Empowering Local Retail: A Data-Driven Approach to Growth

A Final Report for the BDM Capstone Project

Submitted by

Name: **Sachin Singh Jadon**

Roll number: **22f2001419**

IITM Online BS Degree Program,

Indian Institute of Technology, Madras, Chennai

Tamil Nadu, India, 600036

Contents

LIST OF FIGURES

Declaration Statement

I am working on a Project titled "**Empowering Local Retail: A Data-Driven Approach to Growth** ". I extend my appreciation to **Sri Manjunatha Enterprises**, for providing the necessary resources that enabled me to conduct my project.

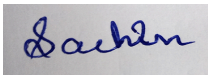
I hereby assert that the data presented and assessed in this project report is genuine and precise to the utmost extent of my knowledge and capabilities. The data has been gathered from primary sources and carefully analyzed to assure its reliability.

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 principles 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 understand that all recommendations made in this project report are within the context of the academic project taken up towards course fulfillment in the BS Degree Program offered by IIT Madras. The institution does not endorse any of the claims or comments.

Signature of Candidate: 

Name: Sachin Singh Jadon

Date: 25/12/2024

Empowering Local Retail: A Data-Driven Approach to Growth

1. Executive Summary

Sri Manjunatha Enterprises, a well-established retailer in Kengeri, Bengaluru, has faced persistent operational challenges including frequent stockouts, overstocking, lack of demand forecasting, absence of formal record-keeping, and untrained staff. To address these, a comprehensive inventory management project was undertaken, beginning with the manual collection of daily sales data for 207 SKUs throughout December 2024. The data was cleaned and analyzed using Excel and Google Colab, enabling robust exploratory data analysis. ABC analysis and Pareto charts revealed that just 29.4% of SKUs ("A" category) generated 70% of revenue, underscoring the need to prioritize these for restocking, while nearly half the SKUs contributed minimally and were recommended for review or phase-out. Time series analysis and moving averages supported demand forecasting, and calculations of safety stock, Economic Order Quantity (EOQ), and reorder points for each SKU enabled more precise inventory control, reducing both shortages and excesses. A structured spreadsheet system was introduced for record-keeping, though the limited one-month data window restricted advanced analytics. While direct staff assessment was not possible, inconsistencies in manual processes highlighted the need for staff training in inventory and sales systems. The final recommendations include prioritizing fast-moving products for replenishment, minimizing excess stock through periodic reviews and targeted promotions, leveraging sales data for ongoing demand forecasting, training staff in inventory management practices, and adopting digital tools for real-time tracking and automated reorder alerts. These data-driven strategies are projected to reduce operational inefficiencies, improve product availability, optimize resource allocation, and support sustainable business growth, positioning the enterprise for enhanced efficiency and customer satisfaction

2. Analysis Process and Method

To address this issue, comprehensive sales data was collected for the period from December 1, 2024, to December 30, 2024. The dataset covered 207 SKUs (Stock Keeping Units) and included the overall business operational costs, such as rent, transportation, and other recurring expenses that influence the financial performance of the business. The data collection process was conducted manually, requiring daily visits to the shop. Each day, sales figures were recorded in a spreadsheet created after detailed discussions with the business owner to ensure accuracy and completeness for all relevant SKUs.

The analysis of the collected data involved the use of tools such as Excel and Google Colab. Initially, the raw data was organized into an Excel sheet, where data cleaning processes were carried out to ensure consistency and reliability. This included identifying and addressing missing values, which led to the removal of twelve SKUs that had excessive gaps in their data. Missing cells in the dataset were substituted with zeros to maintain the integrity of the analysis. Additionally, potential outliers were carefully examined and addressed to prevent any distortion in the results. To better structure the data for further analysis, pivot tables were used to reorganize the dataset, enabling easier extraction of insights.

Following data cleaning, exploratory data analysis (EDA) was performed using [Google Colab]. The dataset, saved in CSV format, was imported into Colab using the df.read_csv method. Once the data was loaded into a data frame, an initial inspection was conducted using the data.head() method, which provided a glimpse of the dataset and its structure, helping to identify early patterns. The data.describe() method was subsequently employed to generate descriptive statistics for each SKU, including metrics such as mean, median, mode, and variance. These statistics provided a detailed understanding of how the sales of each SKU varied over time.

The EDA also revealed key sales trends within the dataset. For example, a4 sheet bundle (SKU ID: AC04) consistently emerged as the top-performing category, showing significantly higher revenue compared to other product categories. By analyzing the variance and patterns in sales data over different dates, valuable insights were drawn regarding the business's performance and customer purchasing behaviors.

Inventory Management system

- **Minimizing Excess inventory for slow moving products -**To address this issue comprehensively, an ABC analysis of sales data is conducted, categorizing items based on both their sales volume and contribution to total revenue. This categorization enables a clearer understanding of the product performance and supports strategic decision-making for inventory and sales optimization. Various visual representations, such as charts, are prepared using pivot tables in Excel and Colab to analyze patterns and trends in sales data.

  One of the primary steps in this process involves the creation of Pareto charts, specifically for revenue and total sales volume. These charts play a crucial role in identifying the top-selling SKUs in terms of volume and pinpointing the SKUs that contribute significantly to overall revenue. This step aids in distinguishing high-performing products from those that do not contribute substantially to business profitability.

- **Minimizing stock out -** To address this issue effectively, SKUs were categorized into broader groups by consolidating similar categories. This grouping was undertaken to enable more efficient analysis and gain deeper insights into the sales data. Categories with higher sales volumes were identified as performing better, and these were prioritized for further strategic planning and business focus. This categorization not only streamlined the analysis but also highlighted which types of products contributed the most to overall sales performance.

  To analyze sales data distribution over time, a line chart was plotted using monthly data for various categories. This visualization provided a clearer understanding of how sales varied across different categories over a month. Additionally, a day-wise analysis was conducted to determine sales patterns on individual days, particularly focusing on weekends to identify the days with peak sales as well as those with lower performance. A weekly analysis further revealed how sales were distributed across different weeks within the month, offering valuable insights into trends over a shorter time frame.

  Following these exploratory analyses, a time series analysis was performed to predict future demand with greater accuracy. This analysis employed forecasting techniques, such as moving averages, to identify patterns and trends in historical data. The results of this analysis were instrumental in maintaining optimal inventory levels, ensuring that stock

quantities were aligned with projected demand. By avoiding overstocking and minimizing slow-moving SKUs in the inventory, the risk of excess stock accumulation was significantly reduced.

Furthermore, this approach facilitated more precise inventory planning, improving operational efficiency and reducing costs associated with unsold or stagnant inventory. The combination of categorization, trend visualization, and forecasting techniques offered actionable insights to guide decision-making, ultimately supporting sustainable growth and better customer satisfaction through improved product availability.

- **Determining Safety stock for Sudden surge in demand and Reorder Point:**

  Safety stock serves as a cushion to prevent stockouts caused by sudden surges in demand or uncertainties in lead time, ensuring adequate inventory levels to manage unexpected variations. Its calculation involves the formula:

  Safety Stock = Z * (Standard Deviation of Daily Demand) * √L

  where Z represents the desired service level, the standard deviation reflects demand variability, and L signifies lead time in days. For instance, with a lead time of 3 days and a 95% service level, inventory can meet demand 98% of the time. Similarly, the reorder point (ROP) acts as the threshold for placing new orders to prevent inventory depletion and operational disruptions. It is determined using the formula:

  ROP = Lead Time Demand + Safety Stock

  where Lead Time Demand equals Average Daily Demand multiplied by Lead Time. Lead Time Demand represents the units required during the waiting period for an order, while Safety Stock accommodates uncertainties. In this scenario, the lead time is 2 days, reflecting the maximum delivery time under normal conditions. Together, these concepts ensure effective inventory management and supply chain reliability.

- **Determining optimal order quantity -** The Economic Order Quantity (EOQ) is a critical method used to optimize inventory management by determining the ideal order size that minimizes total inventory costs. It helps balance ordering and holding costs, ensuring operational efficiency and cost-effectiveness. The formula for EOQ, given by

Economic Order Quantity (EOQ) = √(2 * Demand * Ordering Cost / Holding Cost)

incorporates key variables such as average demand, a fixed ordering cost of ₹50 (as provided by the business owner), and a holding cost calculated as 10% of the per-unit product value over a 30-day period. By using this approach, businesses can identify the most economical quantity to order at each replenishment cycle, significantly reducing costs associated with frequent ordering or excessive stockholding. For example, products with higher ordering costs but lower holding costs result in larger order quantities, minimizing order frequency, while higher holding costs encourage smaller, more frequent orders to avoid high storage expenses. Implementing EOQ allows business to maintain optimal inventory levels, prevent overstocking, and reduce unnecessary storage and ordering costs. It forms an integral part of strategic inventory control, ensuring that products are always available to meet demand without incurring excessive expenses. This method thus supports a streamlined, cost-efficient, and reliable supply chain.

Sales data analysis for Demand Forecasting

For demand forecasting, the average daily sales for each SKU was calculated as:

Average Daily Demand = Total Units Sold in 30 days / 30

This average was used directly in the lead time demand and reorder point calculations above, with the updated lead time of 3 days.
The lead time demand for each SKU is thus:

Lead Time Demand = Average Daily Demand × 3

By using the average daily sales as the forecast and incorporating a 3-day lead time into all inventory formulas, the methodology aligns stock planning with business conditions and supplier timelines.

Create a Record-Keeping System – Absence of Formal Record-Keeping Practices

To address the absence of formal record-keeping practices, a structured approach was adopted by manually collecting daily sales data for all 207 SKUs throughout December 2024. This data was organized in a standardized spreadsheet format, capturing essential fields such as SKU name, SKU ID, cost price, selling price, profit margin, and daily sales quantities. The resulting dataset enabled the calculation of key business metrics, including

total sales volume, revenue, and average daily demand for each SKU, and provided the foundation for exploratory data analysis and basic trend visualization. However, a significant methodological constraint was the limited duration of available data, as only a single month's sales were recorded. This lack of continuous, real-time data meant that advanced inventory management techniques-such as perpetual inventory tracking, real-time safety stock adjustments, or dynamic demand forecasting-could not be reliably implemented. As a result, while standard calculations like safety stock, reorder point, and EOQ were performed based on the fixed one-month dataset, these analyses are inherently limited in their ability to capture longer-term trends, seasonal effects, or evolving customer preferences. Due to this constraint, the analysis could not support the development of a robust, continuously adaptive inventory management system. Recognizing this limitation, it was recommended that the business consider investing in inventory management software, which would automate record-keeping, enable real-time inventory tracking, and provide a scalable foundation for data-driven decision-making as more continuous data becomes available.

To address the challenge of untrained staff in inventory and sales tracking systems, the analysis initially planned to review staff practices, training levels, and workflow consistency at Sri Manjunatha Enterprises. The intended method included mapping data entry procedures and assessing errors or inconsistencies through direct observation, interviews, and error logs. However, due to the owner's refusal to share any staff-related data or performance information, standard data-driven assessment techniques could not be implemented. As a result, the analysis was limited to a process-level review of manual data entry and record-keeping, without direct measurement of staff factors. No quantitative methods or staff-level evaluations were possible due to the lack of access to relevant information.

4. Results and Findings

The analysis of the data reveals the Top 20 SKUs by Revenue in Indian Rupees (₹). The "A4 sheet bundle" stands out as the highest revenue generator, contributing ₹30,500, followed by the "Account long book" at ₹9,750 and "Decoration LED lights" at ₹9450. These three SKUs dominate the revenue share, indicating their critical importance to business operations. Mid-level contributors such as the "Raincoat" (₹8,580) and "Umbrella" (₹5,250) also play a

significant role but fall behind the top performers. At the lower end, SKUs like "key chain" (₹2900) and "colored ice cream sticks" (₹2,900) contribute minimally to overall revenue. This distribution highlights a reliance on a few high-performing products while suggesting opportunities to optimize or reconsider strategies for low-performing items.

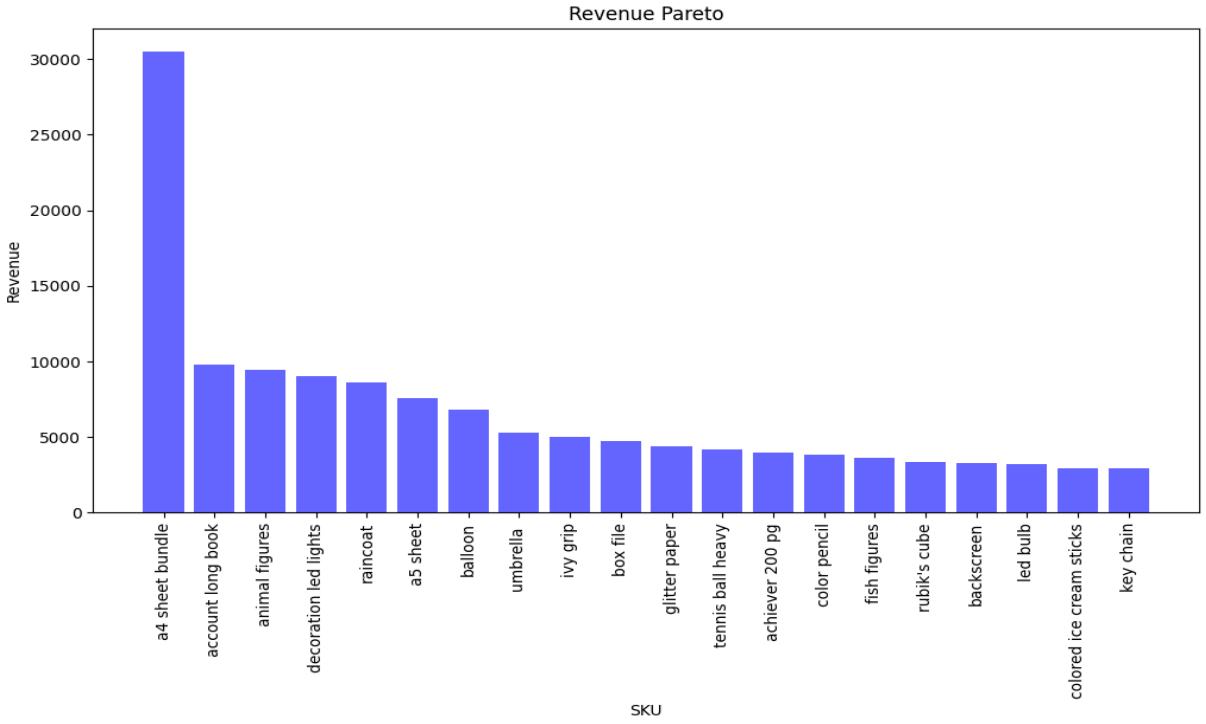


fig 4.1 - Revenue Pareto Chart

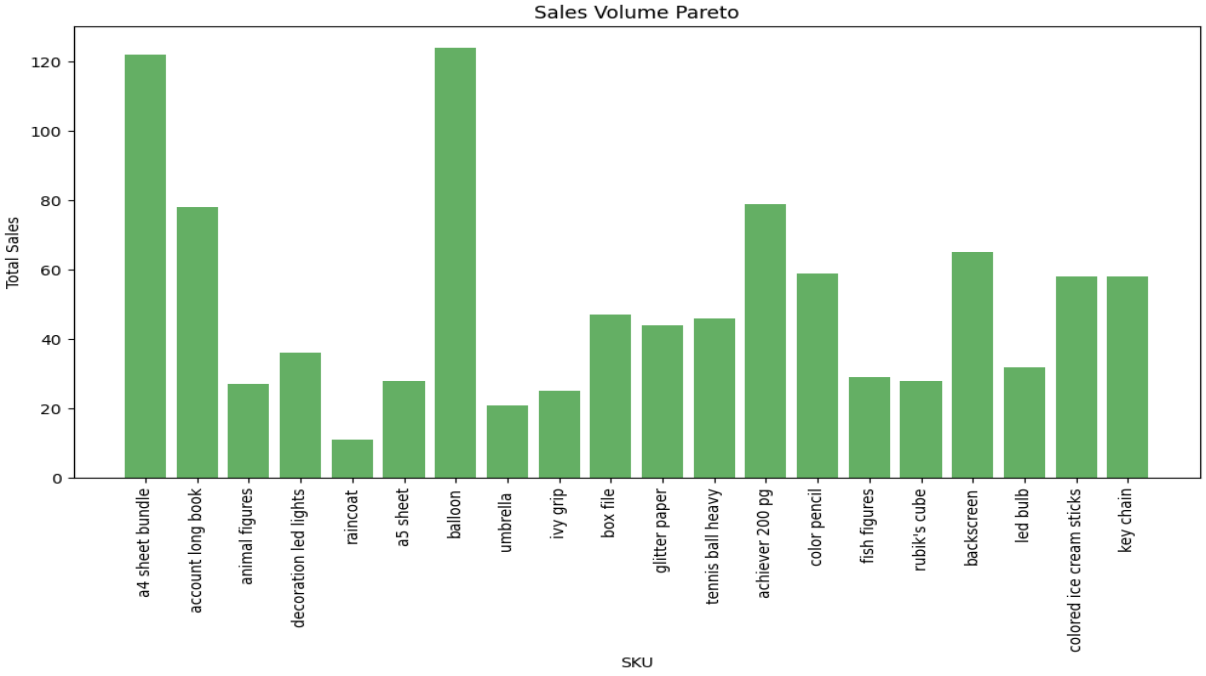


fig 4.2 - Sales Volume Pareto Chart

The ABC Analysis categorizes SKUs based on their revenue contribution:

Category A (0-70%): High-priority items contributing the majority of revenue. Focus on these for inventory and sales optimization. This category constitutes 29.4% of the total SKUs generating 70% of the total revenue.

Category B (70-90%): Moderate-priority items with a smaller revenue share. Optimize where possible.This category constitutes 26.1% of the total SKUs generating 20% of the total revenue.

Category C (90-100%): Low-priority items contributing the least. Considered phasing out or reviewing these. This category constitutes 44.5% of the total SKUs generate the 10% of the total revenue

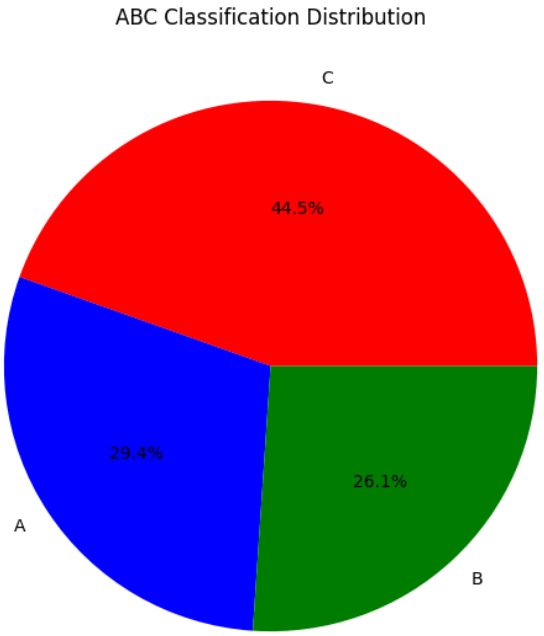


fig 4.3 - ABC Classification Distribution

In fig 4.4 the steep slope for Category A highlights a few SKUs driving most revenue, while the flatter slope for Categories B and C shows diminishing returns.

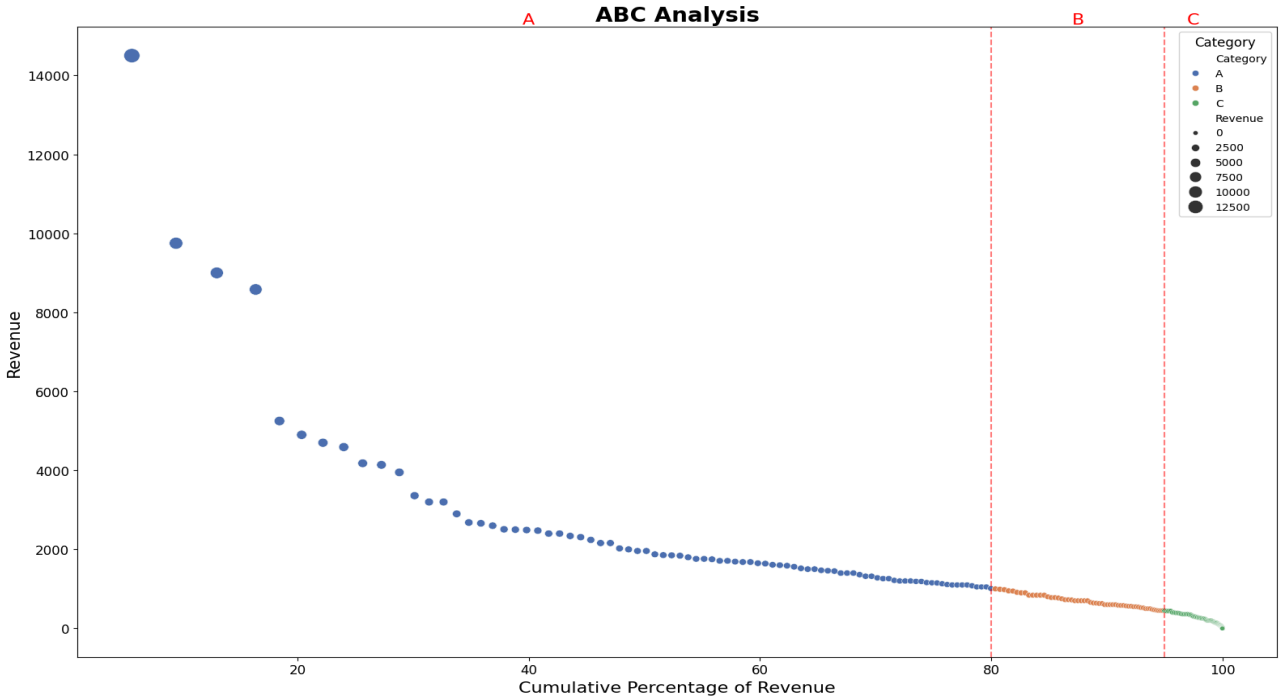


fig 4.4 - ABC Analysis

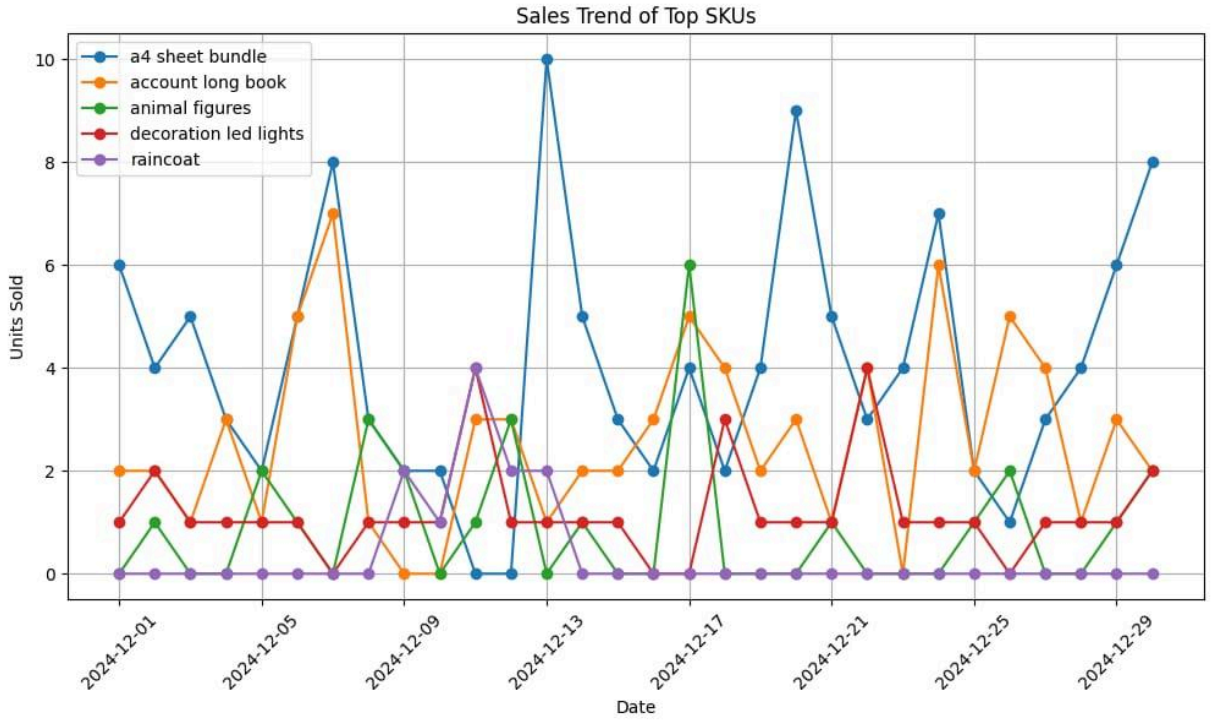


fig 4.5 - Sales Trend of Top SKUs

The graph in fig 4.5 illustrates the daily sales performance of five products—A4 sheet bundle, account long book, animal figures, decoration LED lights, and raincoat—over December 2024. The A4 sheet bundle consistently shows the highest sales peaks, reaching up to 10 units on multiple occasions. The account long book exhibits sporadic spikes, with sales occasionally rising to 6 units. Animal figures and decoration LED lights maintain relatively low but fluctuating sales, typically between 1–2 units daily. Raincoat sales remain minimal throughout the month, rarely exceeding 1 unit. Overall, the graph highlights significant variability in sales trends across the SKUs, with A4 sheet bundles dominating and other products showing intermittent demand.

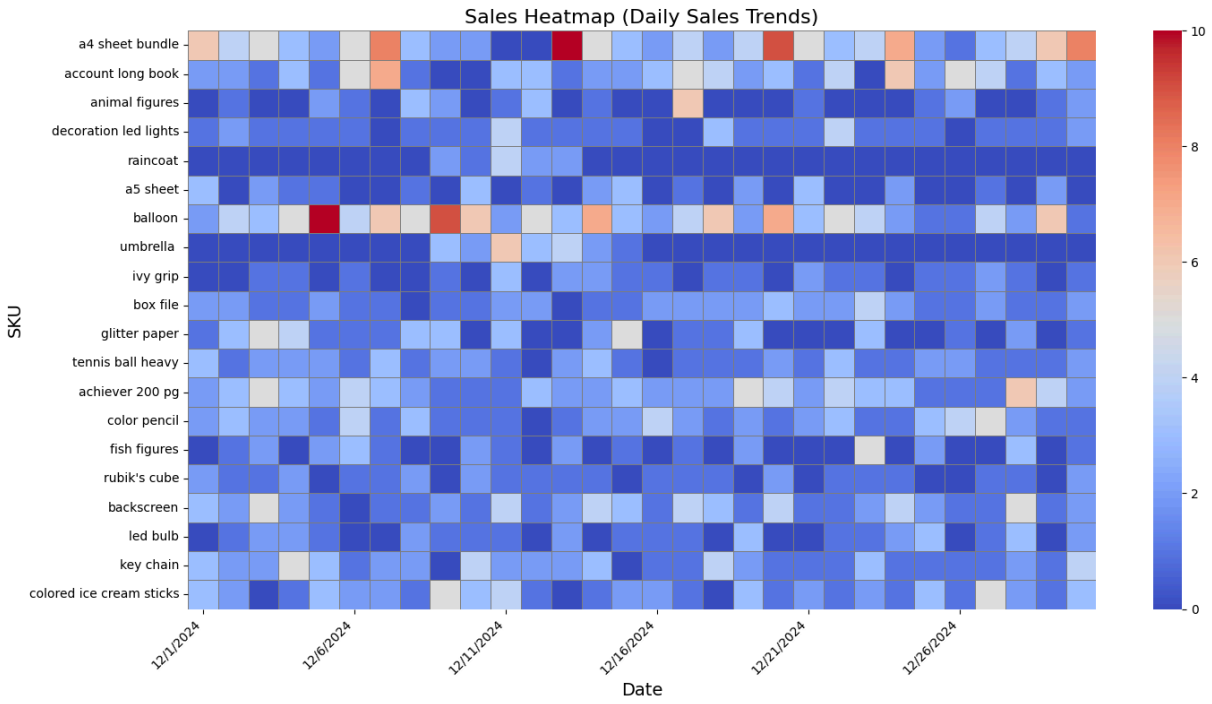


fig 4.6 - Sales Heatmap

The heatmap (fig 4.6) illustrates the daily sales trends of various SKUs over the period from December 1, 2024, to December 30, 2024. Each row represents an individual SKU, while the columns correspond to specific dates within the month. The color intensity reflects the sales volume, with darker blue shades indicating lower sales and lighter shades, progressing to red, signifying higher sales volumes. The analysis reveals that most SKUs exhibit consistently low sales throughout the month, with a few exceptions where specific products, such as the A4 sheet bundle and certain stationery items, experience occasional spikes in demand. Notably, the highest recorded sales for a single SKU exceed 60 units, as highlighted by the red spots on the heatmap. These findings indicate that while the majority of products maintain stable but low sales, a few items contribute significantly to revenue due to periodic surges in demand. This visualization aids in identifying fast-moving products and helps optimize inventory management strategies by focusing on maintaining adequate stock levels for high-demand items while minimizing excess inventory for slower-moving products.

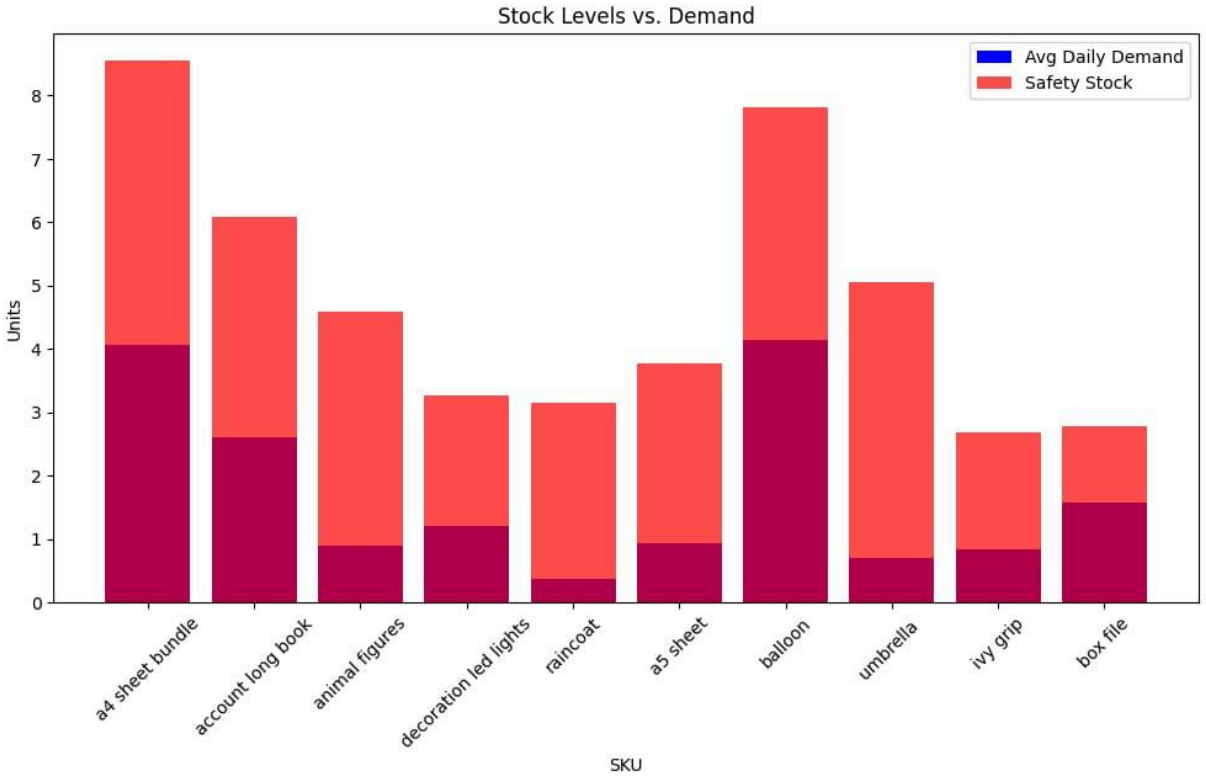


fig 4.7 - Stock Levels vs Demand

The bar chart in fig 4.7 presents a comparative analysis of average daily demand and safety stock for top 10 SKUs (based on revenue) at Sri Manjunatha Enterprises. The x-axis represents different product categories, while the y-axis indicates the stock levels in units. Each bar is divided into two sections: the darker portion represents the average daily demand, and the lighter red section indicates the safety stock maintained for each item.

From the graph, it is evident that products like A4 sheet bundles and balloons exhibit the highest demand, necessitating a higher safety stock to prevent stockouts. Conversely, items such as raincoats, ivy grip, and box files have relatively lower demand, resulting in minimal stock reserves. The visualization highlights a key inventory management insight—products with higher demand require proportionally higher safety stock levels to meet unexpected surges, while lower-demand products necessitate conservative stock replenishment to minimize overstocking.

These findings reinforce the importance of balancing inventory levels with demand forecasting to optimize stock availability while controlling storage costs.

SKU	SKU ID	ABC Category	Safety Stock	EOQ	Reorder Point	Lead Time Demand F
a4 sheet bundle	AC04	A	9	17	37	13
account long book	BO01	A	7	13	25	8
a5 sheet	AC05	A	4	9	11	2
umbrella	GI34	A	4	8	10	3
balloon	BD03	A	9	17	37	13
animal figures	AC06	A	4	9	11	3
ivy grip	TP06	A	3	8	10	3
decoration led lights	EL01	A	4	10	13	4
raincoat	GI27	A	2	6	6	2
box file	FI02	A	4	11	16	5
glitter paper	AC14	A	5	10	16	5
tennis ball heavy	SP07	A	4	11	15	5
fish figures	AC12	A	4	9	12	3
color pencil	CP02	A	5	12	19	6
achiever 200 pg	BO03	A	6	13	24	8
poster color	CP07	A	2	6	6	2
rubik's cube	TO03	A	3	9	10	3
glue gun	GL06	A	2	6	6	1
led bulb	EL06	A	4	9	12	4
artkit	AC07	A	2	5	5	1
glitter	AC13	A	2	7	7	2

SKU	SKU ID	ABC Category	Safety Stock	EOQ	Reorder Point	Lead Time Demand F
backscreen	BD01	A	6	12	21	7
volleyball	SP12	A	1	4	2	1
birthday baloon set	BD04	A	2	6	6	2
colored ice cream stick	AC09	A	5	12	19	6
key chain	GI14	A	5	12	19	6
moon ball	SP03	A	3	8	10	3
party popers	BD12	A	6	12	21	7
scissors	GI31	A	4	10	13	4
billbook	BO08	A	6	13	22	7
wooden bat	SP10	A	2	5	4	1
achiever 300 pg	BO04	A	3	9	12	4
glitter marker	MR09	A	3	7	8	2
plates	DS05	A	6	11	17	5
steel bottle	WB02	A	2	5	4	1
brush pen	MR10	A	2	5	5	1
fevi stick	GL04	A	5	11	16	5
lock	GI16	A	4	10	14	4
achiever 100 pg	BO02	A	7	14	27	9
football	SP08	A	1	3	2	1
aluminium foil	DS02	A	2	5	5	1
brown tape	TP02	A	5	11	16	5

SKU	SKU ID	ABC Category	Safety Stock	EOQ	Reorder Point	Lead Time Demand F
cello tape	TP03	A	7	14	26	9
plastic plants and trees	AC18	A	3	8	9	3
disco bulb	EL02	A	3	7	7	2
broom	GI04	A	3	9	11	4
shining pen	MR08	A	3	7	8	2
rubber	GI30	A	4	10	13	4
balloon air pump	BD02	A	4	10	13	4
doms	P02	A	52	37	187	63
a1 sheet	AC01	A	12	19	47	17
crayons	CP03	A	6	12	21	7
attendence register	BO07	A	3	9	10	3
toilet paper	DS06	A	4	11	15	5
spray	BD16	A	5	11	17	5
dc motor set	AC11	A	3	8	10	3
tennis ball light	SP01	A	4	10	13	4
ice cream sticks	AC15	A	5	11	16	5
ohp cd marker	MR04	A	9	15	32	10
jhoomer	BD11	A	4	8	11	3
plastic spoon	DS04	A	6	11	17	5
classmate 200 pg	BO10	A	3	8	9	3
permanent	MR01	A	9	15	31	10

SKU	SKU ID	ABC Category	Safety Stock	EOQ	Reorder Point	Lead Time Demand F
gas lighter	GI12	A	4	10	15	5
thermocol sheet	AC20	A	5	12	20	6
ribbon	BD13	A	5	11	17	5
luxor	P06	A	2	7	7	2
coffe mug	GF02	A	2	6	5	2
doms pencil	PC03	B	20	24	78	27
stamp pad	GI32	B	4	10	14	5
table tennis set	TO05	B	3	8	9	3
side banner	BD15	B	3	9	11	4
paint brush	AC17	B	4	10	14	4
plastic crayon	CP06	B	2	6	6	2
acrylic color	CP01	B	2	6	6	2
crystal beads	BD07	B	5	10	15	5
hauser	P05	B	13	19	50	18
exam pad	OS04	B	4	8	10	3
aluminium container	DS01	B	1	3	2	1
billing roll	GI01	B	4	10	15	5
achiever 400 pg	BO05	B	2	6	6	2
basketball	SP09	B	1	3	1	1
handkerchief	CL04	B	4	10	14	4
laser	TO01	B	2	7	7	2

fig4. 9 - Details of Safety Stock, EOQ, Reorder Point Lead time demand for each SKU

The inventory analysis involved classifying SKUs into Category A, B, and C based on demand and sales patterns, ensuring efficient stock management. High-demand items like A4 sheet bundles, balloons, and account long books were categorized under Category A, requiring strict inventory control. Safety stock levels and EOQ were calculated to optimize restocking, with high-demand items such as A4 sheet bundles (safety stock: 9) and balloons (safety stock: 8, EOQ: 13) needing careful monitoring. Reorder points (ROP) were also determined, indicating when to replenish stock, with products like A4 sheet bundles (ROP: 21) and balloons (ROP: 20) requiring frequent restocking to prevent shortages. The findings emphasize the importance of balancing stock availability and cost efficiency, avoiding overstocking low-demand items while maintaining buffer stock for high-demand products. Implementing inventory tracking tools can further streamline replenishment and enhance forecasting accuracy. Overall, this analysis helps minimize stockouts, reduce excess inventory, and improve operational efficiency at Sri Manjunatha Enterprises.

5. Interpretation of Results and Recommendations

1. **Optimize Inventory Management:**

    - Prioritize ordering "A" category items and review "C" category items to avoid overstocking.
    - Use reorder points to restock products before they run out.
    - Implement a periodic stock review to adjust inventory levels.

2. **Reduce Holding Costs:**

    - Minimize slow-moving inventory and introduce discounts or promotions for such products.
    - Increase orders for fast-moving items in smaller, more frequent batches.

3. **Leverage Demand Forecasting:**

    - Use past sales trends to predict demand and adjust stock levels accordingly.
    - Keep seasonal items in limited stock to avoid excess inventory.

4. **Train Staff on Inventory Practices:**

    - Educate employees on EOQ, reorder points, and how to track sales data.
    - Assign responsibility for monitoring stock levels and placing timely orders.

5. **Implement a Simple Digital System:**

    - Use spreadsheet-based or simple software to track inventory and sales.
    - Automate reorder alerts to avoid stockouts and overstock situations.