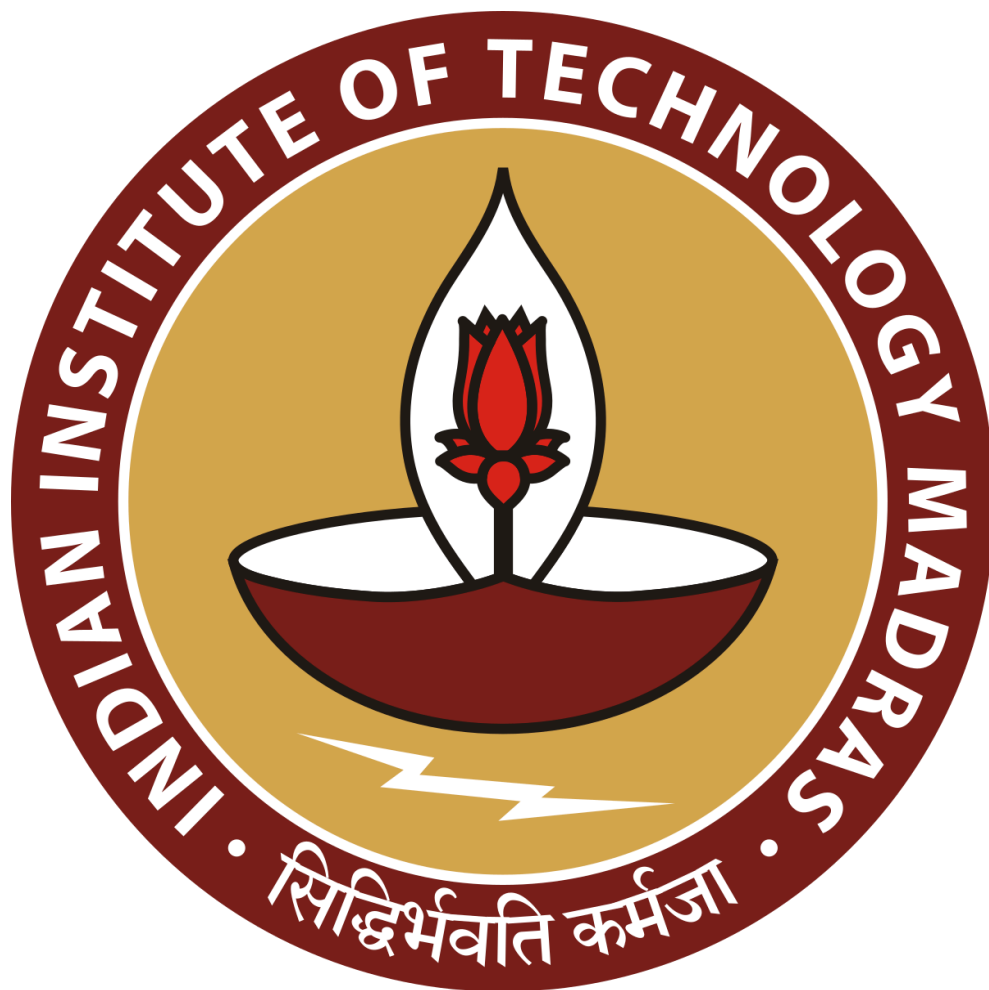


**Enhancing Sales and Inventory Management of Kalpataru Through Data-Driven Strategies**  
**Final Report for the BDM capstone Project**

**Submitted by**

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**Contents**

1. Executive Summary and Title	3
2. Detailed Explanation of Analysis Process/Method	4
3. Results and Findings	9
4. Interpretation of Results and Recommendation	18

### **Declaration Statement**

I am working on a Project titled “Enhancing Sales and Inventory Management of Kalpataru Through Data-Driven Strategies”. I extend my appreciation to Kalpataru, for providing the necessary resources that enabled me to conduct my project.

I hereby assert that the data presented and assessed in this project report is genuine and precise to the utmost extent of my knowledge and capabilities. The data has been gathered through primary sources and carefully analyzed to assure its reliability.

Additionally, I affirm that all procedures employed for the purpose of data collection and analysis have been duly explained in this report. The outcomes and inferences derived from the data are an accurate depiction of the findings acquired through thorough analytical procedures.

I am dedicated to adhering to the information of academic honesty and integrity, and I am receptive to any additional examination or validation of the data contained in this project report.

I understand that the execution of this project is intended for individual completion and is not to be undertaken collectively. I thus affirm that I am not engaged in any form of collaboration with other individuals, and that all the work undertaken has been solely conducted by me. In the event that plagiarism is detected in the report at any stage of the project's completion, I am fully aware and prepared to accept disciplinary measures imposed by the relevant authority.

I agree that all the recommendations are business-specific and limited to this project exclusively, and cannot be utilized for any other purpose with an IIT Madras tag. I understand that IIT Madras does not endorse this.

Signature of Candidate: Purbendu Halder

Name: Purbendu Halder

Date: 15/08/2024

## 1. Executive Summary and Title

Kalpataru, a local B2C take-away restaurant in Bijoygarh market, Kolkata, faces challenges in managing inventory and sales effectively, leading to issues like understocking, overstocking, and resultant wastage. This report presents a comprehensive analysis of six months of sales data for Biryani, along with procurement and inventory data for two critical raw materials—Basmati Rice and Oil. The aim is to enhance operational efficiency, optimize inventory management, and improve profitability by leveraging data-driven insights.

Key Data Points and Methodology:

- Sales Data: Includes details on the date of sale, product name, quantity sold, and unit price. This data helps in identifying sales patterns, peak periods, and customer demand trends.
- Purchase Data: Encompasses the date of purchase, quantity bought, and unit price for Basmati Rice and Oil. Analyzing this data uncovers trends in procurement and raw material costs.
- Inventory Data: Tracks changes in stock levels, providing insights into inventory management practices and helping to prevent understock or overstock situations.

The data underwent thorough preprocessing, including the conversion of dates to datetime format, handling missing values, removing duplicates, and standardizing formats. Subsequently, the data was resampled to a monthly frequency and aggregated to identify long-term trends. Exploratory Data Analysis (EDA) involved visualizing time series data to uncover seasonal patterns and anomalies. For forecasting, Exponential Smoothing was employed to predict future sales and inventory needs, particularly focusing on trends during peak demand periods.

Significant Findings:

- Sales Trends: Biryani sales peak during festive seasons like Durga Puja, with a noticeable dip around the Christmas and New Year period. These fluctuations highlight the influence of cultural events on consumer behavior.
- Price Fluctuations: Basmati Rice prices are lowest in December and January due to the new harvest, while Oil prices dip in February. These seasonal trends suggest opportunities for cost savings through strategic procurement during low-price periods.
- Inventory Management: Basmati Rice inventory shows greater variability, indicating a need for more strategic stock management. In contrast, Oil inventory remains relatively stable, reflecting consistent procurement practices.

Recommendations:

- Strategic Procurement: Kalpataru should increase stock levels of Basmati Rice and Oil during their respective low-price periods to reduce costs and enhance profit margins.
- Optimized Inventory Levels: By aligning inventory levels with forecasted demand, particularly during peak festive seasons, the restaurant can avoid shortages and overstocking, ensuring smooth operations and customer satisfaction.

In conclusion, the report emphasizes the importance of data-driven decision-making in optimizing inventory management and sales strategies at Kalpataru. By adopting these recommendations, the restaurant can mitigate operational challenges, reduce wastage, and improve overall customer satisfaction and profitability.

## **2. Detailed Explanation of Analysis Process/Method**

For the analysis conducted at Kalpataru, data was gathered across three critical areas: Biryani sales, procurement of Basmati Rice and Oil, and inventory levels for these raw materials. This holistic approach allows for a comprehensive examination of how different elements influence the company's operations. The sales data provides valuable insights into product performance and customer demand, while the purchase data highlights the costs and quantities of raw materials acquired. The inventory data, on the other hand, helps in monitoring stock levels, shedding light on inventory management practices. By examining these datasets together, we can gain a clearer understanding of Kalpataru's operational efficiency and the impact of raw material costs on overall profitability.

### **a. Meta Data**

<b>Data Type</b>	<b>Variable</b>	<b>Description</b>	<b>Reason</b>
<b>Sales Data</b>	Date	Date of each Biryani sale	Identify sales patterns and peak periods
	Product Name	Name of the product sold	Determine which products are most popular
	Quantity	Number of Biryani units sold	Measure sales volume
	Unit Price	Selling price per unit of Biryani	Analyze revenue and pricing strategy
<b>Purchase Data</b>	Date	Date of each Purchase order	Track timing of purchases and price changes
	Quantity	Quantity of Basmati Rice or Oil bought	Monitor supply levels and consumption rates
	Unit Price	Purchase price per unit of Basmati Rice or Oil	Assess cost trends and impact on profit margin
<b>Inventory Data</b>	Date	Date when stock levels changed	Track inventory movements
	Product Name	Name of the raw material	Identify inventory composition
	Quantity	Quantity present in inventory	Prevent understock and overstock situations

b. Descriptive Statistics

Statistic	Quantity	Unit Price
Count	106	106
Mean	114.43	129.97
Standard Deviation	21.83	1.21
Minimum	80	128
25th Percentile	96.25	129
50th Percentile(Median)	113	130
75th Percentile	133	131
Maximum	150	132

*Table 1: Descriptive Statistics for Sales Data (Biryani)*

Statistic	Basmati Rice Quantity (Kg)	Basmati Rice Unit Price (Rs./Kg)	Oil Quantity (Liters)	Oil Unit Price (Rs./Liter)
Count	36	36	36	36
Mean	17.78	115.53	8.14	110.94
Standard Deviation	6.40	3.04	2.45	2.91
Minimum	10	110	4	105
25th Percentile	11	113	6	108.75
50th Percentile(Median)	18	116	8.20	112
75th Percentile	23	118	10.40	113
Maximum	30	120	12	115

*Table 2: Descriptive Statistics for Purchase Data (Basmati Rice and Oil)*

Statistic	Basmati Rice Quantity (Kg)	Oil Quantity (Liters)
Count	213	213
Mean	52.81	81.39
Standard Deviation	27.47	44.07
Minimum	10	11
25th Percentile	29	49
50th Percentile(Median)	50	75
75th Percentile	73	109
Maximum	120	180

*Table 3: Descriptive Statistics for Inventory Data (Basmati Rice and Oil)*

### Explanation of Descriptive Statistics

The tables above provide a detailed summary of the key statistics for the sales, purchase, and inventory data.

- **Table 1** outlines the sales data for Biryani. The average monthly sales quantity of 114.43 units, combined with a relatively low standard deviation of 21.83, suggests stable demand. The pricing data, with an average unit price of INR 129.97, shows minimal fluctuations, indicating price stability.
- **Table 2** covers the purchase data for Basmati Rice and Oil. The average quantities and prices for both items reveal procurement trends. Basmati Rice exhibits greater variability in both quantity and price compared to Oil, implying that more strategic purchasing decisions are needed for rice to effectively manage costs.
- **Table 3** illustrates the inventory data, showing average stock levels and turnover rates. The inventory of Basmati Rice has an average quantity of 52.81 kg, with higher variability, while Oil maintains a more consistent inventory level with a mean of 81.39 liters. This information is vital for optimizing stock levels and preventing issues like overstocking or stockouts.

By analyzing these descriptive statistics, Kalpataru can make data-driven decisions regarding inventory management, pricing strategies, and sales forecasting, ultimately improving operational efficiency and profitability.

### c. Data Preprocessing

Before analysis, the raw data required significant preprocessing to ensure accuracy and consistency. The following steps were taken:

- **Conversion of Dates to Datetime Format:** All date columns were converted to a standardized datetime format using `pd.to_datetime()` in Python. This step was crucial for time-based operations, ensuring that the data could be accurately grouped and analyzed over different periods.
- **Handling Missing Values:** Missing values were identified and appropriately handled. For numerical data, missing values were imputed with the mean or median values, while categorical data was filled with the most frequent values. This ensured that the analysis was based on complete datasets.
- **Removing Duplicates:** Any duplicate records were removed to avoid skewing the results. This step was particularly important for maintaining the integrity of the sales and inventory data.
- **Standardizing Data Formats:** All numerical values were standardized to ensure consistency across the dataset. This included ensuring that quantities were in appropriate units (e.g., kilograms for rice, liters for oil).

### d. Data Aggregation

- **Resampling to Monthly Frequency:** The dataset was resampled to a monthly frequency using the `resample('M')` function from the pandas library. This method aggregates data into monthly intervals, facilitating a clearer analysis of long-term trends.
- **Data Aggregation:** By utilizing aggregation functions such as `sum()` and `mean()`, the data was consolidated within each month. This process helps to smooth out short-term fluctuations, making it easier to detect underlying patterns.
- **Trend Analysis:** Monthly resampling and aggregation are crucial for identifying seasonal trends and patterns, providing a more comprehensive view of the data over time.

### e. Exploratory Data Analysis (EDA)

- **Time Series Visualization:** The `matplotlib.pyplot` library was employed to generate time series plots, enabling the visualization of temporal trends within the sales data and wheat flour (maida) price data.
- **Line Plot Generation:** Line plots were constructed to depict the progression of sales and price metrics across various time periods. These plots are essential for capturing temporal patterns, seasonality, and potential anomalies in the data.
- **Pattern Recognition:** The visualizations facilitated the identification of patterns, trends, and deviations within the time series data, offering a preliminary understanding of the data's behavior over the observed periods.



## f. Time Series Modeling and Forecasting

To forecast future sales and inventory requirements, we employed time series analysis using the Exponential Smoothing method. This approach was selected for its capability to handle trends and seasonality in the data. Below are the details of the methodology

- **Model Selection:**

- Exponential Smoothing: This method from the statsmodels.tsa.holtwinters module was chosen for its robustness in capturing both trend and seasonal patterns in time series data. It is particularly effective for forecasting data with identifiable trends and seasonal variations.

- Exponential Smoothing Formula: The Exponential Smoothing model is generally represented by:  $Y_{t+1} = \alpha Y_t + (1 - \alpha)Y_{t-1}$  where,

$Y_{t+1}$  is the forecasted value for the next time period,

$\alpha$  is the smoothing parameter,

$Y_t$  is the actual value at time t and

$Y_{t-1}$  is the actual value at time t-1.

- **Model Fitting:**

- Parameter Estimation: The ExponentialSmoothing function from statsmodels was employed to build the model. The parameter  $\alpha$  was estimated to minimize forecast error, using the fit() method.
- Evaluation Metrics: Model performance was evaluated using metrics such as Mean Absolute Error (MAE) and Root Mean Squared Error (RMSE) to ensure the accuracy of the forecasts.

- **Generating Forecasts:**

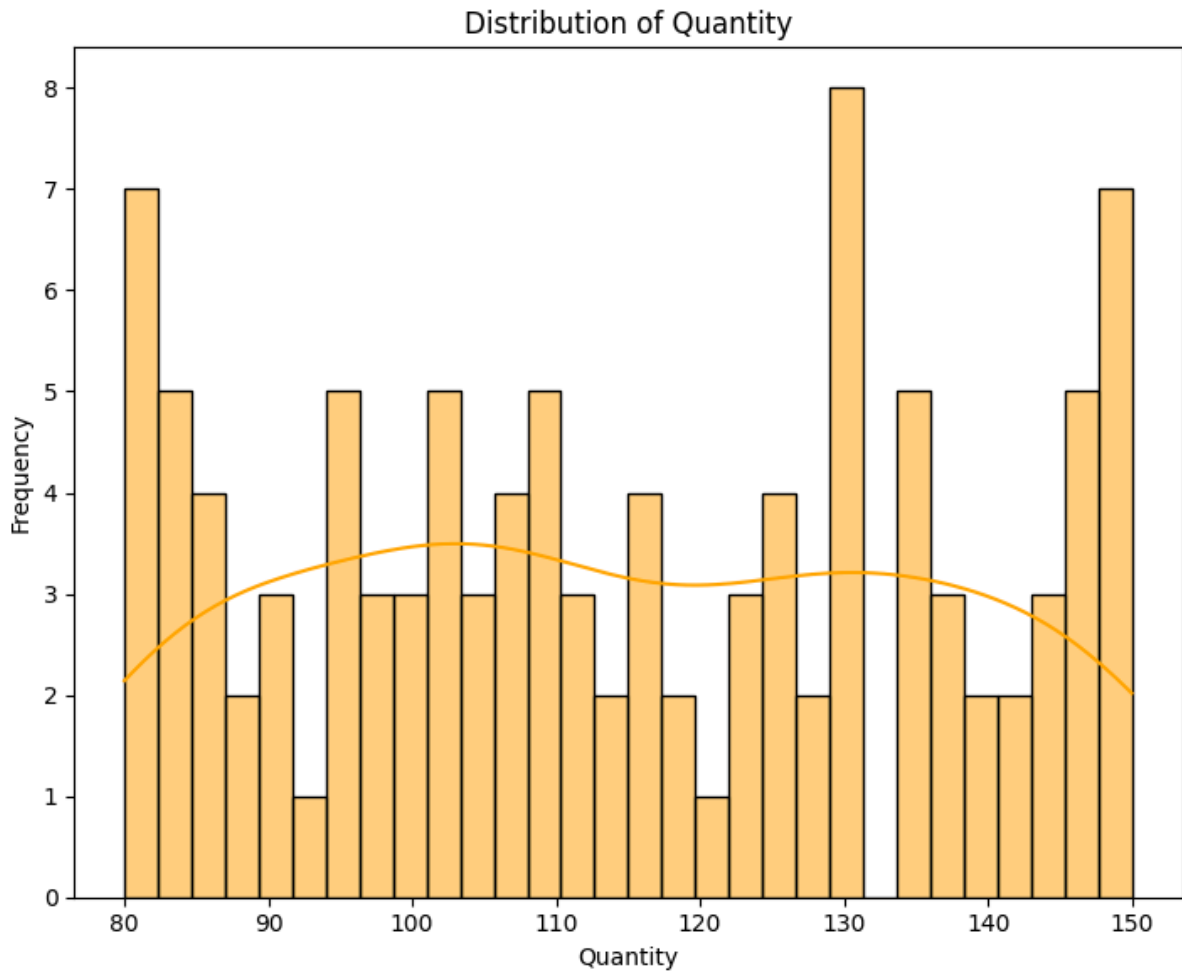
- Forecast Generation: The forecast() method was used to project future values based on the fitted model. This process involved calculating future estimates by applying the smoothing formula.
- Validation: Forecasted values were compared with historical data to validate the model's predictive accuracy and adjust for any discrepancies.

By employing this method, we were able to forecast future sales and inventory levels with a focus on capturing essential patterns in the data. This approach supports effective planning and decision-making for sales and inventory management.

### 3. Results and Findings

#### 1. Analyzing the data through Distribution Plots

##### Sales Dataset



*Fig.1: Distribution of Biryani Sales Data*

This plot illustrates the distribution of the quantity field in the sales dataset ranging from a minimum of 80 units to a maximum of 150 units, providing insight into the range and typical volume of sales orders for Kalpataru. From this, we can infer that there is a balanced mix of small and medium orders mostly.

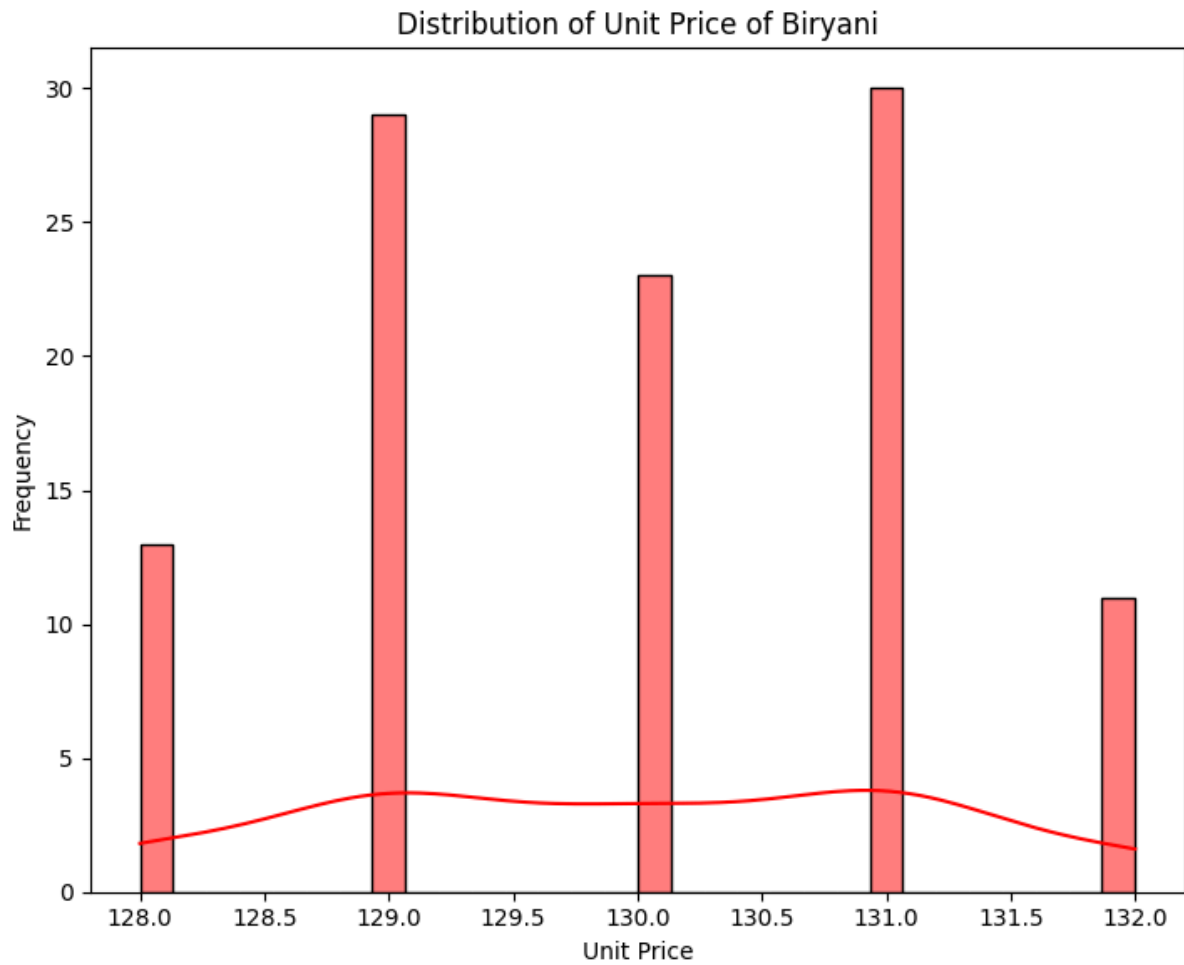
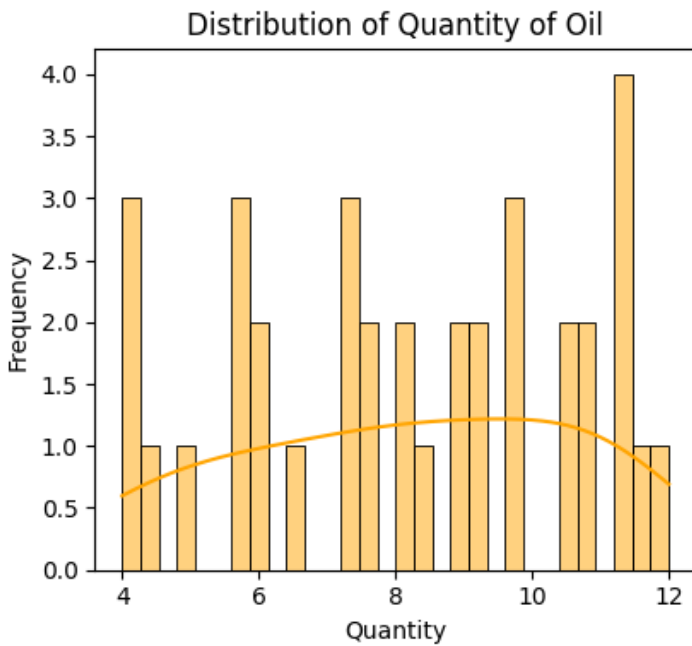


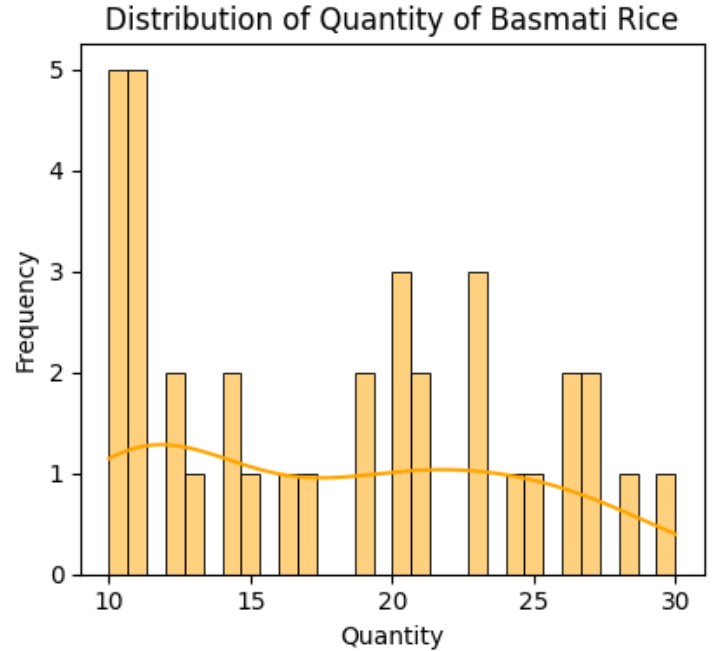
Fig.2: Distribution of Unit Price of Biryani

The minimum and maximum prices are Rs. 128 and Rs. 132, respectively. Since the graph shows fewer sales at these extremes, it suggests that these prices are less common compared to the prices within the central range. The graph also shows a high frequency of sales at specific price points, suggesting consistent pricing practices at around Rs. 130

### Buy Dataset



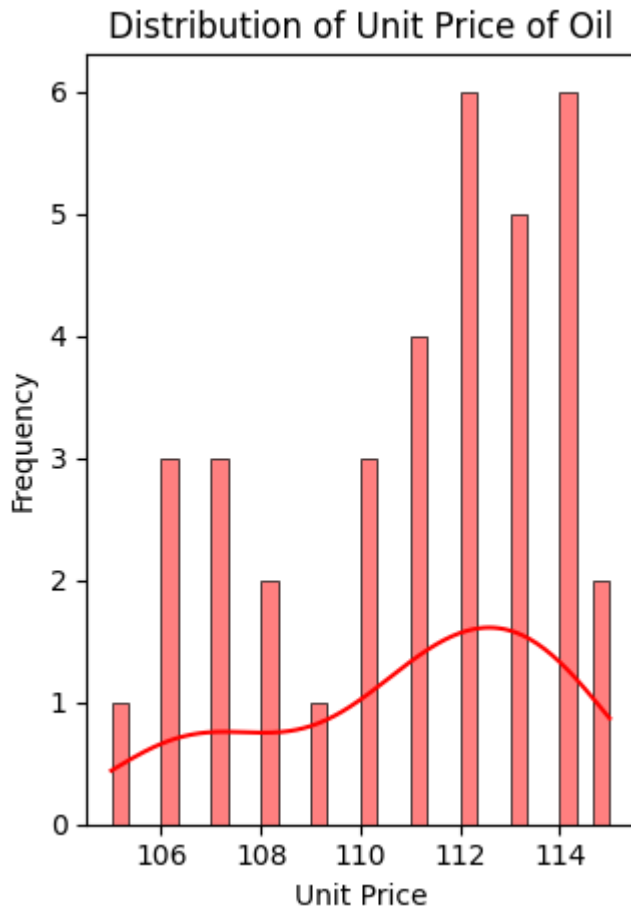
*Fig.3: Distribution of Quantity of Oil*



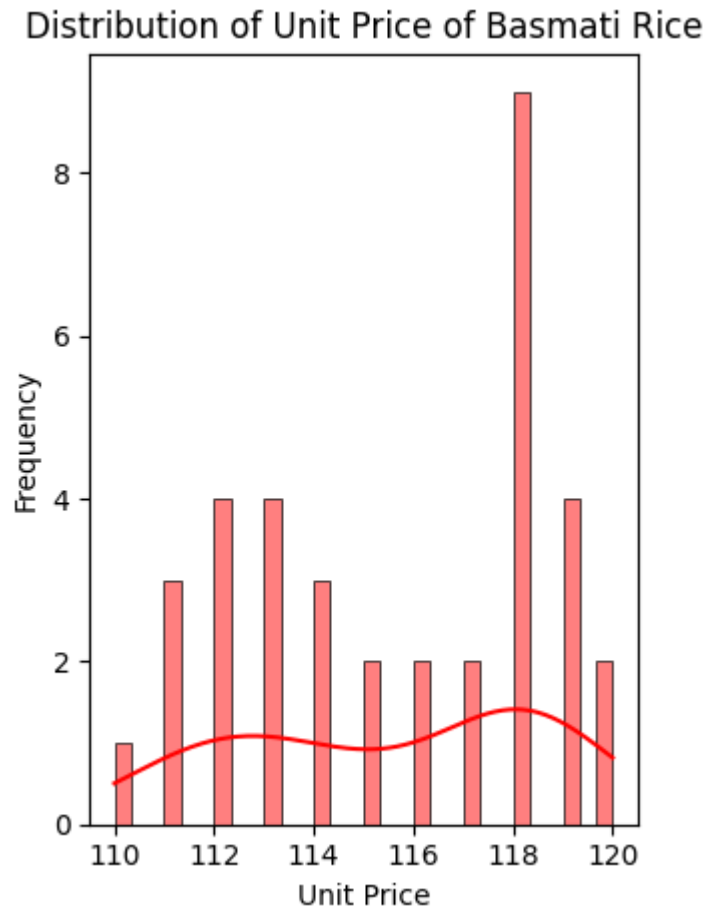
*Fig.4: Distribution of Quantity of Rice*

**Basmati Rice Quantity:** The distribution of quantities purchased for Basmati Rice **ranges from 10 Kg to 30 Kg per order**, with a mean purchase volume of approximately 17.78 Kg. Notably, most procurements are between 10 Kg and 20 Kg. This range indicates that purchases are typically made in moderate-sized batches, balancing the need to maintain adequate stock levels while managing storage constraints.

**Oil Quantity:** The purchase quantities for Oil **range from 4 Liters to 12 Liters per order**, with an average volume of around 8.14 Liters. The narrower range compared to Basmati Rice implies more consistent purchasing practices for Oil, likely due to its longer shelf life and less frequent need for reordering. This consistency aids in maintaining a stable inventory and minimizes the risk of stockouts.



*Fig.5: Distribution of Unit Price of Oil*



*Fig.6: Distribution of Unit Price of Rice*

This analysis provides insights into the distribution of unit prices for Basmati Rice and Oil in the purchase dataset.

- The variation in Basmati Rice prices, **ranging from Rs. 110 to Rs. 120 per kilogram**, reflects moderate fluctuations in procurement costs, with most purchases concentrated around Rs. 112 to Rs. 116 per kilogram. Kalpataru can lower its operational costs by procuring the rice when the prices are on the lower side, thereby enhancing overall profitability.
- Similarly, Oil prices show a **range from Rs. 105 to Rs. 115 per liter**, with the majority of transactions occurring near the Rs. 118 mark. Given that Oil has a longer shelf life, bulk procurement when prices dip towards the lower end can also help Kalpataru to further reduce operational expenses and enhance profitability.

### Inventory Dataset

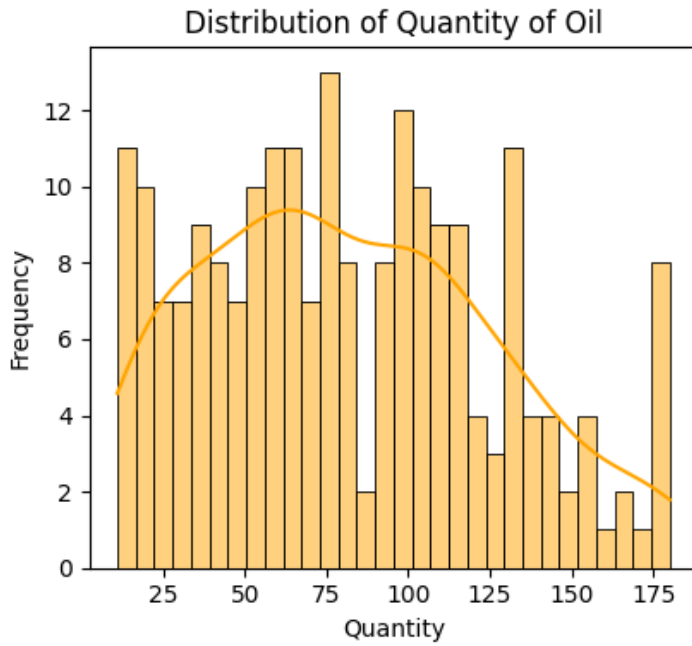


Fig.7: Distribution of Quantity of Oil

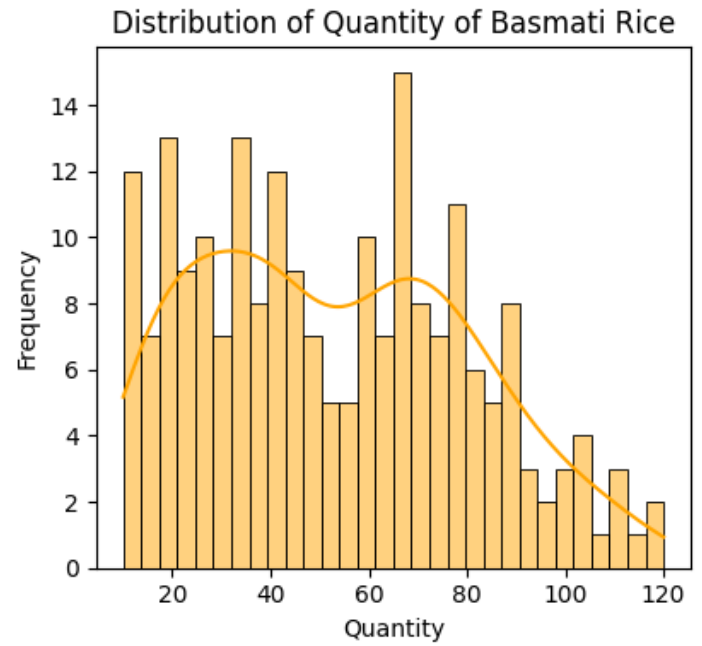
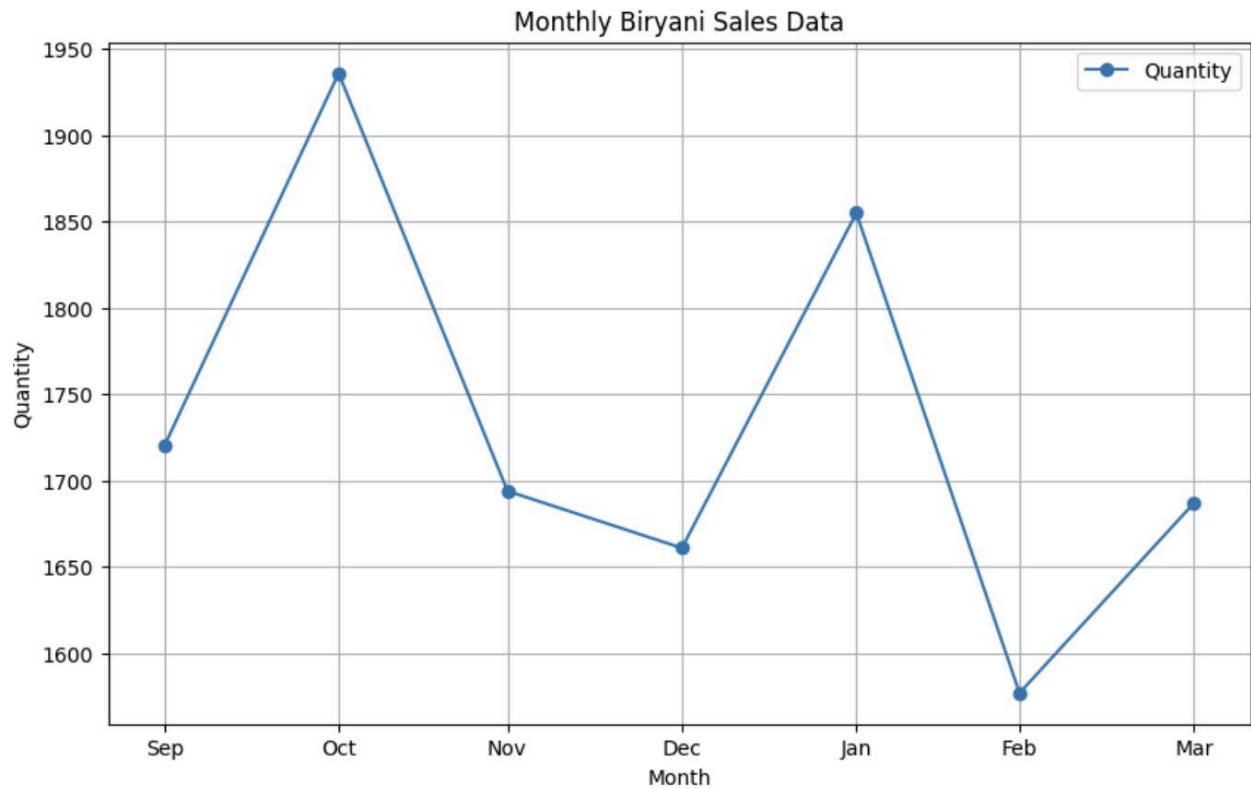


Fig.8: Distribution of Quantity of Rice

This plot illustrates the distribution of Basmati Rice and Oil quantities in the inventory. The frequency of larger quantities of Basmati Rice is lower, likely due to its shorter shelf life, suggesting that the shop is cautious about overstocking. On the other hand, the distribution of Oil quantities is more consistent across different amounts, indicating a more balanced inventory management approach for this product.

## 2. Analyzing the data through Time Series Analysis

### Sales Data



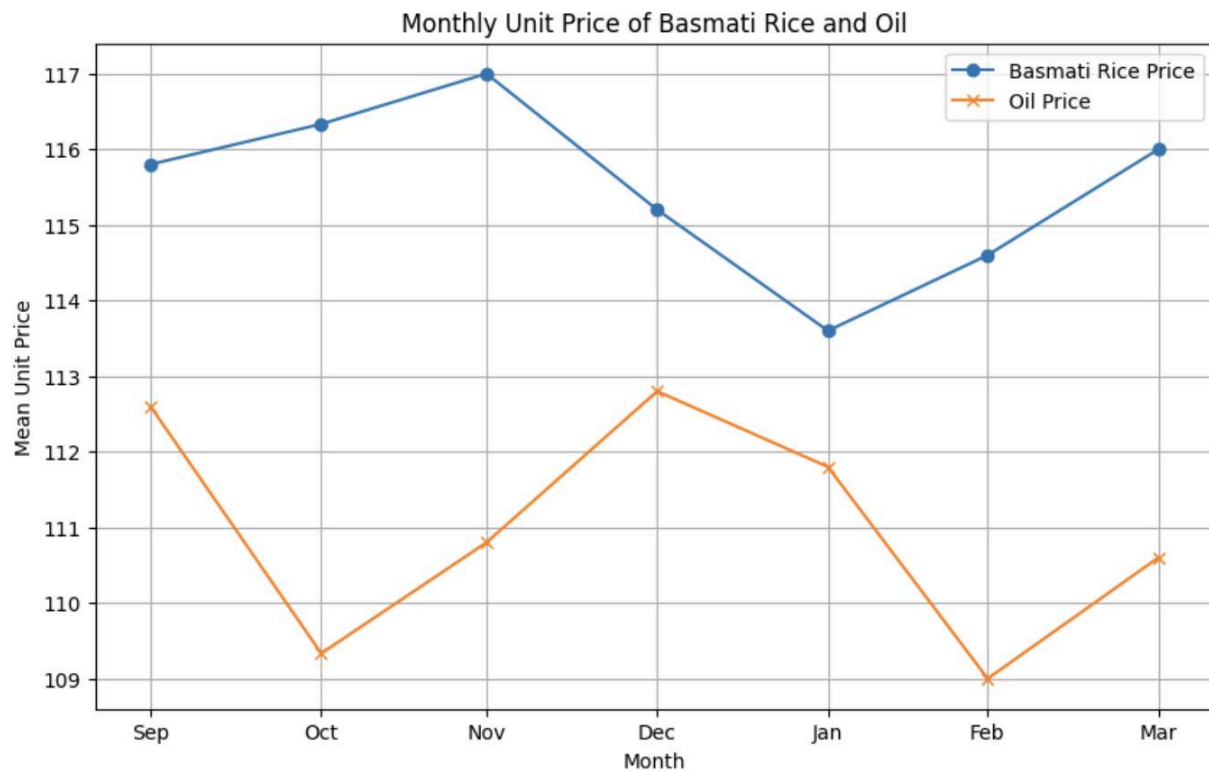
*Fig.9:Monthly Biryani Sales Data*

Effective time-series analysis of the sales data is crucial for identifying seasonal patterns and fluctuations in demand. By examining these trends, we can pinpoint periods of high and low sales activity, which enables us to understand the underlying dynamics of consumer behavior. This insight allows us to develop targeted strategies to address demand variations, optimize inventory levels, and ensure that we are well-prepared to meet the needs of our customers throughout different times of the year.

Following are the observations from the plot:

- Demand Peaks During Durga Puja: Sales data shows a significant increase in demand for Biryani during October, aligning with the peak festive season of Durga Puja in West Bengal.
- Demand Fluctuations: Variations in demand are evident around major holidays. For instance, there's a noticeable dip in sales during December, suggesting a potential shift in consumer preferences during the holiday season.
- Seasonal Trends: The data indicates recurring seasonal trends in demand, with increased sales during specific festive periods and fluctuations during other times of the year.

## Buy Data



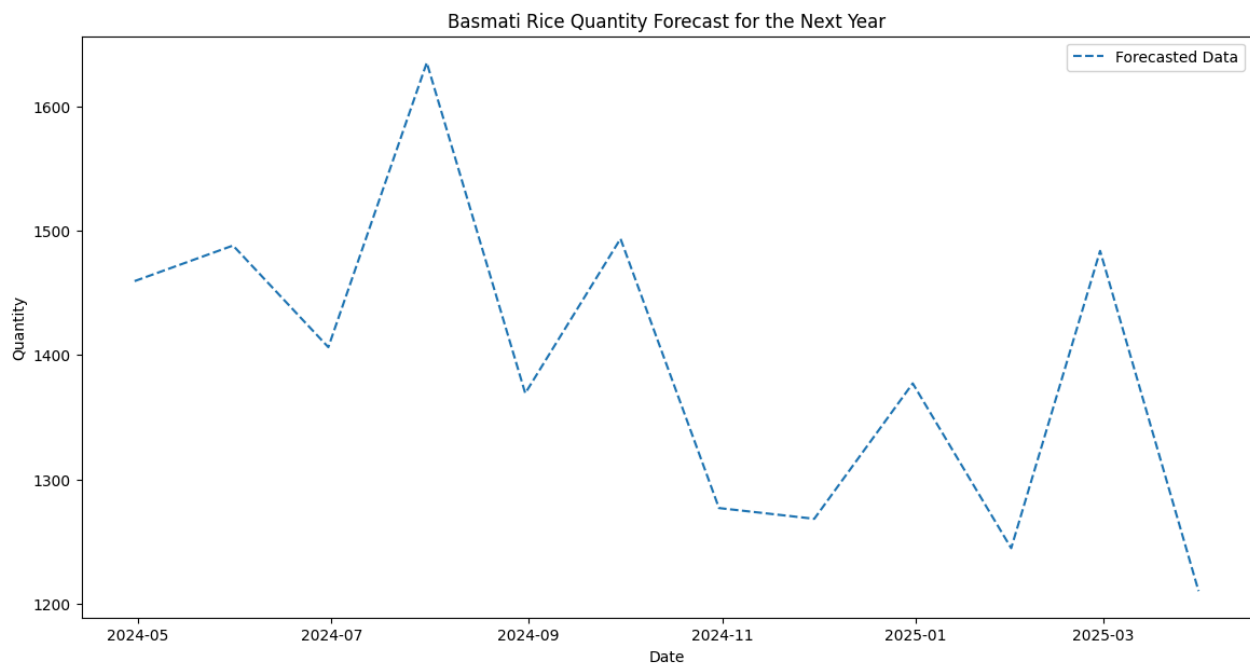
*Fig.10: Monthly Unit Price of Basmati Rice and Oil*

Following are the observations from the plot:

- Seasonal Price Trends
  - Basmati Rice
    - Low Prices in Winter: The lowest prices for Basmati Rice are observed in December and January
    - Slightly Increased Prices During Peak Seasons: Prices tend to rise during festive periods such as October due to increased demand.
  - Oil
    - Price Fluctuations: Lower oil prices are observed in February



### 3. Forecasting

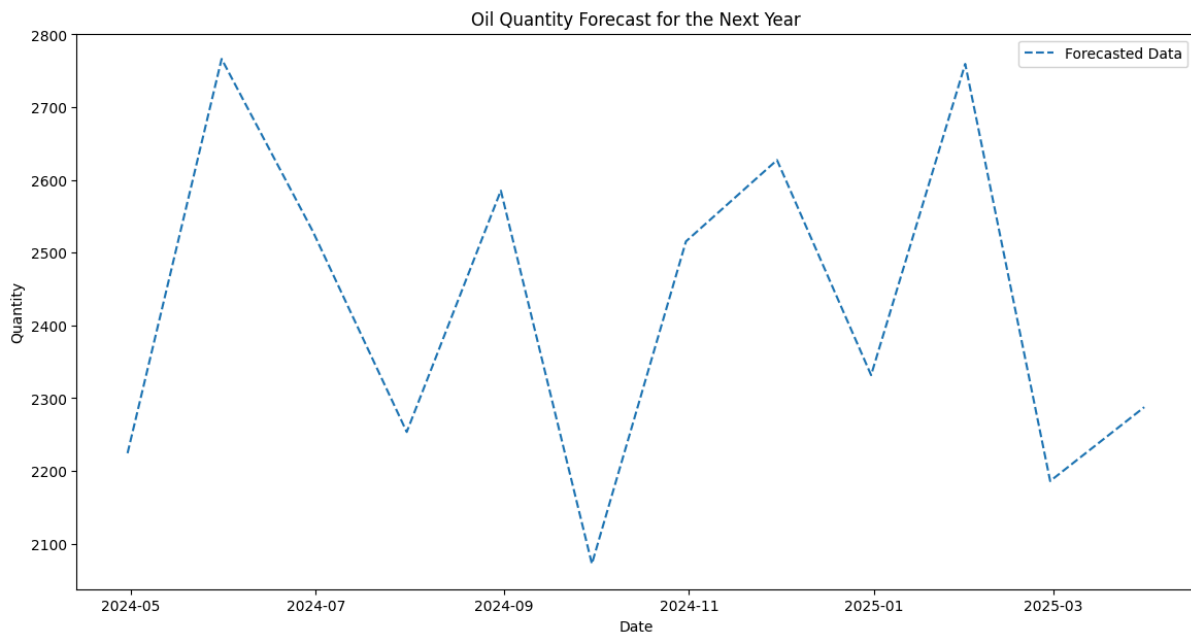


*Fig.11: Forecasting of Basmati Rice Inventory*

Effective forecasting of Basmati Rice inventory is essential for optimizing procurement strategies and managing supply chain dynamics. Accurate predictions help in mitigating potential risks associated with fluctuations in inventory levels and ensuring sufficient stock to meet future demand.

The forecasted inventory data for Basmati Rice over the next 9 months indicates the following:

- Anticipated Trends: The forecast reveals expected variations in inventory levels, which can guide strategic stock adjustments to handle anticipated demand changes.
  - October Demand Surge: The forecast indicates a significant increase in demand for Basmati Rice in October, coinciding with Durga Puja celebrations. To accommodate this anticipated surge, Kalpataru should strategically increase its inventory levels to ensure it can meet the higher demand during this period.
  - February and March Trends: While there is a notable increase in demand for Basmati Rice in February and March, the forecast suggests that these peaks are not as high as those observed in October. Consequently, procurement strategies should reflect this pattern, with a relatively lower inventory increase during these months compared to October.
- Strategic Stock Management: By aligning inventory procurement with the forecasted demand trends, Kalpataru can optimize its stock levels, minimize potential shortages, and better manage its inventory costs throughout the year.



***Fig.12: Forecasting of Oil Inventory***

Effective forecasting of Oil inventory is crucial for refining procurement strategies and balancing supply chain operations. Accurate forecasting enables the company to anticipate price trends, manage inventory levels efficiently, and minimize risks related to stock shortages or surpluses. By aligning procurement with forecasted demand and price fluctuations, Kalpataru can ensure consistent supply and cost-effectiveness.

The forecasted inventory data for Oil over the next 9 months indicates the following:

- **February Stocking Strategy**: The forecast data shows that February is an optimal time for higher oil procurement due to the lowest observed prices. By increasing inventory during this period, Kalpataru can take advantage of the reduced costs, leading to better profitability in the long run.
- **Year-Round Inventory Management**: To maintain operational efficiency and cost-effectiveness, Kalpataru should focus on monitoring price trends closely and adjust inventory levels accordingly. By doing so, the company can ensure it capitalizes on favorable pricing conditions and manages stock levels efficiently throughout the year.
- **Strategic Procurement**: Given Oil's longer shelf life, bulk procurement during lower price periods will not only help in reducing overall costs but also ensure a steady supply, preventing shortages and optimizing inventory turnover.

#### 4. Interpretation of Results and Recommendation

##### 1. Seasonal Fluctuations in Basmati Rice and Oil Prices

- Observation: The price of Basmati Rice changes throughout the year, with lowest during the winter months. For Oil, the price is lowest in February.
- Factors Influencing Prices
  - Production Costs: Variations in production costs throughout the year impact raw material prices. For instance, costs might decrease in winter due to **lower energy usage for storage**.
  - Agricultural Conditions: The lowest prices observed in December and January coincide with the **cultivation period of rice during December**. The drop in prices during these months is typical due to the higher availability of rice and oilseeds following the harvest season.
- Implication: Understanding these seasonal price fluctuations allows businesses to optimize procurement strategies. By purchasing raw materials like rice and oilseeds during their low-price periods, companies can:
  - Reduce Costs: Lower procurement costs during off-peak seasons can improve overall cost efficiency.
  - Enhance Profit Margins: Strategic stockpiling during periods of lower prices helps maintain profitability during times of price increases.

##### 2. Volatility of Prices in Raw Materials Compared to the End Good

- Observation
  - Price Variability in Raw Materials: Analysis indicates that prices for Basmati Rice and Oil exhibit significant volatility when compared to the relatively stable price of Biryani. This variability in raw material costs is more pronounced than the price fluctuations of the final product, Biryani.
- Implications
  - Cost Savings: By managing inventory in response to price fluctuations, businesses can reduce overall procurement costs and prevent sudden price increases for consumers.
  - Profit Maximization: Stable raw material costs contribute to consistent pricing strategies, supporting better profit margins and financial stability for the business.
- Recommendation
  - Stocking During Low Prices: To mitigate the impact of price fluctuations, businesses should strategically stock up on raw materials during periods of lower prices. By anticipating price drops and increasing inventory during these times, companies can buffer against future price hikes.

### 3. Effect of Festive Seasons on Demand

- Observation
  - Correlation with Festive Seasons: Analysis of sales data reveals a significant correlation between festive periods and fluctuations in Biryani demand. This pattern highlights how cultural events influence consumer behavior and purchasing habits.
- Implications
  - Demand Surge During Festivals: A marked increase in Biryani sales is observed during major festivals like Durga Puja in West Bengal, as **consumers opt for quick, delicious meals to complement their festive activities.**
  - Demand Decline During Holidays: Conversely, there is a noticeable drop in sales around holidays such as **Christmas and New Year**, likely due to a shift in consumer preference towards **upscale dining experiences**, reducing demand for local take-away options.
- Recommendation
  - Strategic Planning: Businesses should engage in effective forecasting and strategic inventory planning to optimize stock levels during peak demand periods. This ensures they can meet increased consumer demand during festivals, capitalize on sales opportunities, and avoid inventory shortages or missed sales.

### 4. Impact of Price Fluctuations on Cash Flow

- Observation: Fluctuations in raw material prices, particularly Basmati Rice and Oil, can cause significant variations in monthly cash outflows.
- Implication: Businesses may face cash flow challenges when prices peak, requiring careful budgeting and financial planning.
- Recommendation: Implementing a cash reserve strategy or securing favorable credit terms with suppliers during low-price periods can help manage cash flow more effectively.

### 5. Risk Mitigation through Diversified Sourcing

- Observation: Relying on a single supplier or region for Basmati Rice and Oil could expose the business to greater risks from price spikes or supply chain disruptions.
- Implication: Price volatility and supply risks can be exacerbated by external factors such as weather conditions, political instability, or global market trends.
- Recommendation: Consider diversifying suppliers or sourcing regions to reduce dependency on a single source. This approach can mitigate the risk of supply disruptions and provide leverage in price negotiations.