A Final Submission for the BDM Capstone Project

Unravelling the Dynamics of Inventory Management

Declaration Statement

I am working on a Project Title "**Unravelling the Dynamics of Inventory Managemen**t" I extend my appreciation to [**TAHAL RAM DEVENDRA KUMAR**], 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 analysed 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. If 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:

puneet

Name: Puneet Gunwani

Date: 05/03/2024

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EXECUTIVE SUMMARY

Unravelling the Dynamics of Inventory Management

This summary presents a thorough analysis of financial data from Tally software for Tahal Ram Devendra Kumar, overseen by Mr. Ashwani Kumar. The analysis covered data cleaning, exploratory data analysis (EDA), inventory analysis, demand forecasting, inventory optimization, and visualization/reporting.

Data cleaning ensured precision, followed by EDA to explore purchase and sales distributions, and calculate descriptive statistics. Inventory analysis provided insights into levels, turnover rates, and aging, while demand forecasting predicted future sales. Inventory optimization, including EOQ modelling, minimized costs and ensured optimal stock levels.

Pareto charts and multi-level Pareto analysis provided insights into sales distribution and inventory prioritization. Findings include seasonal sales fluctuations, heightened demand during weddings, and recommendations for inventory management, seasonal planning, promotions, resource allocation, and continuous monitoring.

Implementing these recommendations will enhance efficiency, optimize inventory, and drive growth for Tahal Ram Devendra Kumar.

This concise summary encapsulates the analysis process and key findings, providing stakeholders with insights for strategic decision-making and business success.

Detailed Explanation of Analysis Process/Method

In the process of consolidating and refining financial data extracted from Tally software, overseen by Mr. Ashwani Kumar, a rigorous and comprehensive approach was adopted. The dataset, spanning 7.5 months and initially maintained in Excel format, presented unique challenges that demanded meticulous attention.

Methods Used:

1. Data Cleaning: cleaning of data by removing unknown variables and inserting the date in right format using MS Excel.

2. Data Loading: Load the purchase and sales data from Excel files into Pandas Data Frames.

3. Data Preparation: cleaning was already done in midterm submission. Now, I Ensured that the date columns are in datetime format.

4. Exploratory Data Analysis (EDA):

   - Explored the distributions of purchase amounts and sales amounts.

- Calculate basic statistics like mean, median, and standard deviation for purchase and sales amounts.
- Visualize the distributions using histograms or box plots.

5. Inventory Analysis:

- Calculated inventory levels over time by aggregating purchase and sales quantities.
- Determined the inventory turnover rate.
- Analysed inventory aging to identify slow-moving or obsolete items.

6. Demand Forecasting:

- Used time series forecasting techniques to predict future sales.
- Forecast demand for individual products or categories.

7. Inventory Optimization:

- Determine reorder points and reorder quantities.
- Implement inventory classification methods.

8. Visualization and Reporting: Create visualizations and reports to present the findings and recommendations.

Cleaning Of Data: -

Initiate data cleaning using Excel as the initial step.

There were so many files initially, some of them are: -

https://docs.google.com/spreadsheets/d/1LerzW8A4GfrOJcjHofjfx4xsil_7jm1RAv6Jbwhi-qA/edit?usp=sharing

https://docs.google.com/spreadsheets/d/1AWuo99y28gKXshG3du6pXx1ezz9UV2eLqqvjhwOA9os/edit?usp=sharing

https://docs.google.com/spreadsheets/d/1DKAHgV9NtiQIZYUxVPDdchRqX3aJm9V1-CVZ17uHnC0/edit?usp=sharing

https://docs.google.com/spreadsheets/d/1KhMAam3OikGc-X1LMEsvPDLl8RGCl-yUDE4cjNc9rsk/edit?usp=sharing

(PERMISSION ONLY GIVEN TO IIT MADRAS)

These data are for sales and purchase, In Mid-Term submission I cleaned data for one product I am avoiding data cleaning process as it is not much relevant here.

I systematically refined the dataset by aligning it with the original source. Discrepancies were identified, particularly in the form of extraneous columns absent from the original data. Subsequently, a deliberate decision was made to eliminate these superfluous columns from our Excel file, ensuring a more streamlined and accurate representation of the pertinent information.

Having successfully curated and refined the dataset, we proceeded to leverage the capabilities of data visualization within Excel. The resulting charts afford us valuable insights into the sales and procurement activities of Tahal Ram Devendra Kumar.

Data Loading: Let us start by loading the data into Python using Pandas. I had my Excel files ready, as I cleaned it in midterm submission using excel.

First, I commenced by importing the requisite data into my Python environment

EDA (Exploratory Data Analysis):

, I conducted an **exploratory data analysis (EDA)** on both sales and purchase datasets, meticulously examining their distributions.

Furthermore, I performed comprehensive descriptive statistical analyses to gain deeper insights into the datasets. To facilitate a clearer understanding, I utilized histograms and various graphical plots to visually represent the data. These measures were undertaken to enhance comprehension and interpretation of the data sourced from our store.

Descriptive Statistics

Purchase Data Statistics:		Sales Data Statistics:	
	Amount		Amount
count	1.470000e+02	count	3.460000e+02
mean	2.019408e+05	mean	4.551420e+05
std	3.785220e+05	std	3.115141e+05
min	2.500000e+01	min	2.400000e+01
25%	1.571140e+05	25%	2.855000e+04
50%	5.157500e+04	50%	3.772650e+05
75%	6.522500e+05	75%	2.338022e+05
max	1.945149e+06	max	1.835050e+06

Purchase Data:

1. Count: There are 147 transactions recorded in the purchase data.

2. Mean: The average purchase amount is approximately 4,55,142 INR. This represents the central tendency of the purchase amounts.

3. Standard Deviation: The standard deviation of approximately 378,522 INR indicates the dispersion or variability of purchase amounts around the mean. A higher standard deviation suggests greater variability in purchase amounts.

4. Minimum and Maximum: The minimum purchase amount recorded is 24 INR, while the maximum is 1,835,050 INR. This range highlights the spread of purchase transactions, indicating the diversity in transaction sizes.

5. Percentiles (25th, 50th, and 75th): These percentiles provide insights into the distribution of purchase amounts. For example, the 25th percentile (Q1) is 157,114 INR, indicating that 25% of the transactions have purchase amounts below this value. Similarly, the median (50th percentile or Q2) is 377,265 INR, which represents the middle value of the data. The 75th percentile (Q3) is 652,500 INR, indicating that 75% of the transactions have purchase amounts below this value.

Sales Data:

1. Count: There are 346 transactions recorded in the sales data.

2. Mean: The average sales amount is approximately 201,940 INR, indicating the central tendency of sales transactions.

3. Standard Deviation: The standard deviation of approximately 311,514 INR suggests variability in sales amounts around the mean.

4. Minimum and Maximum: The minimum sales amount recorded is 25 INR, while the maximum is 1,945,149 INR. This range highlights the diversity in sales transaction sizes.

5. Percentiles (25th, 50th, and 75th): Like purchase data, these percentiles provide insights into the distribution of sales amounts. For example, the 25th percentile (Q1) is 28,550 INR, the median (50th percentile or Q2) is 51,575 INR, and the 75th percentile (Q3) is 233,802 INR.

which can guide further analysis and decision-making in inventory management and financial planning.
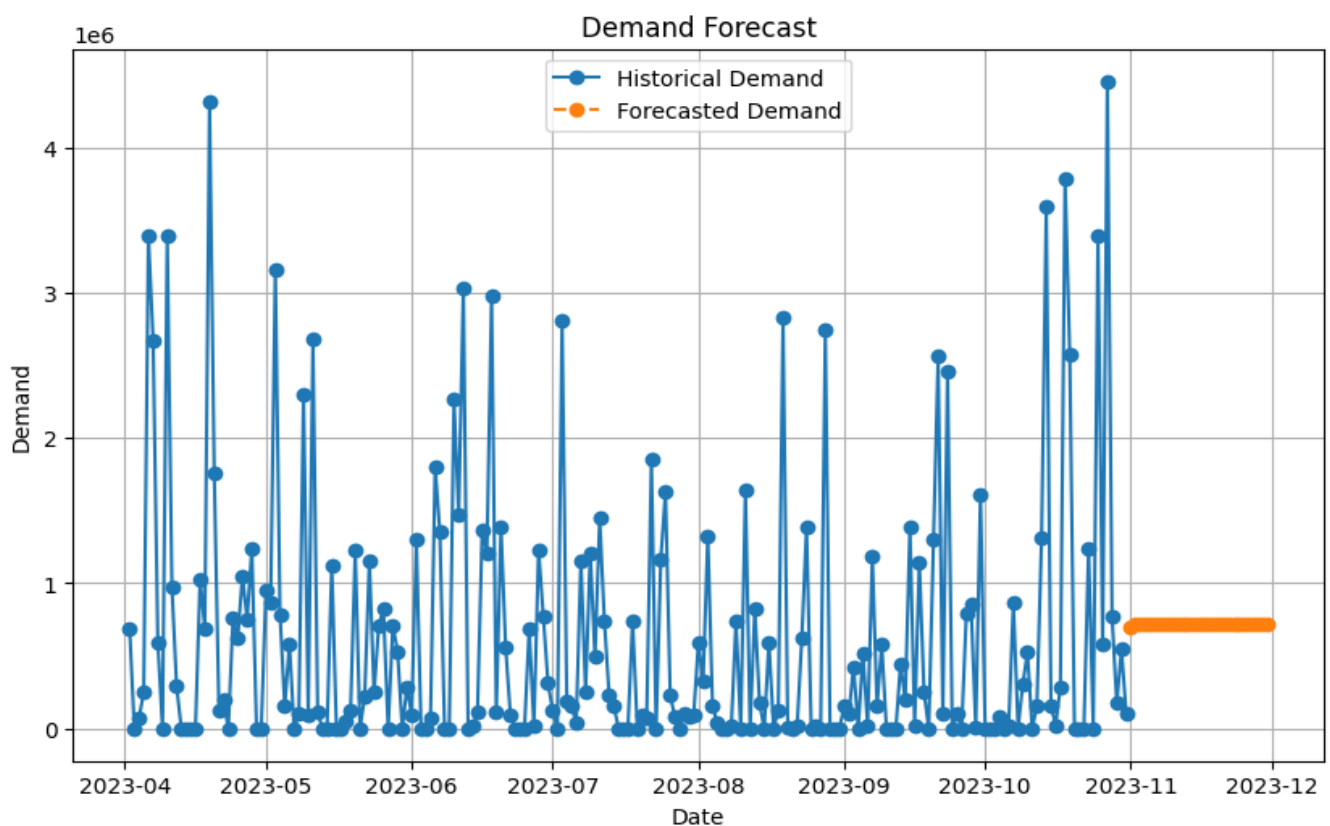
Inventory Analysis:
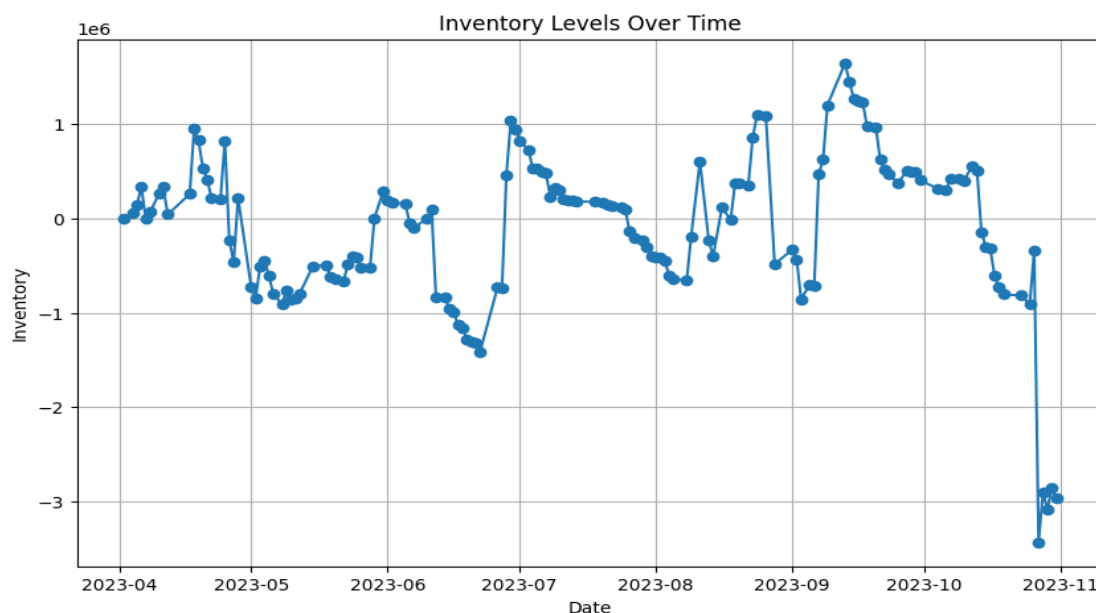
Now, I have calculated the inventory levels over time by summing up the changes in inventory due to purchases and sales. The plot shows how the inventory levels have changed over time. In last we can see dip this is because of construction going on and data is up to 15th December only.

**Demand Forecasting (Time Series Analysis):**

Demand Forecasting using ARIMA model-

- We concatenate the purchase and sales data to create a single demand dataset.

- We resample the data to daily frequency and fill any missing values with 0.

- We plot the demand data to visualize its trend and seasonality.

- We check for stationarity using the autocorrelation function (ACF) and partial autocorrelation function (PACF) plots.

- We fit an ARIMA model to the demand data.

- We forecast future demand using the fitted ARIMA model.

- Finally, we plot the historical demand along with the forecasted demand.

- Now we will check stationarity using most important function in TSA (Time Series Analysis) which is PACF and ACF.
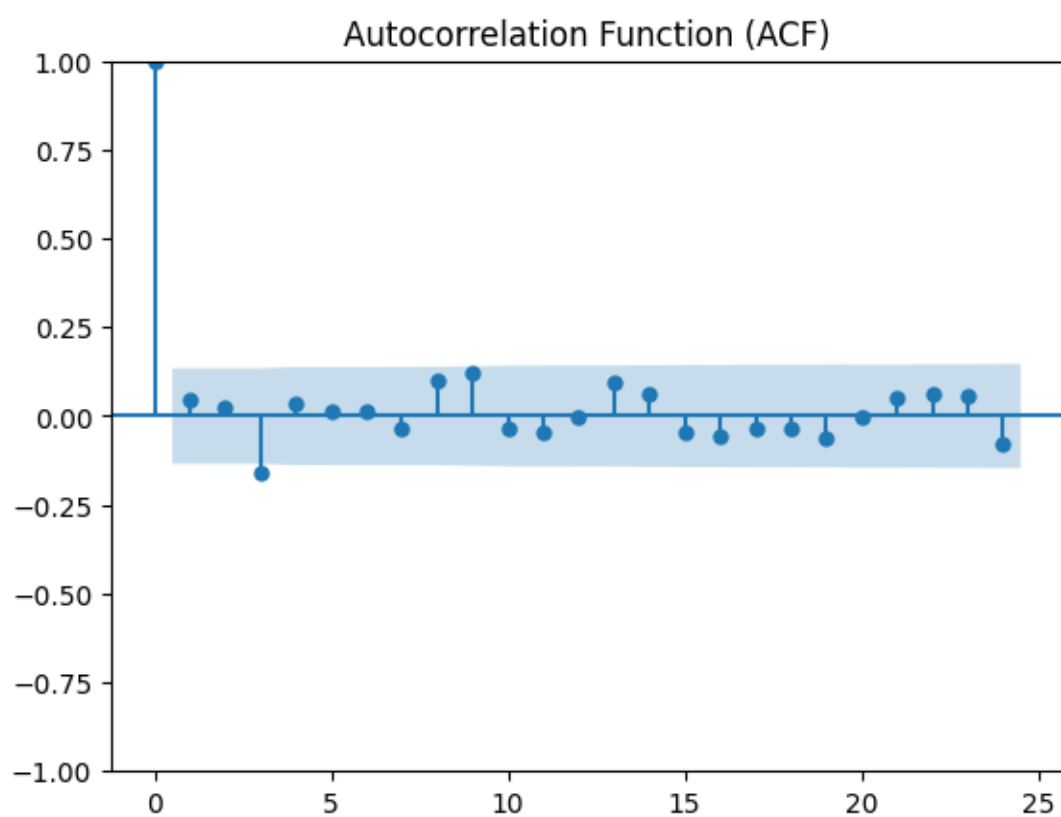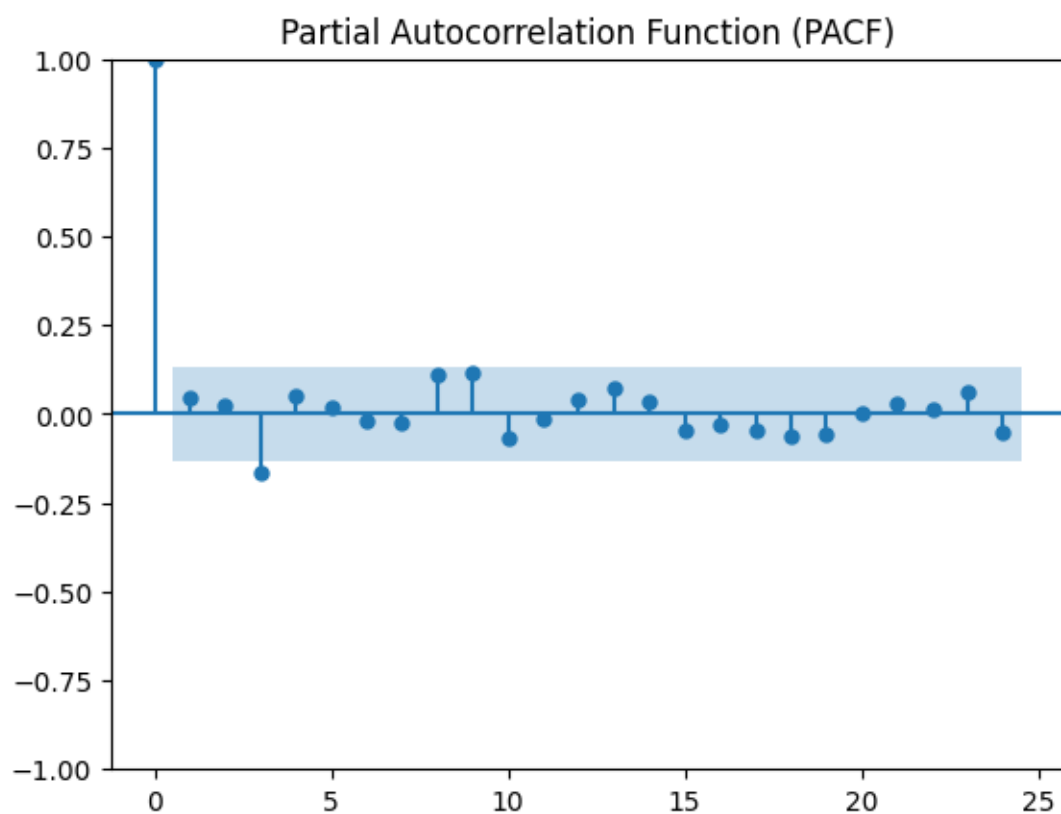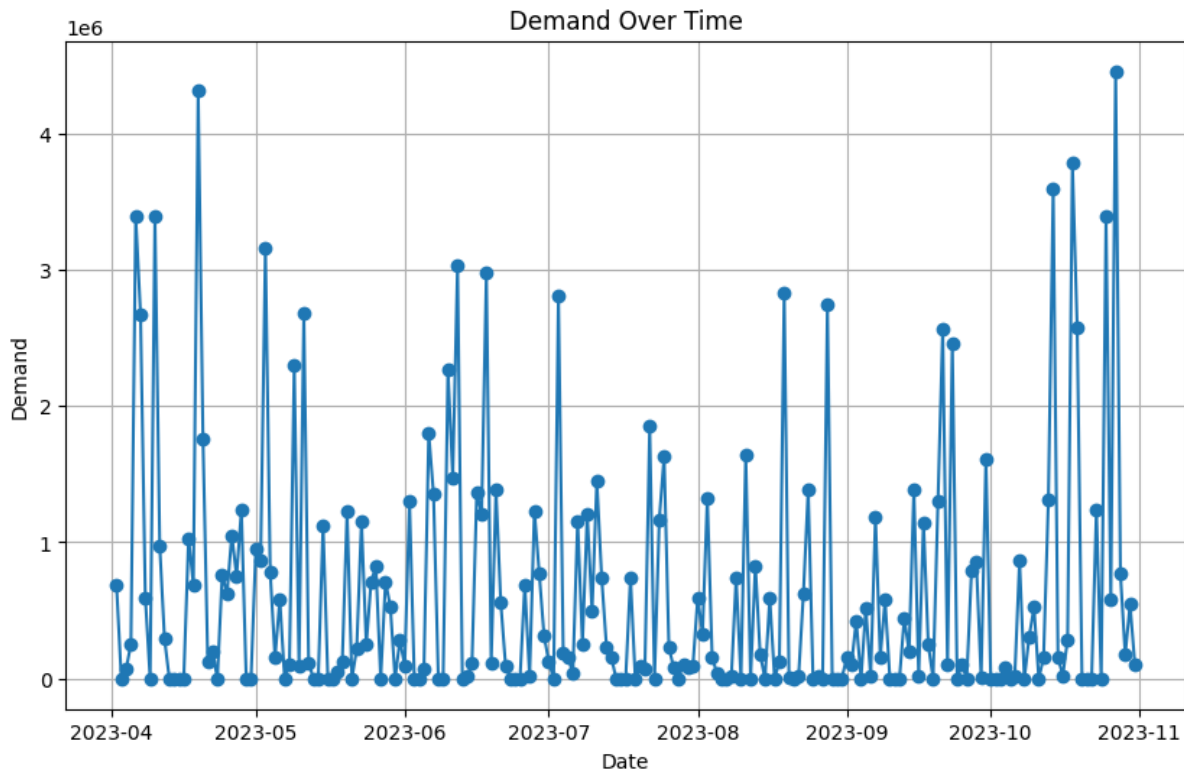
Inventory Optimization:

Inventory optimization involves determining the optimal reorder points and quantities to ensure that inventory levels are sufficient to meet demand while minimizing excess inventory and associated costs. There are various methods and approaches to inventory optimization, and one common technique is the Economic Order Quantity (EOQ) model.

The EOQ model calculates the optimal order quantity that minimizes total inventory costs, considering factors such as ordering costs, holding costs, and demand rate.

Our procedure:

- We calculate the demand rate as the average demand per unit time from the historical demand data.

- We define the ordering cost per order, which represents the cost incurred each time an order is placed.

- We define the holding cost per unit, which represents the cost of holding one unit of inventory per unit time.

- We calculate the EOQ using the EOQ formula.

- We calculate the reorder point, which is the inventory level at which a new order should be placed.

- Finally, we print the calculated EOQ and reorder point.

3. Inventory Optimization Results:

- Economic Order Quantity (EOQ): 566633.6270677409

- Reorder Point: 4495031.342535212

The EOQ is calculated to be approximately 566633. This means that if Tahal Ram Devendra Kumar order this Amount of quantity each time, they will minimize the total cost associated with inventory, considering both the cost of ordering, and holding inventory.

The reorder point is calculated to be approximately 4495031. This means that when the inventory amount level reaches this point, it is time to place a new order to avoid running out of stock before the new order arrives.
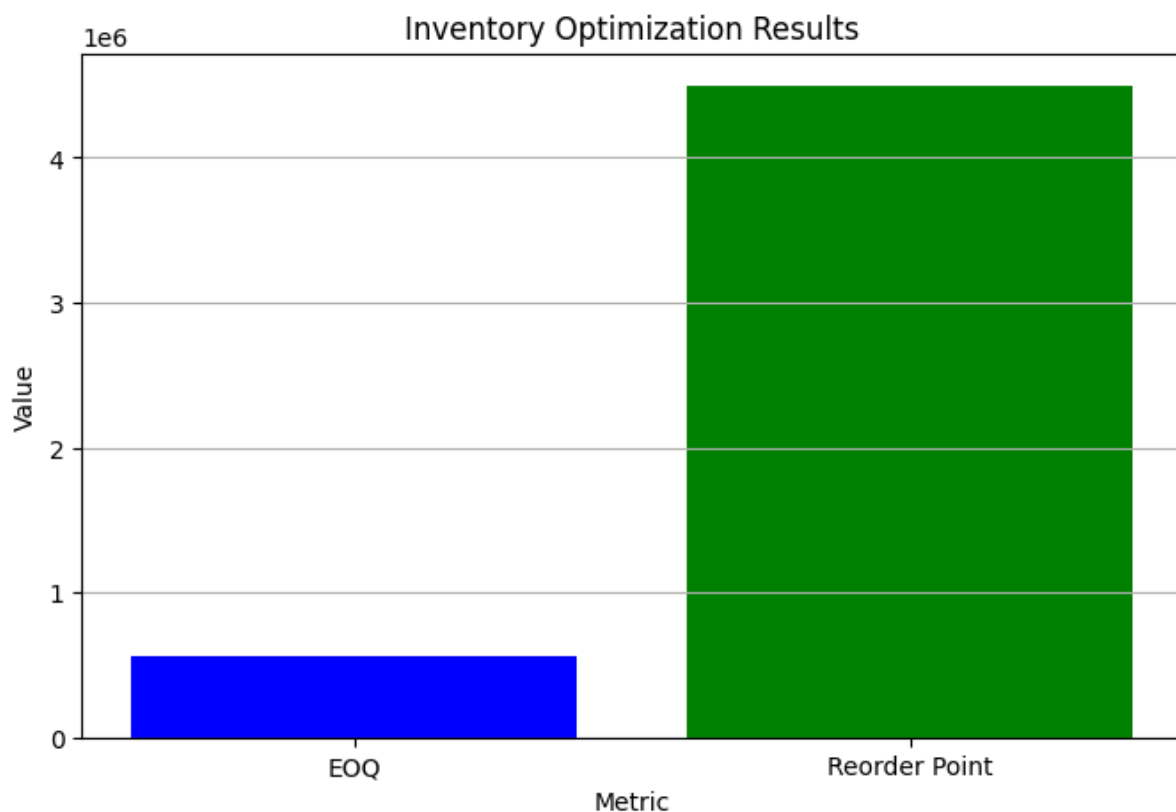

# Results and Findings (Visualization and Reporting)

Initially, we conducted an exhaustive examination of the store's sales and purchase records to gain a comprehensive understanding of the data. Subsequently, we employed Pareto charts to identify the months with the highest sales volume, enabling us to prioritize our analytical focus. Finally, we performed an ABC analysis of the inventory, categorizing stocks based on their relative importance. This facilitated the identification of high-priority stocks warranting immediate attention, as well as less critical items. By leveraging the insights

gleaned from these analyses, we pursued inventory optimization strategies to enhance overall efficiency and performance, considering various product dynamics.

SALES
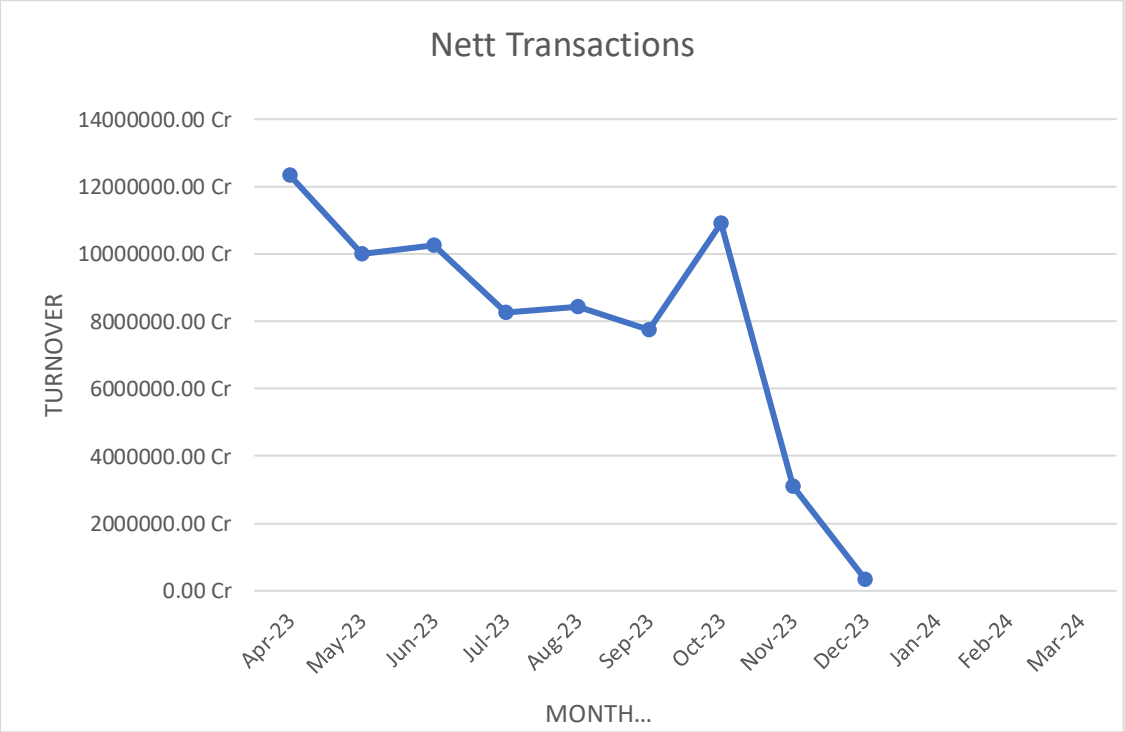
PURCHASE
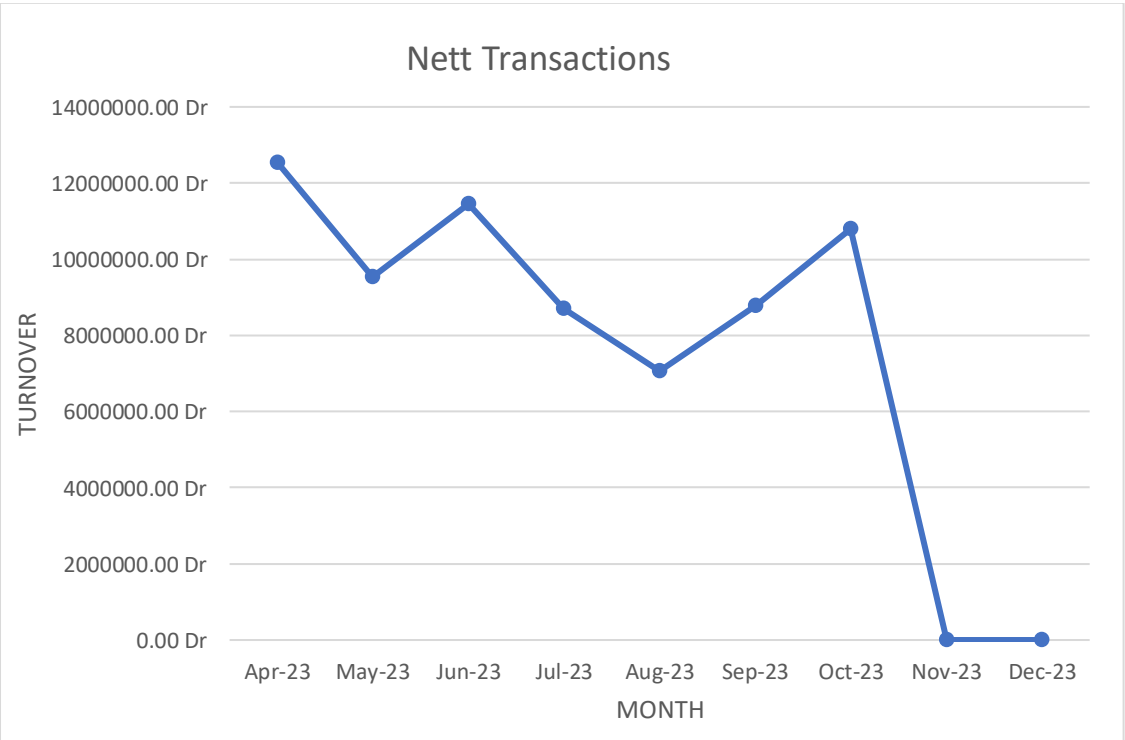
These two charts interpreting the nett transaction per month.

Our analysis allows us to discern patterns in sales fluctuations across different months, providing a comprehensive overview of the sales dynamics. This strategic evaluation identifies peak sales months, allowing for targeted strategies to capitalize on favourable market conditions.

Moving forward, our secondary **project objective** centres around the meticulous management of inventory data. This entails implementing a comprehensive inventory control system to optimize stock levels, streamline procurement processes, and ensure efficient supply chain management. By addressing both sales optimization and inventory management, we aim to enhance overall operational efficiency and drive sustained business growth.

The dataset for November and December presents challenges due to its incomplete nature, extending only until the 15th of December. During this period, notable fluctuations were observed in procurement patterns. Specifically, a reduction in stock acquisition was noted in November, attributable to ongoing warehouse maintenance and construction activities undertaken by Tahal Ram Devendra Kumar. This temporary slowdown in stock acquisition coincided with the infrastructure enhancements in their warehouse facility, impacting operational dynamics during the specified timeframe.
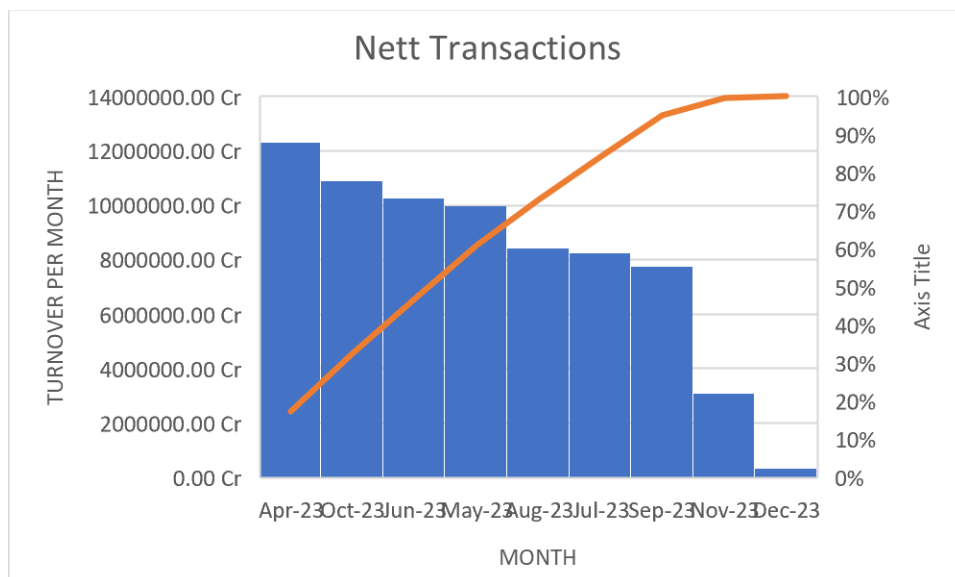
PARETO CHARTS

SALE DATA
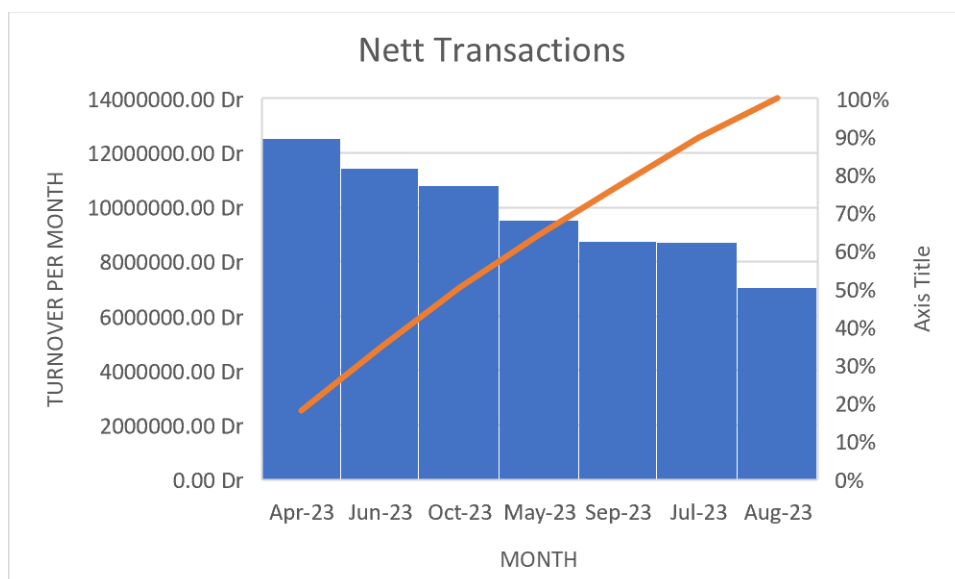
Utilizing Pareto analysis, it becomes evident that substantial sales peaks occurred notably in April, June and October surpassing the significant threshold of 1 crore. This observation aligns with prevailing regional beliefs in India, where the preferred months for wedding

celebrations, as per most Hindu traditions, span from October to December and mid-April to May. Notably, the data suggests a correlation between heightened sales and the wedding season, wherein customers exhibit increased demand for diverse products, particularly staples such as oil, sugar, and Maida (wheat flour), essential for wedding preparations.

Recognizing this trend, it is recommended that Tahal Ram Devendra Kumar strategically anticipates the surge in demand during the wedding season. Proactive inventory management practices, such as pre-stocking these high-demand products well in advance of the wedding season, would be instrumental in capitalizing on the lucrative market conditions and maximizing overall sales. This strategic approach ensures not only the satisfaction of customer requirements during peak periods but also enhances operational efficiency and revenue generation for the business.
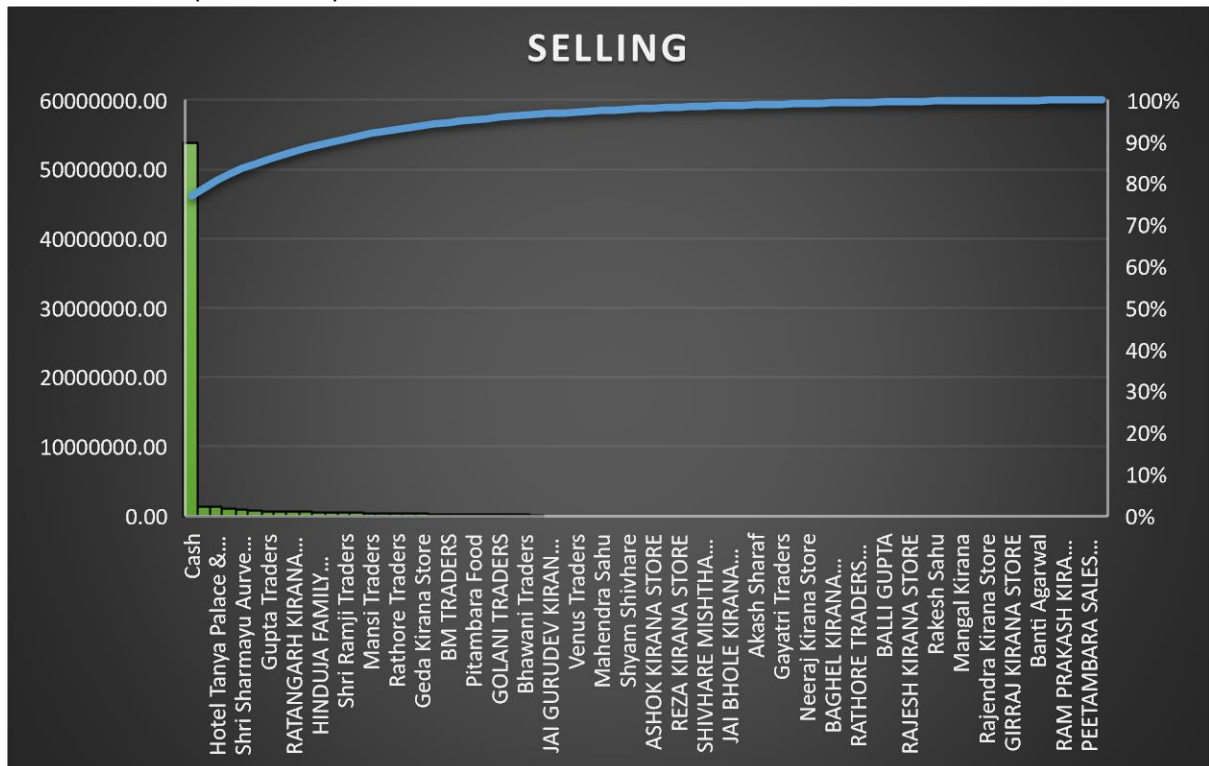
PURCHASE DATA

The Pareto chart depicting Tahal Ram Devendra Kumar's procurement activities reveals a discernible pattern, with the highest purchasing volume occurring notably in April, succeeded by substantial transactions in October, June, and May, among others.

**Objective of Debit stock and Credit Stock charts:**

1. By analysing our data, we can identify our top customers who consistently make large purchases from our store.

2. This analysis also helps us address our second issue, which is the impact of loan issuance on our profitability. We have been facing challenges because we have extended significant loans to customers, which has affected our profits and overall financial health, especially in a competitive market.

3. Additionally, by examining these charts, we can prioritize our best-selling products. The names listed on the x-axis under "credit stock" represent the dealers from whom Tahal Ram Devendra Kumar buys stock to sell.

DEBIT STOCK:-(**sales data**)

CREDIT STOCK:-(**purchase data)**
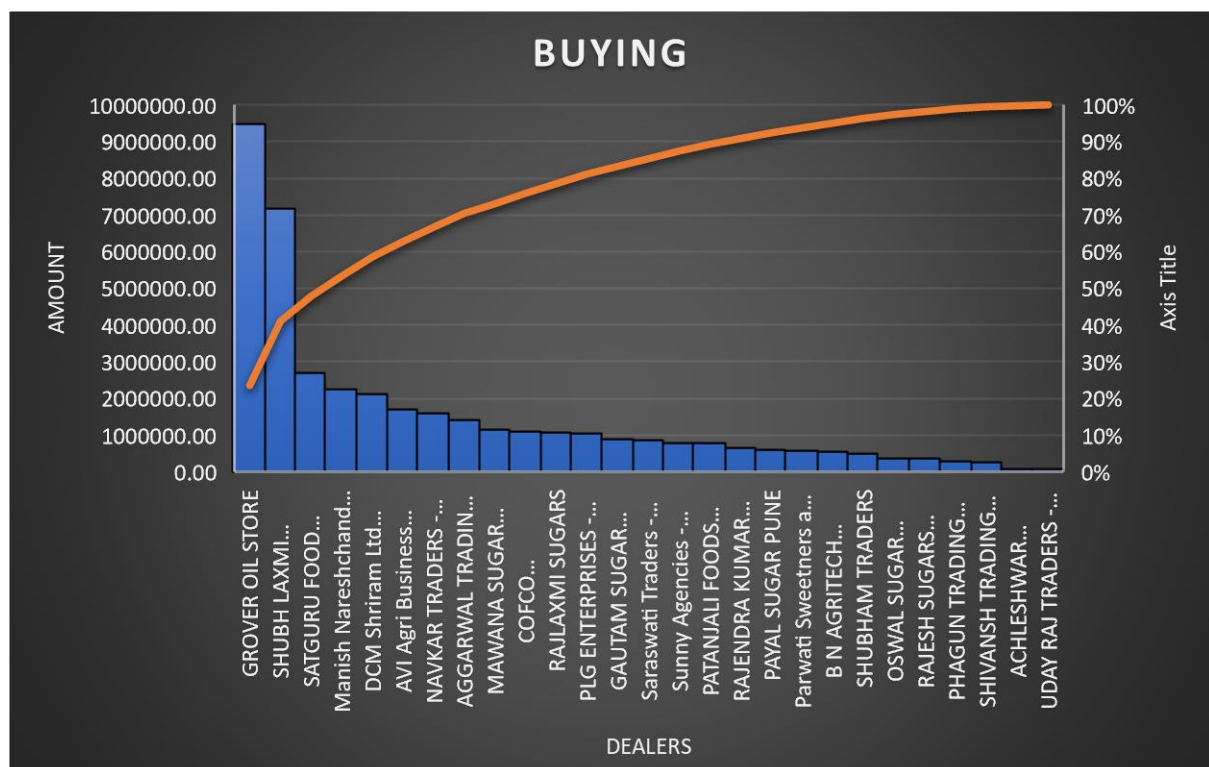
It is noteworthy that cash transactions predominate the primary sales channels, indicating a preference for **immediate payments** and a reliance on traditional financial methods. This insight into transaction preferences can inform financial management strategies and facilitate smoother transactions between Tahal Ram Devendra Kumar and their clientele.

Further analysis reveals the composition of product categories driving sales within Tahal Ram Devendra Kumar's portfolio. The data highlights that the highest sales volumes are attributed to **oil products**, indicating a strong demand for cooking oils among consumers. Following closely behind are flour and sugar, with each product category demonstrating distinct patterns of procurement and distribution.

For instance, the sugar procurement process involves engagement with multiple suppliers, including prominent transactions with Sat guru Foods and Manish Naresh Chand Jain. This diversified sourcing strategy suggests a deliberate effort to ensure product availability and mitigate supply chain risks.

Based on these findings, it is evident that optimizing inventory management for Tahal Ram Devendra Kumar should prioritize oil products due to their significant contribution to overall sales revenue. This can be followed by strategic management of sugar and flour inventory to align with customer demand patterns and maximize profitability.

Inventory Management Optimization: -

Upon examination of our Pareto charts, which provide insights into our sales distribution, and our multi-level Pareto analysis, also known as ABC analysis, we have identified our **top-selling products (3 Oil and two edible Products)** as follows:

1. MAHAKOSH 13.5 kg jar
2. MAIDA 50 kg
3. MAHAKOSH 1ltr*12 packet (offer)
4. Sugar M-31 50 kg
5. MAHAKOSH 899G (1L petti)

Conversely, the products with the **least sales**, indicating prolonged inventory retention, are:

1. Surya Gold Vanaspati
2. Nutrilive refined soyabean oil

Objective: -

By analysing our products, we can forecast the demand for specific items identified through our ABC or multi-level Pareto analysis. This enables us to efficiently manage inventory by allocating resources to items that are in high demand during peak selling periods.

Now, let us proceed with the analysis of these selected products. We have meticulously refined our dataset by addressing missing values and conducting deep cleaning to ensure the accuracy of our analysis."

MAHAKOSH 13.5 kg jar

I have manually cleaned the data and after cleaning of each product I visualize the data using MS Excel and create the following visualizations: -

Findings from this data is this: -

MAHAKOSH 13.5 kg jar
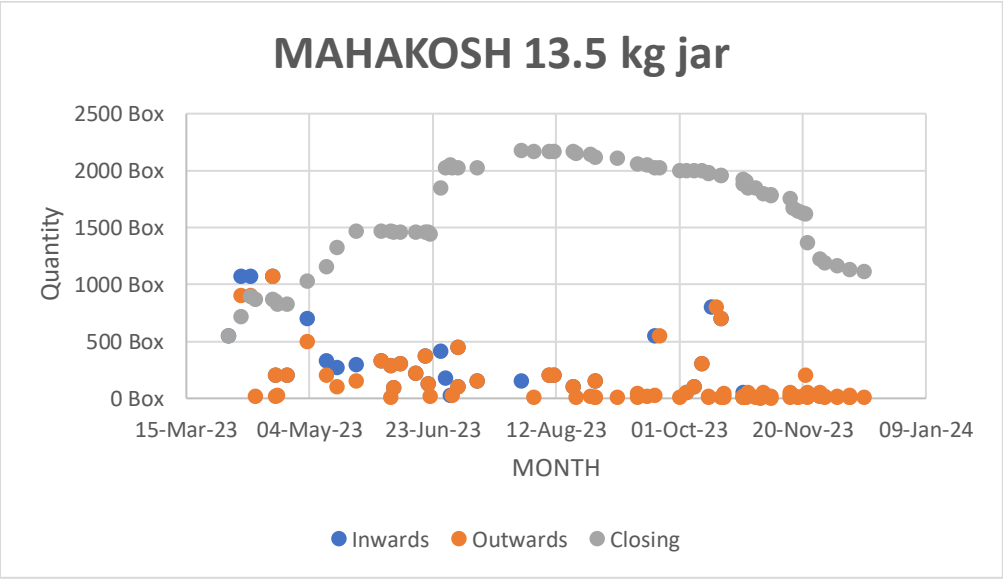
The MAHAKOSH 13.5 kg jar experienced a surge in demand in April-May, leading to excess inventory. Strategic resource reallocation to high-demand products like Mahakosh's promotional offer is essential. October-November sales uptick highlights the need for agile inventory management to maximize revenue and operational efficiency.

MAIDA 50kg
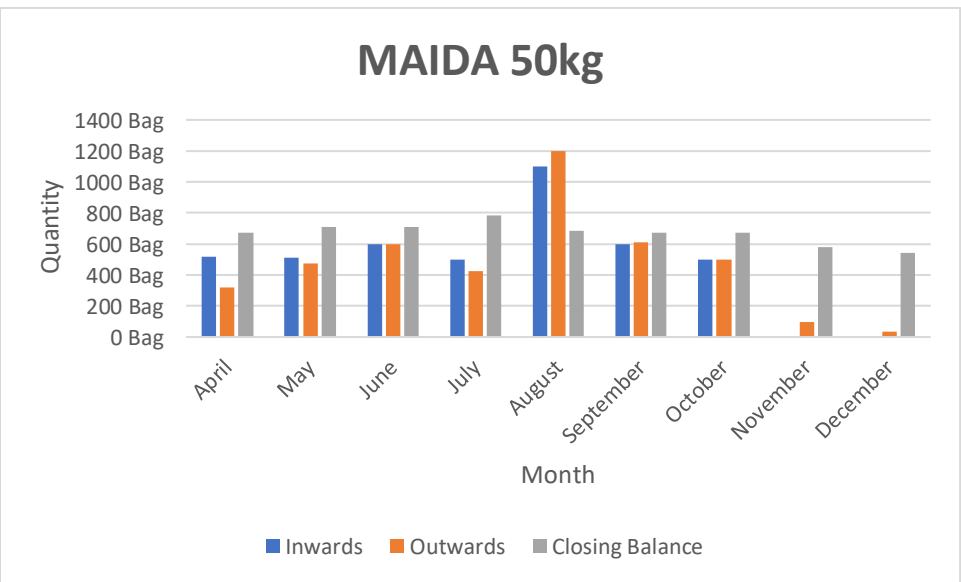
Maida or flour, a flagship product of Tahal Ram Devndra Kumar, consistently shows strong sales performance. Sourced solely from Satguru Foods, sales optimization is evident, notably in April with 300 bags sold and a peak of 1200 bags in August. However, November-December sales dipped due to warehouse construction. Historical data suggests a cyclical pattern, highlighting June, August, and September as optimal times to boost flour inventory for heightened demand.

**MAHAKOSH 1litre offer pack**
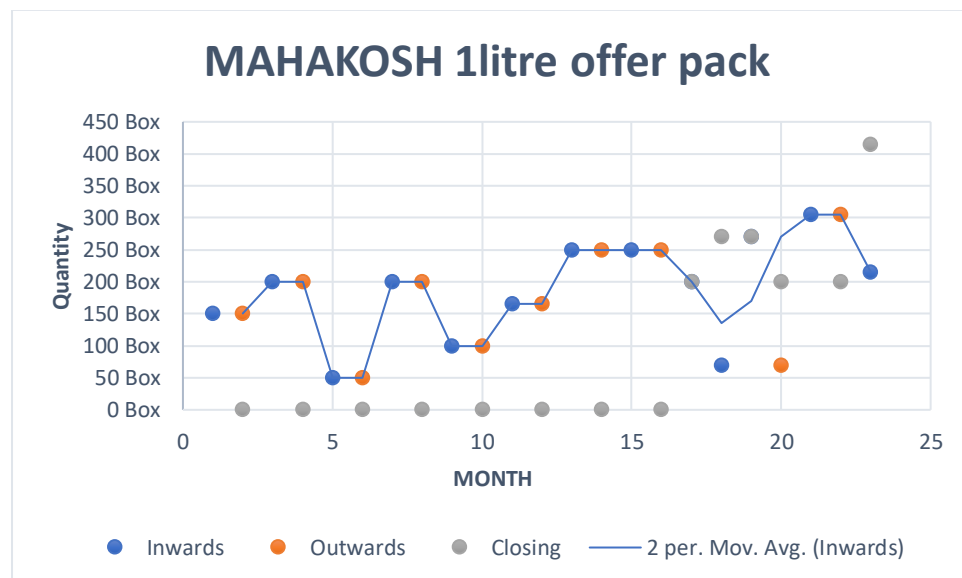
The product under discussion features a unique promotional bundle, including 10 1-liter pouches of soybean oil and 2 1-liter pouches of sunflower oil. Analysis indicates that products offered with such incentives experience accelerated sales rates due to perceived added value by customers. This promotional offer, implemented from May to July 2023, aimed to promote the company's sunflower oil. Insights suggest future similar offers are likely to generate significant sales. Hence, Tahal Ram Devendra Kumar may consider procuring bulk quantities of these products. It is important to note that prolonged inventory maintenance may be unnecessary due to rapid turnover and minimal storage requirements

SUGAR M-31 50KG__PP
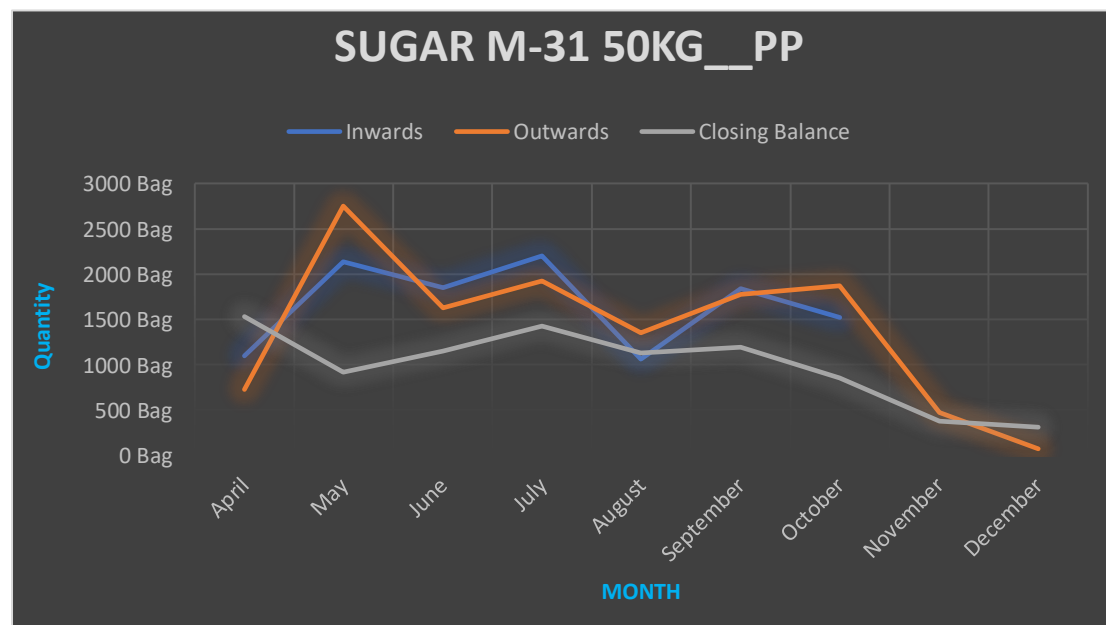
Analysis of the SUGAR M-31 50KG__PP demand chart reveals a spike in May, with a 500-bag supply shortfall. Predictive modelling can aid in forecasting future demand, optimizing inventory. August saw a downturn aligning with rainy season concerns. October shows a demand resurgence, guiding inventory decisions. This approach ensures meeting customer needs while managing seasonal risks.

MAHAKOSH 899G (1L petti)
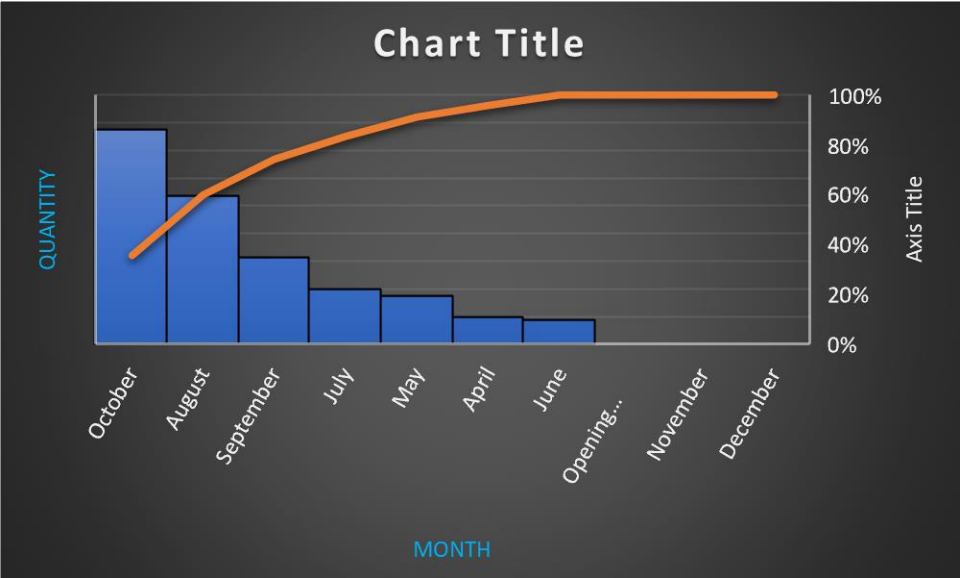
The Pareto analysis highlights October as the top-selling month, followed by August, September, and July, indicating an opportunity to prioritize inventory for October to meet peak demand. Additionally, the absence of November and December sales data reflects a deliberate pause in distribution due to warehouse construction, ensuring operational efficiency. Leveraging these insights, Tahal Ram Devendra Kumar can optimize inventory allocation and navigate operational challenges effectively.
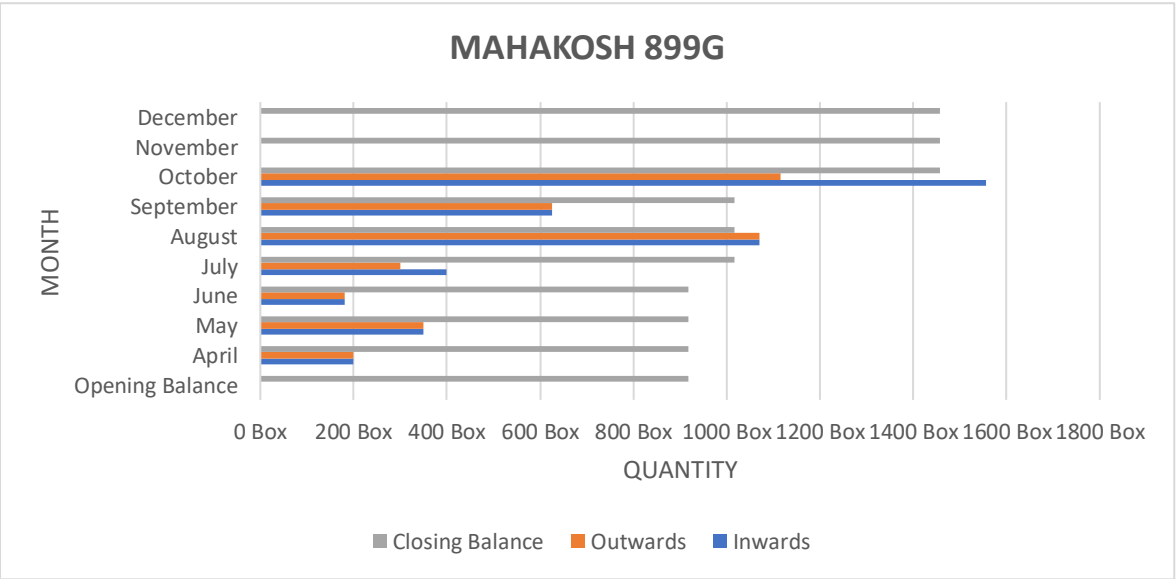
The company maintained a significant inventory of the product before April, allowing strategic management by prioritizing sales and procuring fewer quantities from distributors.

Post-July, demand surged due to promotional offers on specific products, notably MAHAKOSH 899G (1kg petti). Recognizing this trend, Tahal Ram Devendra Kumar can optimize inventory utilization and capitalize on emerging demand trends, ensuring efficient resource management.

Surya Gold Vanaspati
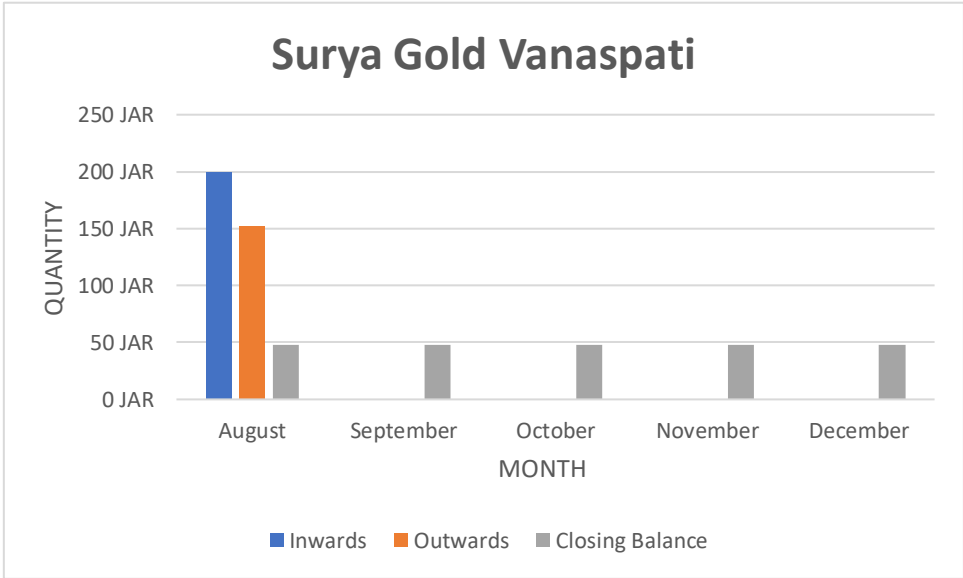
The analysis reveals an inventory surplus for Surya Gold Vanaspati, with 200 jars procured but only 152 sold in August, resulting in immobilized capital. This stagnant inventory poses a risk to cash flow, hindering operational liquidity and business functionality. To address this challenge, implementing effective inventory management strategies such as optimizing procurement, monitoring demand closely, and expediting inventory movement is crucial. By doing so, Tahal Ram Devendra Kumar can enhance cash flow efficiency, minimize financial risks, and adapt to market dynamics for sustained growth and stability.

Nutrilive refined soyabean oil
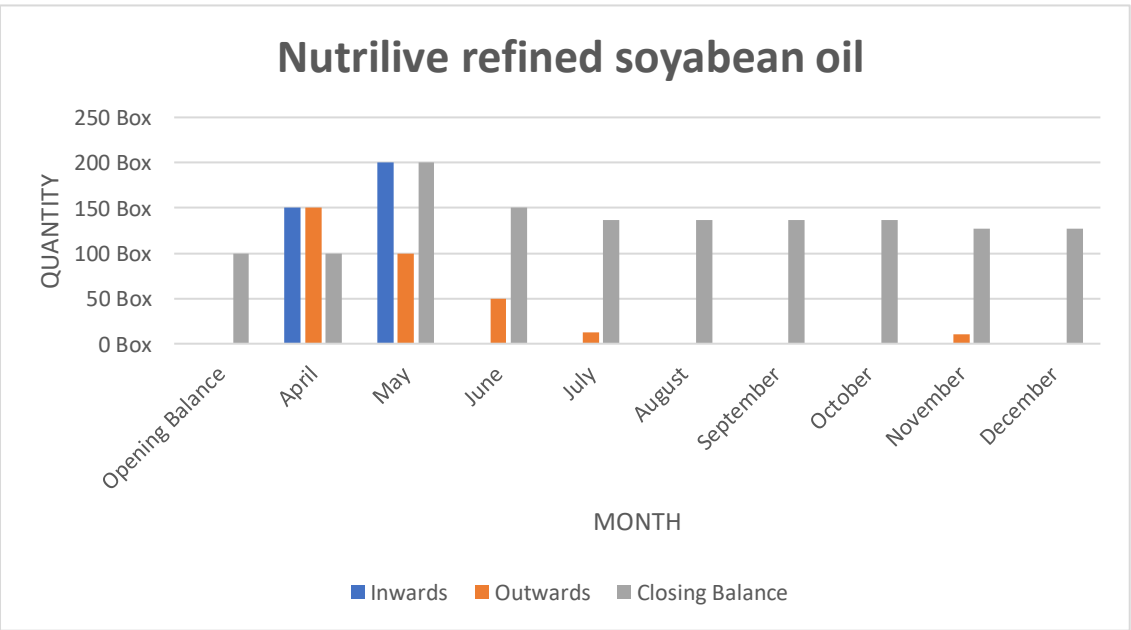
The analysis reveals a decline in demand from May to July, resulting in stagnant inventory accumulation and cash flow challenges. To optimize profitability, Tahal Ram Devendra Kumar should focus on high-demand products, reallocating resources from low-performing items. This strategic inventory management approach involves monitoring market demand, adjusting procurement strategies, and promptly responding to consumer preferences. By aligning inventory investments with market dynamics, the company can enhance efficiency, mitigate financial risks, and drive sustainable profitability.

Interpretation of Results and Recommendation

1. Data Cleaning and Preparation:

   - Through meticulous cleaning and preparation of the data extracted from Tally software, irrelevant variables were removed, and dates were formatted correctly.

   - The dataset was refined to ensure precision and efficiency in subsequent analyses.

2. Exploratory Data Analysis (EDA):

   - EDA provided insights into the distributions of purchase and sales amounts, allowing for a deeper understanding of the data.

   - Descriptive statistics such as mean, median, and standard deviation were calculated, offering valuable context for the dataset's characteristics.

3. Inventory Analysis:

   - Inventory levels were tracked over time, enabling the determination of inventory turnover rates and identification of slow-moving items.

   - Analysis of inventory aging facilitated the recognition of obsolete inventory items, crucial for optimizing inventory management strategies.

4. Demand Forecasting:

   - Time series forecasting techniques were employed to predict future sales, aiding in inventory planning and procurement decisions.

   - Forecasted demand for individual products or categories provided insights into expected sales trends.

5. Inventory Optimization:

   - Economic Order Quantity (EOQ) model was utilized to determine optimal reorder points and quantities, minimizing inventory costs while ensuring adequate stock levels.

   - Implementation of inventory classification methods facilitated the prioritization of high-demand products for efficient resource allocation.

6. Visualization and Reporting:

- Visualizations such as Pareto charts and multi-level Pareto analysis offered comprehensive insights into sales distribution and inventory prioritization.

- Detailed reporting of findings and recommendations provided actionable insights for strategic decision-making.

Recommendations:

1. Strategic Inventory Management:

- Prioritize high-demand products identified through Pareto analysis for proactive inventory management like keeping Maida in august and sugar in month of may rather than keep 899gm(1L) oil packet in these months.

- Implement inventory control systems to optimize stock levels and streamline procurement processes. (using new generation method and inventory alarm system they can maintain their inventory easily)

2. Seasonal Demand Planning:

- Anticipate and prepare for peak demand periods, such as the wedding season, by pre-stocking high-demand products.

- Utilize historical sales data to forecast demand fluctuations and adjust inventory levels accordingly (As we can see using ARIMA Model we forecasted the demand)

3. Promotional Strategies:

- Leverage promotional offers, as observed with MAHAKOSH 1-liter offer pack, to stimulate sales and capitalize on market opportunities.

4. Efficient Resource Allocation:

- Allocate resources towards top-selling products identified through ABC analysis to maximize revenue generation.

- Optimize procurement practices to ensure timely replenishment of inventory while minimizing excess stock.

5. Continuous Monitoring and Adaptation:

- Regularly monitor sales trends and inventory levels to identify emerging patterns and adjust strategies accordingly.

- Stay agile in responding to market dynamics, such as seasonal fluctuations and changes in consumer preferences, to maintain competitiveness.

By implementing these recommendations, Tahal Ram Devendra Kumar can enhance operational efficiency, optimize inventory management practices, and drive sustainable growth in their business endeavours.