: Clearly define roles and responsibilities, implement quality control measures, ensure the schedule remains consistent, and evaluate capacity.
2. Fine-tune: Establish optimal inventory levels, implement rules and controls to increase operational efficiency, and minimize unnecessary inventory changes.
3. Refine: Increase productivity by standardizing methods and reducing the number of components in production processes.
4. Review: Implement quality measurements and metrics, investigate the root causes of issues, prioritize continuous improvement, and track trends to align with production goals.

X. ARIMA Model

Accurate predictions are essential for maximizing resource allocation and satisfying customer requests in the domains of demand forecasting and production planning. Among the many tools available for forecasting is the AutoRegressive Integrated Moving Average (ARIMA) model.

The ARIMA model combines three key elements: autoregression (AR), differencing (I), and moving average (MA). This amalgamation enables ARIMA to capture complex patterns and trends inherent in time series data, making it particularly suitable for forecasting tasks where historical patterns influence future outcomes.



ARIMA Model Methodology

The quality of the data, the choice of model parameters, and the particular application context are some of the variables that affect the effectiveness of ARIMA models in the food sector. An overview of ARIMA models potential applications in the food sector is provided below:

1. Seasonal patterns in food demand, such as variations during holidays, seasons, or special events, are best analyzed using ARIMA models.
2. ARIMA models can analyze time series data related to food quality parameters, such as freshness, spoilage rates, and sensory attributes.
3. ARIMA models give more comprehensive representation of the underlying data producing process by allowing modeling flexibility for both autoregressive and moving average components. Because of its adaptability and capacity to record temporal dynamics, ARIMA is an effective tool for precise demand forecasting and production scheduling in the food sector.

XI. Result & Analysis

1. In the Weighted Moving Average Method, the forecast numbers are more influenced by current sales data, leading to more responsive predictions to changes in demand.
2. In the Exponential Smoothing method, lower α values (e.g., 0.2 and 0.3) rely more on historical data, offering smoother, long-term projections that lag behind demand shifts. Higher α values (0.5 and above) prioritize recent data, providing quicker responses to demand changes but may be more sensitive to data variations.
3. In summary, by combining exponential smoothing and trend analysis, estimates are changed to incorporate both recent sales data and underlying trends, resulting in more accurate predictions.

XII. Conclusion

Forecasts that combine two forecasting techniques, like trends plus smoothing, can be more accurate. Businesses may improve prediction accuracy and better anticipate demand changes by utilizing the benefits of each approach, which will improve decision-making. A hybrid forecasting strategy adapted to unique conditions and forecasting objectives is recommended to be adopted after examination of many existing forecasting models and a thorough analysis of research papers. This hybrid model, by combining the benefits of various forecasting methodologies, is provided as a robust and adaptive solution for efficiently addressing the complexities and uncertainties inherent in demand forecasting situations. Development of the applicability of the ARIMA model (Autoregressive Integrated Moving Average) is recommended as part of the future scope of this project. Medium-sized to large-scale food companies seeking more reliable and accurate demand forecasting solutions will benefit from this model. For the algorithm to function at its best and predict demand accurately, it must undergo extensive conditioning that includes every relevant variable and data.

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