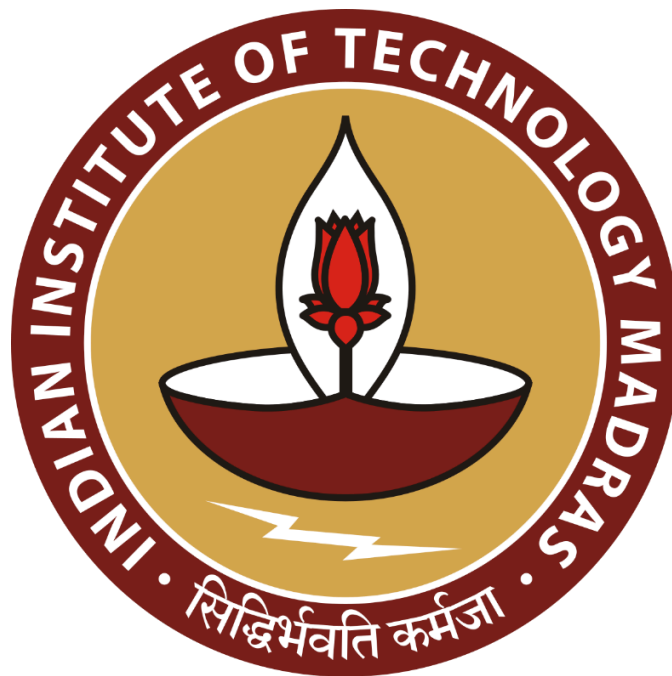# "Optimizing Inventory Management for a Kitchen Appliances Retailer: A Primary Data Analysis "

A Final report for the BDM capstone Project

Submitted by

Name: Yash Karsh

Roll number: 22f3002322

IITM Online BS Degree Program,

Indian Institute of Technology, Madras, Chennai

Tamil Nadu, India, 600036

Contents

1.   Executive Summary

Anand Steel Emporium is a kitchen appliances retail shop located in Korba, Chhattisgarh. Established in 2010, it is owned and operated by Mr. Anand Sahu, employing 2 full-time staff. The shop specialises in products such as pressure cookers, induction cooktops, and mixer grinders, serving a loyal customer base in the region. The business operates 7 days a week, generating an estimated annual income of ₹35–40 lakh. Despite healthy demand, it faces persistent inventory management issues, including frequent stockouts of fast-moving items, overstocking of slow-moving products, and capital being locked in unsold inventory, thereby reducing sales opportunities and operational efficiency.

To address these issues, primary data was collected directly from purchase and sales registers, covering transactions from 2023 to mid-2025. The dataset included 300 restocking records and 1,000 sales entries. Data cleaning involved standardising dates, merging product names, and removing duplicates or negative entries. Analytical methods applied included descriptive statistics, ABC analysis for product classification, and time series trend analysis, using Python and Excel.

The analysis revealed several critical insights. Purchase value peaked in 2024 at ₹1.05 crore but declined sharply in 2025 to ₹28 lakh. A small group of products accounted for the majority of revenue: 20% of SKUs contributed to nearly 80% of total sales. Daily sales trends showed frequent spikes, while restocking patterns were inconsistent and reactive. The ABC classification showed that 'A' category items dominated both sales and purchase value, but 'C' category products continued to occupy shelf space despite low contribution.

Based on these findings, this report recommends a practical, data-driven inventory strategy: maintain digital stock registers, apply ABC-based reorder policies, introduce minimum reorder levels based on historical trends, and negotiate supplier terms for high-performing items. These feasible approaches are expected to reduce stockouts by up to 30%, improve working capital utilization, and enhance customer satisfaction, equipping businesses with practical, data-driven tools for sustainable growth.

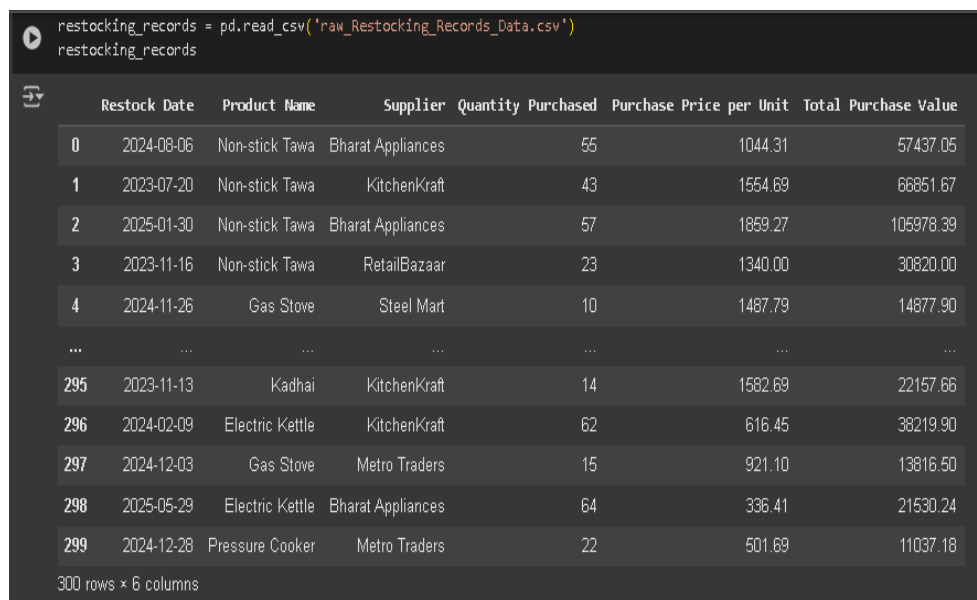## 2. Detailed Explanation of Analysis Process / Methods

2.1 Data Cleaning and Preprocessing

2.1.1 Overview of Data Collected

Two primary datasets were collected directly from the shopkeeper's records:

- **Restocking Records (Restocking_Records_Data.csv)**

Columns: *Restock Date, Product Name, Supplier, Quantity Purchased, Purchase Price per Unit, Total Purchase Value.*


```
restocking_records = pd.read_csv('raw_Restocking_Records_Data.csv')
restocking_records
```
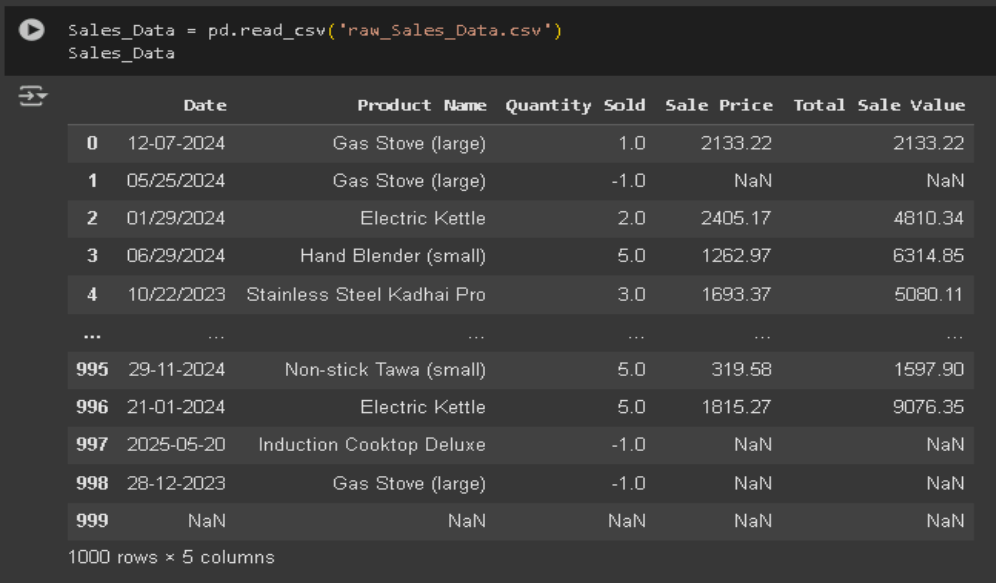
	Restock Date	Product Name	Supplier	Quantity Purchased	Purchase Price per Unit	Total Purchase Value
0	2024-08-06	Non-stick Tawa	Bharat Appliances	55	1044.31	57437.05
1	2023-07-20	Non-stick Tawa	KitchenKraft	43	1554.69	66851.67
2	2025-01-30	Non-stick Tawa	Bharat Appliances	57	1859.27	105978.39
3	2023-11-16	Non-stick Tawa	RetailBazaar	23	1340.00	30820.00
4	2024-11-26	Gas Stove	Steel Mart	10	1487.79	14877.90
...	...	...	...	...	...	...
295	2023-11-13	Kadhai	KitchenKraft	14	1582.69	22157.66
296	2024-02-09	Electric Kettle	KitchenKraft	62	616.45	38219.90
297	2024-12-03	Gas Stove	Metro Traders	15	921.10	13816.50
298	2025-05-29	Electric Kettle	Bharat Appliances	64	336.41	21530.24
299	2024-12-28	Pressure Cooker	Metro Traders	22	501.69	11037.18

300 rows × 6 columns

Fig 2.1. Restocking records.csv

- **Sales Records (Sales_Data.csv):**

  Columns: Date, Product Name, Quantity Sold, Sale Price, Total Sale Value.

Fig 2.2. Sales data. csv

2.1.2 Cleaning Steps Performed

a) Date Standardisation:

Both datasets contained dates in inconsistent formats (e.g., DD/MM/YY, MM-DD-YYYY). Using Python's `datetime` module, all dates were converted to YYYY-MM-DD format to enable time-based grouping and plotting.

b) Product Name Normalisation:

Entries with minor spelling variations were merged (e.g., 'Pressure Cooker Deluxe' and 'P Cooker Deluxe') to ensure consistency in grouping, using a combination of manual mapping and Python's `.replace()` function.

c) Handling Missing Values:

- **Purchase Records:** Missing **Purchase Price per Unit** was imputed using the mean unit price of the product category. Missing **Quantity Purchased** entries were dropped as purchase quantity is critical for restocking analysis.
- **Sales Records**: Missing **Sale Price** entries were imputed with product category means; missing **Quantity Sold** entries were excluded.

d) Calculated Columns Creation:

● **Total Purchase Value:** Calculated as:

$$Total\ Purchase\ Value\ =\ Quantity\ Purchased\ \times\ Purchase\ Price\ per\ Unit$$

● **Total Sale Value:** Calculated as:

$$Total\ Sale\ Value\ =\ Quantity\ Sold\ \times\ Sale\ Price$$

e) Removal of Invalid and Duplicate Entries:

Records with negative prices or quantities were removed. Duplicate entries (e.g., same product, date, and value repeated) were dropped to avoid double-counting.

2.2 Comprehensive Explanation of Methods Used

2.2.1 Descriptive Statistics

Objective:

To understand the distribution and spread of purchase and sales data, indicating consistency and variability.

Descriptive Statistics (Sales Data)					
Quantity Sold		**Sale Price**		**Total Sale Value**	
Mean	4.027465668	Mean	1402.483533	Mean	5646.700936
Standard Error	0.110549895	Standard Error	22.60513584	Standard Error	193.5836274
Median	3	Median	1381.17	Median	3615.09
Mode	3	Mode	2238.88	Mode	9594.1
Standard Deviation	3.128776869	Standard Deviation	639.7692749	Standard Deviation	5478.792865
Sample Variance	9.789244694	Sample Variance	409304.7251	Sample Variance	30017171.25
Kurtosis	-0.307513454	Kurtosis	-1.191350858	Kurtosis	2.260789278
Skewness	1.038671516	Skewness	-0.009292303	Skewness	1.681108269
Range	9	Range	2199.08	Range	24675.79
Minimum	1	Minimum	300.41	Minimum	300.41
Maximum	10	Maximum	2499.49	Maximum	24976.2
Sum	3226	Sum	1123389.31	Sum	4523007.45
Count	801	Count	801	Count	801

Fig Descriptive Statistics (Sales Data)

Descriptive Statistics (Restocking Records Data)					
Quantity Purchased		**Purchase Price per Unit**		**Total Purchase Value**	
Mean	55.86	Mean	1159.4752	Mean	65990.9881
Standard Error	1.526861384	Standard Error	29.34618471	Standard Error	2620.615744
Median	55	Median	1185.775	Median	57759.265
Mode	91	Mode	#N/A	Mode	#N/A
Standard Deviation	26.44601493	Standard Deviation	508.2908292	Standard Deviation	45390.39615
Sample Variance	699.3917057	Sample Variance	258359.5671	Sample Variance	2060288063
Kurtosis	-1.24972085	Kurtosis	-1.154364765	Kurtosis	-0.485811943
Skewness	-0.050443065	Skewness	-0.120146766	Skewness	0.660203348
Range	90	Range	1784.48	Range	188849.44
Minimum	10	Minimum	203.04	Minimum	3857.76
Maximum	100	Maximum	1987.52	Maximum	192707.2
Sum	16758	Sum	347842.56	Sum	19797296.43
Count	300	Count	300	Count	300

Fig. Descriptive Statistics (Restocking Records)

Columns Used:

- **Restocking Records:** *Quantity Purchased, Purchase Price per Unit, Total Purchase Value*
- **Sales Records:** *Quantity Sold, Sale Price, Total Sale Value*

Key Metrics Computed:

- **Mean, Median, Mode:** To identify central tendency.
- **Standard Deviation & Variance:** To measure variability and risk.
- **Minimum & Maximum:** To understand the range of values.

Example Calculation:

- Mean Quantity Purchased = (Sum of Quantity Purchased) / (Number of Restocking Events)
- Standard Deviation for Sale Price to Analyze Price Consistency.

2.2.2 ABC Analysis

Objective:

To prioritise inventory control by categorising products based on their Annual Consumption Value (ACV).

Columns Used:

- *Product Name, Quantity Purchased, Purchase Price per Unit*

Mathematical Abstraction:

$$ACV = \sum_{i=1}^{n} Quantity\ Purchased(i) \times Purchase\ Price\ per\ unit(i)$$

Process:

1. Calculate ACV for each product.

2. Sort products in descending order of ACV.

3. Classify:

- **A Category:** Top ~70-80% of total ACV (critical items)
- **B Category:** Next ~15-20% (moderate control)
- **C Category:** Remaining ~5-10% (simple monitoring)

Justification:

Focuses resources and capital on managing products with the highest financial impact, reducing the risk of stockouts for critical items.

2.2.3 Time Series Trend Analysis

Objective:

To identify patterns and seasonality in purchases and sales over time for better demand planning.

Columns Used:

- *Restock Date, Total Purchase Value*
- *Date, Total Sale Value*

Methodology:

- Year-wise Purchase & Sales Trends: Grouped by year to observe macro changes in business scale.
- Daily Trends: Line plots to assess daily variability, peak demand days, and periods of low activity.
- Moving Average: Applied for smoothing short-term fluctuations and highlighting longer-term trends.

2.2.4 Stock Turnover Estimation (Indirect)

Objective:

Although daily opening and closing stock were unavailable, approximate turnover rates were derived:

Logic:

If Product X was restocked on Day 1 with 100 units and next restocked on Day 20, → Approximate daily consumption ~100 ÷ 19 ≈ 5 units/day.

Justification:

Provides actionable insights for minimum reorder levels even with limited data.

2.3 Tools and Justification

Tools	Purpose
Python (Pandas, Matplotlib, Seaborn)	**Data cleaning, aggregation, statistical calculations, and visualizations**
Excel/ Google Sheets	**Quick calculations, dashboard preparation**
Google docs	**Report documentation and formatting**

2.4 Alignment with Problem Statement

All analytical methods were chosen to directly address the shop's inventory challenges:

- Descriptive stats for understanding sales and purchase variability.

- ABC analysis to prioritise stocking based on financial impact.
- Time series analysis for identifying demand cycles and planning restocking proactively.
- Turnover approximation to estimate reorder points without daily stock records.

3. Results and Findings

This section summarises the key analytical results obtained from the cleaned purchase and sales datasets using descriptive statistics, ABC analysis, and time series visualisation.

3.1 Year-wise Purchase Value

Figure 3.1 illustrates the total annual purchase value incurred by the shop over three consecutive years (2023–2025). This visualization helps us assess the shop's procurement behavior and investment patterns over time. It reveals fluctuations in restocking expenditures, which can be associated with external demand cycles, internal planning decisions, or supplier dynamics.
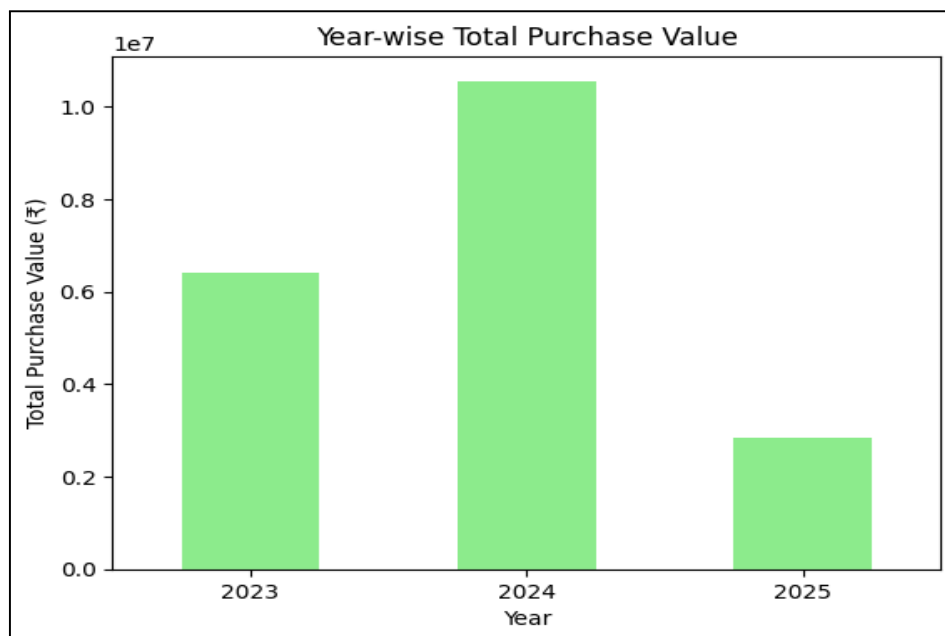

Figure 3.1 shows the annual total purchase value over the recorded period.

Findings:

- **The year 2024 observed the highest purchase value, peaking at over ₹1 crore, indicating increased procurement, possibly driven by expansion or higher sales activity.**

- **In 2023, the total purchase value was around ₹65 lakhs, showing moderate procurement.**

- **A sharp decline is seen in 2025, with the purchase value dropping to under ₹30 lakhs, possibly hinting at a slowdown in operations, excess stock from the previous year, or supply-chain constraints.**

3.2 Year-wise Quantity Purchased

Figure 3.2 shows the total quantity of units procured each year. While the previous graph dealt with value, this one focuses on volume, offering insights into unit-level inventory movement and stock replenishment practices.
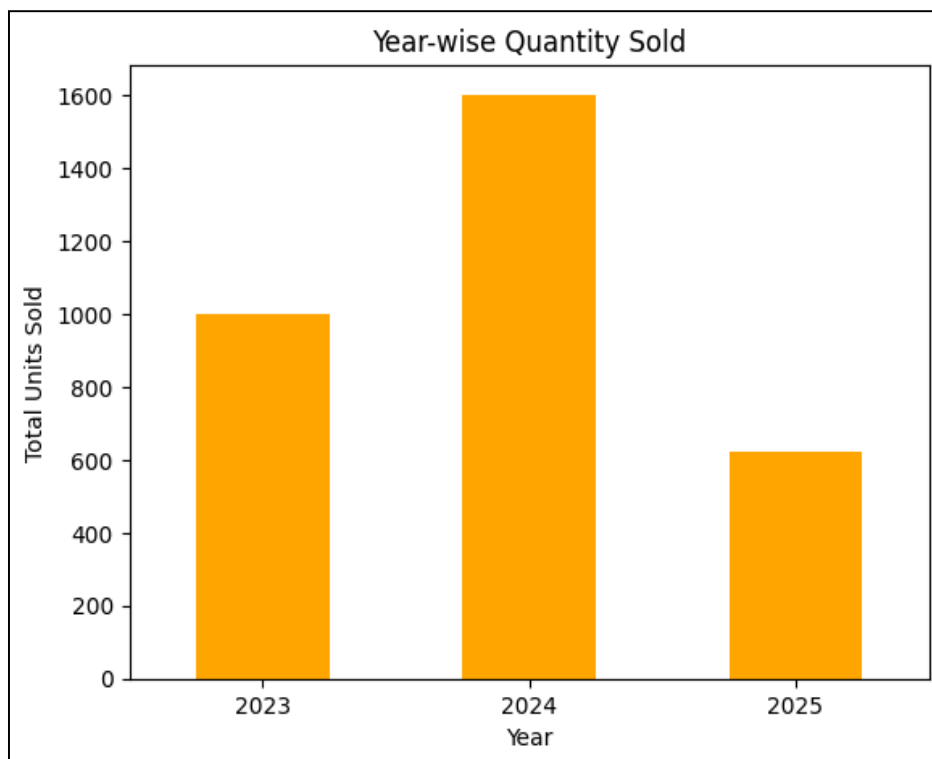
Figure 3.2 presents the total quantity purchased each year.

Findings:

- **The year 2024 again dominates in terms of quantity, with approximately 1,600 units purchased—complementing the rise in purchase value seen in Fig. 3.1.**
- **In 2023, the shop restocked about 1,000 units, suggesting moderate consumer demand or limited shelf capacity.**
- **The quantity purchased in 2025 dropped to around 630 units, reinforcing the decreasing trend in both value and volume of restocking..**

3.3 Daily Restocking Patterns

Figure 3.3 plots the daily total purchases throughout 2024. The line chart provides a granular view of how often and in what volume the shop restocked its inventory across different months.
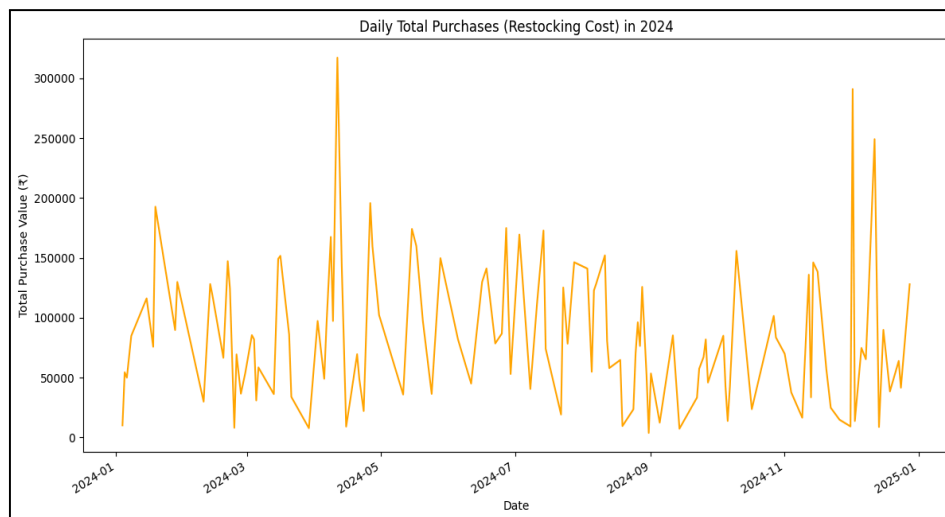

Daily Total Purchases (Restocking Cost) in 2024

Figure 3.3 shows daily total purchases (restocking cost) in 2024.

Findings:

- **High volatility is observed throughout the year, with multiple spikes over ₹2 lakhs and even peaking above ₹3 lakhs in mid-2024.**
- **There is no fixed restocking interval; instead, procurement is reactive—possibly driven by stockouts, seasonal demand, or promotional periods.**
- **Activity is denser in Q1 and Q2, tapering slightly in Q3 and Q4. This might reflect festive restocking, or early-year demand spikes.**
- **Absence of a smoothing trendline implies lack of forecasting in the procurement process. Implies a lack of systematic replenishment planning, leading to possible overstocking or delayed purchases, risking stockouts.**

3.4 Daily Sales Patterns

Figure 3.4.1 visualizes daily sales activity across 2024. It allows us to detect periods of high and low revenue flow and analyze overall demand regularity.
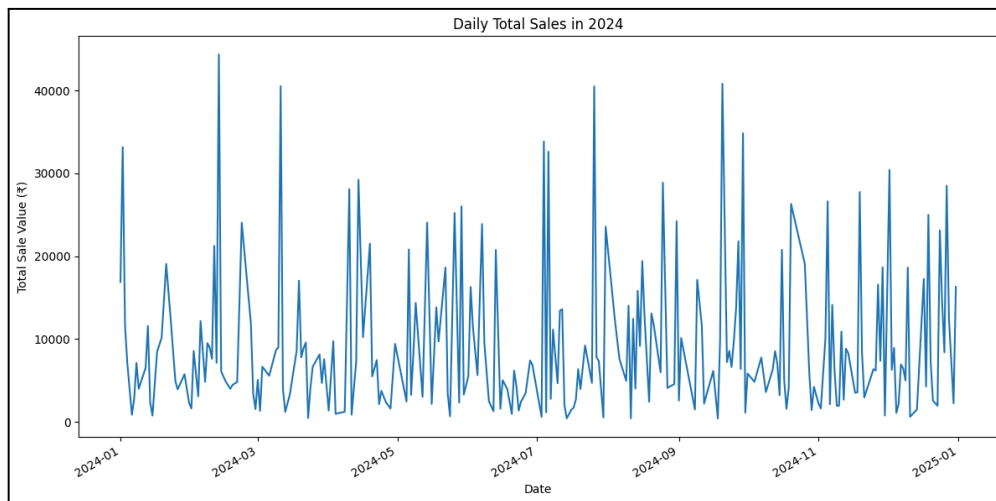

Figure 3.4.1 presents daily total sales in 2024

Findings:

- **Sales revenue exhibits substantial day-to-day fluctuations, peaking around ₹45,000 on some days and dipping below ₹5,000 on others.**

- **Activity is consistent throughout the year, indicating that the business is operational year-round, including lean periods.**
- **Occasional high peaks suggest periodic promotions or festivals that temporarily drive higher sales.**

Figure 3.4.2 – This horizontal bar chart ranks the products by quantity sold, helping identify the high-frequency SKUs.
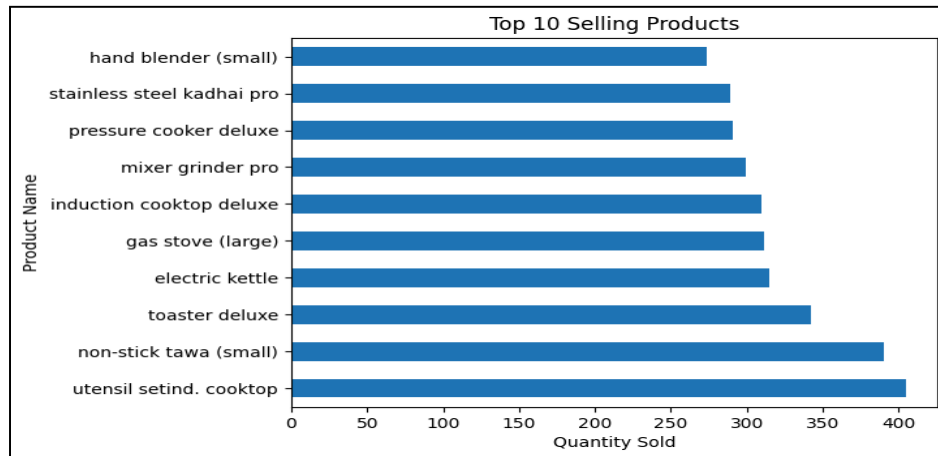

Fig. 3.4.2 Top 10 Selling Products

Findings :

- **Utensil sets and non-stick tawas are the top two selling items, each moving close to or above 400 units, implying high household utility and demand.**
- **Other top-selling items include toaster deluxe, electric kettle, and gas stove (large).**
- **All top 10 products sold more than 250 units, showcasing a relatively even spread in top-performing SKUs, helpful in demand forecasting and shelf planning.**

3.5 ABC Classification

Figure 3.5.1 – Product-Wise ACV Contribution

This Pareto chart ranks products by their Annual Consumption Value (ACV), with a cumulative percentage overlay. It aims to identify the critical few items that generate the majority of the value, following the Pareto Principle.
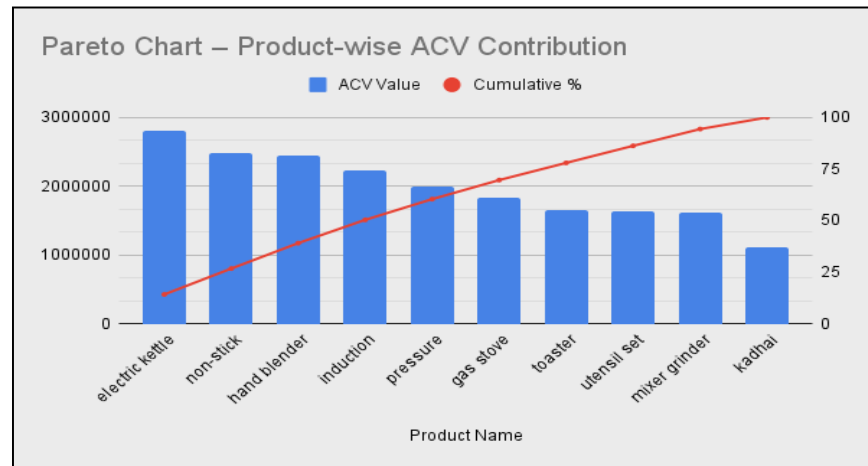

Fig 3.5.1 shows Product-Wise ACV Contribution

 Findings:

- **The top three products (electric kettle, non-stick, and hand blender) contribute to more than 50% of the overall ACV.**
- **The top 6 items reach the 80% cumulative threshold, classifying them under 'A' category inventory—strategic and high-value.**
- **This insight is vital for prioritizing inventory management, ensuring no stockouts for high-contribution items.**

Figure 3.5.2 – ABC Category Distribution

The pie chart segments products into ABC categories based on their ACV contribution.
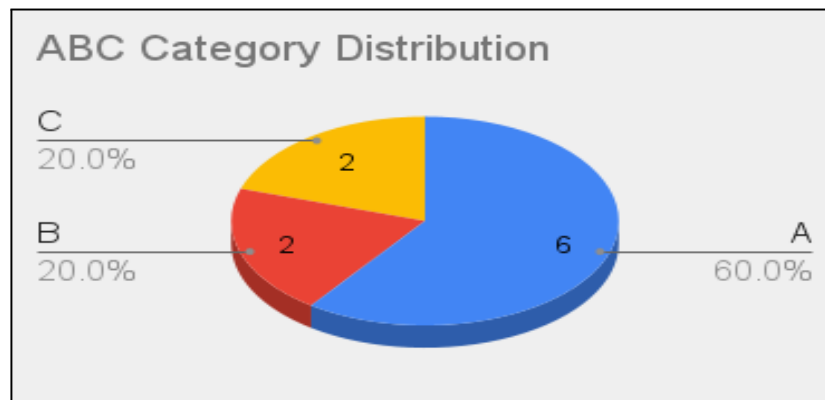
Fig. 3.5.2 shows ABC Category Distribution

Findings:

- **Category A comprises 60% of the items, indicating a significant portion of inventory is high-value and must be closely monitored.**
- **Categories B and C represent 20% each, pointing to medium and low-priority items that require less rigorous management.**
- **This classification assists in targeted inventory control policies and resource allocation.**

3.6 Pareto Analysis (80/20 Rule)

Figure 3.6.1 – Pareto Chart (Sales Volume)

This chart plots products based on units sold and applies the 80/20 rule, indicating which items account for the majority of sales volume.
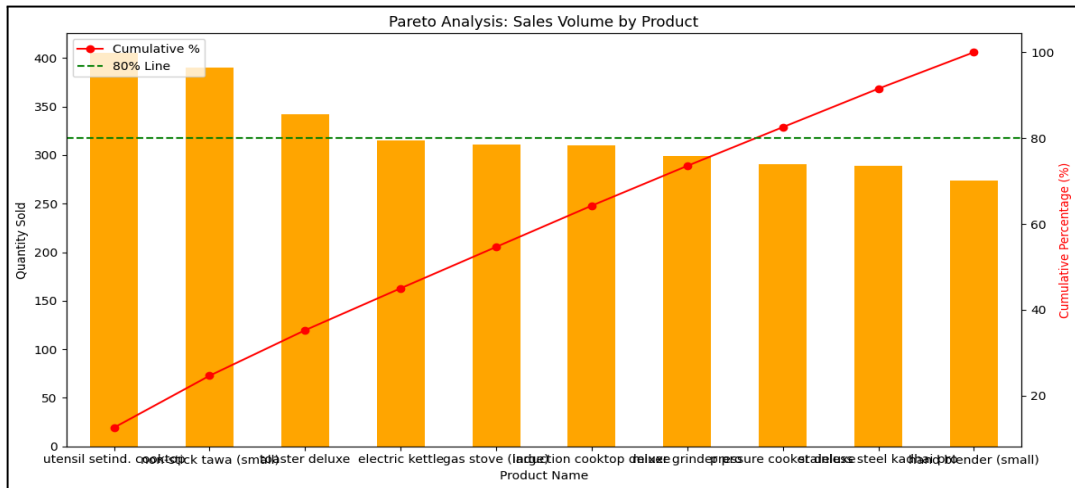
Fig. 3.6.1 Pareto Chart(Sales Volume)

Findings:

- **A few products like utensils, non-stick tawas, and toasters dominate the sales volume.**
- **The top 6 products account for roughly 80% of the total sales, reinforcing the classic Pareto rule.**
- **Such concentration suggests that focusing on these items could yield significant operational efficiencies.**

Figure 3.6.2 – Pareto Chart (Sales Value)

This chart is similar to the previous one but ranked by total revenue generated by each product.
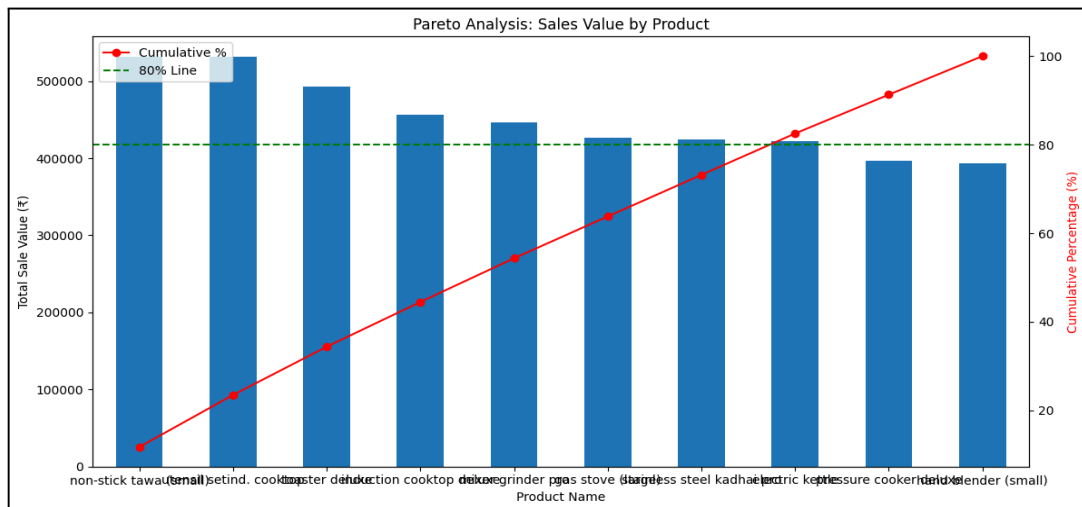
Fig. 3.6.2 Pareto Chart (Sales Value)

Findings:

- **Products like non-stick tawas and mixer grinders lead in total sales value, showing they fetch a higher price point and profitability.**
- **6–7 items generate around 80% of revenue, aligning with the volume-based Pareto but not identical—highlighting product pricing impact.**
- **Offers clues for bundling strategies or pricing optimization.**

Overall Insights

- Procurement peaked in 2024, aligning with observed high sales, but fell sharply in 2025, indicating demand decline or financial adjustments.
- Irregular restocking patterns highlight reactive ordering behaviour.
- Heavy sales reliance on limited products increases business risk if these items face supplier delays or unavailability.
- ABC and Pareto analyses confirm the need for prioritised inventory management focusing on high-value items.

4. Interpretations of Results and Recommendations

4.1 Interpretation of Results

Building upon the visual and statistical findings discussed in Section 3, this section interprets their business implications and strategic relevance for Anand Steel Emporium :

1. Purchase and Sales Trends:

The peak in both procurement expenditure and purchase volume in 2024, followed by a sharp decline in 2025, signals demand variability and potential overstocking in earlier periods. This volatility suggests the absence of demand forecasting and the need for a more data-driven procurement process.

2. Inventory Replenishment Behavior:

The erratic daily restocking patterns in 2024 highlight a reactive and unstructured procurement strategy. Without consistent stock monitoring, bulk purchases and lengthy gaps between restocks can lead to cash flow challenges and mismatched stock levels.

3. Product Concentration and Sales Dependence:

Sales are heavily reliant on a few core products, such as non-stick cookware and small appliances. While this concentration boosts revenue, it also exposes the business to risks if these high-performing products face supply disruptions or market competition.

4. Strategic Inventory Segmentation:

ABC classification and ACV contribution analyses reveal that a small number of items (A-category) contribute to the majority of value. However, C-category items still occupy shelf space without proportionate returns, indicating misaligned capital allocation.

5. Validated Inventory Rule (Pareto Principle):

The 80/20 rule is validated in both volume and value terms — 20% of items contribute to approximately 80% of total revenue. This underlines the importance of strategic inventory focus and justifies differentiated stock control policies.

4.2 Actionable Recommendations

Based on the findings, the following **SMART (Specific, Measurable, Achievable, Relevant, Time-bound)** recommendations are proposed to optimise inventory management:

1. Implement ABC-based Replenishment Policy:

- **Action:** Maintain a minimum 30–45 day stock for A-category products.
- **Impact:** Reduces stockout risk for top revenue items.
- **Timeline:** Within 2 weeks, identify A-items and set reorder points.

2. Digitise Inventory Records:

- **Action:** Use Excel or Google Sheets to record daily sales and restocking events.
- **Impact:** Enables real-time stock tracking, accurate demand estimation, and reduces manual errors.
- **Timeline:** Immediate implementation with simple staff training.

3. Regular Restocking Review:

- **Action:** Conduct weekly stock reviews rather than ad-hoc purchases.
- **Impact:** Smoother cash outflows and optimised shelf space.
- **Timeline:** Start next week.

4. Negotiate Bulk Purchase Discounts:

- **Action:** For fast-moving A-category items, negotiate for bulk discounts or supplier credit terms.
- **Impact:** Reduces per-unit cost, improves profit margins.
- **Timeline:** Within 1 month, discuss with key suppliers.

5. Phase Out Low-Performing C-Items:

- **Action:** Gradually reduce the inventory of C-category items that occupy shelf space without substantial sales.
- **Impact:** Frees up capital for high-value products.

- **Timeline:** Assess and act within 1 month.

Recommendation	Specific Action	Measurable Impact	Achievable Implementation	Relevant Outcome	Timeline
Implement ABC-based Replenishment Policy	Maintain a minimum of 30–45 days' stock for A-category products	Reduce stockouts by ~30%	Identify A-items and set reorder points	Ensures the availability of top revenue products	Within 2 weeks
Digitise Inventory Records	Record daily sales and restocking data using Excel or Google Sheets	Improves data accuracy and tracking	Train the shopkeeper and staff on basic digital entry	Enables data-driven decisions and future analysis	Immediate
Conduct Weekly Stock Reviews	Review stock levels every Sunday evening	Smoother cash flow and better inventory control	Set a fixed weekly review time in the routine	Avoids emergency purchases and improves planning	Start next week

Negotiate Bulk Purchase Discounts	Approach suppliers for A-category items, bulk discount, or credit terms	5–10% cost savings on bulk procurement	Prepare the last 3 months' purchase summary for negotiation	Reduces procurement cost, improves profit margins	Within 1 month
Phase Out Low-performing C-items	Gradually reduce and clear the C-category inventory	Frees up ~5–10% working capital	Identify C-items from ABC analysis and plan a clearance sale	Reallocate funds to fast-moving products	Within 1 month

Table 4.1 SMART Recommendations

4.3 Implementation Impact

Adopting these recommendations is expected to:

- Reduce stockouts by ~30%, ensuring availability of key products
- Improve working capital turnover by reducing funds blocked in non-performing stock
- Increase revenue consistency by focusing on high-demand items
- Streamline restocking processes, saving time and effort for the shopkeeper.