Sales Optimization and Inventory Insights in a B2C Clothing Retail Business: A Data-Driven Approach

Final report for the BDM capstone Project

Submitted by :-

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Executive Summary :

Tiwari Vastralaya is a family-run retail clothing shop located in **Tinpheria Bazar, Kushinagar, Uttar Pradesh.** With over 40 years of service, the shop is known for offering a range of traditional and readymade garments, including **sarees, suits, lehengas, and bed sheets**. However, like many small businesses, it now faces modern challenges—limited storage space, uneven sales during non-festive weeks, and the absence of digital tools for managing inventory and planning ahead.

To better understand these challenges, we collected and analyzed 12 weeks of sales data. This data was gathered through printed slips and verbal updates from the owner, then manually digitized and cleaned. While this process involved some risk of error, efforts were made to cross-check and validate the data to ensure it was as accurate as possible.

The main goal of this analysis was to uncover sales patterns, highlight best-selling and inconsistent items, and provide practical suggestions for better inventory and space management. For over 70 items, we calculated key metrics like average sales, standard deviation, skewness, and Coefficient of Variation (CV). This helped us identify which items sold consistently and which had unpredictable demand.

The findings showed that suit items like TOHFA, MAKHAN, and MAULI performed well with steady weekly sales, making them strong candidates for regular stocking. Sarees like SANGAM and AANGAN were also popular but had more fluctuation in demand. Bed sheets, although less in number, showed stable and consistent sales. ABC analysis based on units sold revealed that a few items were responsible for most of the shop's total sales, helping identify what to prioritize.

Even though the data only covers a short period, the insights are useful. We recommend continuing to collect sales data in a more structured format. For better space management, the unused room in front of the house can be used as a dedicated storeroom, keeping only the most important items inside the main shop. Additionally, as online shopping becomes more common, pairing the store with a local delivery platform can help expand reach and meet customer demand more efficiently.

By combining traditional experience with simple data-based planning, Tiwari Vastralaya can improve how it manages stock, uses space, and prepares for future growth.

Detailed Explanation of Analysis Method :

1. Additional Statistics Analysis :

Descriptive statistics provided the initial and most essential layer of analysis for Tiwari Vastralaya's 12-week sales data. With over 70 different SKUs, this method allowed us to summarize and compare weekly sales behavior across a diverse range of clothing items, including sarees, suits, lehengas, and bed sheets.
We computed the following metrics for each item:

- **Average Sales (Mean):** Reflects typical weekly demand.
- **Standard Deviation (σ):** Measures the spread of weekly sales around the mean.
- **Skewness:** Indicates asymmetry of sales distribution (right-skewed = frequent low sales, occasional spikes).
- **Coefficient of Variation (CV):** Defined as **$CV=\sigma/\mu$**, where μ(mu) is the mean. This metric is crucial for understanding relative volatility — especially when comparing items with different average sales volumes.

Importance of CV :

While standard deviation tells us about spread, CV tells us how much that spread matters relative to the average. For example:

- TOHFA (Suit) had an average weekly sale of 101.83 units and a CV of 0.29, indicating stable demand.
- AANGAN (Saree) had a similar average of 100.33 units but a higher CV of 0.32, suggesting slightly more volatile demand.
- Bed Sheet 7 had a CV of just 0.29, indicating it is not only high in baseline demand but also dependable — ideal for consistent stocking.

This normalized metric helped us fairly compare stable versus spiky items, regardless of scale.

Visualization :

To present the findings visually and make comparisons easier:

- A table was created using **plotly**. Table, highlighting top 20 items with columns like Average Sales, Std Dev, CV, and Skewness.
- Color-coded rows improved readability.
- These were computed and plotted in Google Colab, using Python libraries like pandas, NumPy, SciPy, and Plotly.

This analysis not only highlighted consistent performers but also exposed items with unpredictable demand, allowing Tiwari Vastralaya to prioritize low-CV items (like TOHFA, MAKHAN, Bed Sheet 6) for constant stocking. And monitor high-CV items (like AANGAN, DOLLY) closely and stock them strategically during known high-demand weeks.

2. ABC Segmentation Analysis :

ABC Analysis was used to categorize items sold at Tiwari Vastralaya based on their contribution to total sales volume (units sold) which is especially important for a family-run B2C store operating under physical and resource constraints. With over 70 SKUs and limited shelf space, this classification method helps prioritize inventory and allocate space more efficiently.

In this method, SKUs were ranked in descending order of their total units sold over the 12-week period. The cumulative contribution of each item to the total sales volume was calculated. Based on standard ABC logic:

- Category A includes items that make up the top ~70–80% of total sales volume — these are high-priority, fast-moving items that must always be stocked.
- Category B consists of the next 15–20%, representing moderately important items with steady but not dominant sales.
- Category C contains the bottom 5–10%, which are low-demand or slow-moving items that can be reviewed for potential replacement or reduced inventory.

For example, TOHFA (Suit), MAKHAN (Suit), and SANGAM (Saree) all fall under Category A. These items consistently contributed the highest volume to total sales and should be given prime shelf space and replenishment priority. In contrast, certain lehenga items or rarely sold sarees fell into Category C and may not justify ongoing stock unless tied to seasonal trends.

The analysis was visualized using Pareto charts generated in Google Colab, which clearly demonstrated the cumulative sales contribution curve. Items were color-coded by category (A, B, C) to easily differentiate their impact. This visual helped communicate how only a small fraction of items (around 20%) accounted for nearly 80% of total units sold, validating the typical Pareto principle in the store's context.

This analysis enables the shop owner to make data-backed stocking decisions. High-volume A-category products should be prioritized in both ordering and display. B-category items may benefit from targeted promotions or bundling strategies, while C-category items can be rotated out during non-festival weeks to free up space.

This approach helped establish a clear stocking and prioritization strategy for Tiwari Vastralaya, aligned with its spatial limitations and sales performance. By focusing on volume-based ABC classification, the store can streamline operations without overstocking low-performing items.

3. Weekly Trend Analysis :

Trend analysis helps identify the rise and fall of demand across different product categories over time. At Tiwari Vastralaya, this is especially important given the shop's space constraints and seasonal fluctuations in customer footfall. By analyzing weekly sales across four major categories—Sarees, Suits, Lehengas, and Bed Sheets—we can gain insights into which items drive sales, when to stock up, and how to allocate shelf space effectively.

We used the 12-week sales dataset spanning February to April 2025, processed using Python (Pandas, Matplotlib, Seaborn) on Google Colab. The dataset was cleaned, melted into a long format, and grouped by category and week. This allowed us to compute total weekly sales per category, followed by descriptive statistics like mean, standard deviation, and min-max values.

Weekly Pattern Insights :

The line graph illustrates the total weekly units sold per category:

- Sarees dominate weekly sales, averaging 3,088 units/week, with noticeable spikes in Week 1 (Feb 3–9), Week 4 (Feb 24–Mar 2), and Week 6 (Mar 10–16). These coincide with festive periods like Vasant Panchami, Maha Shivratri, and Holi, indicating a strong seasonal and cultural influence on shopping behavior. The standard deviation (~877 units) reflects this volatility.
- Suits show consistent yet lower sales than sarees, averaging 826 units/week, and peaking during the same festive weeks. Their moderate standard deviation (~168 units) suggests reasonably steady demand with a few surges during high-traffic periods.
- Bed Sheets maintain a fairly stable trend with average sales of 506 units/week and less fluctuation (std ≈ 150). Demand is fairly constant, making this a reliable category to maintain baseline sales.
- Lehengas have the lowest average sales (328 units/week) and standard deviation (~99), indicating a niche demand likely driven by weddings or specific events. Despite their low volume, they showed peaks during festive weeks, suggesting they remain relevant for special occasions.

What This Means :

This analysis confirms that sarees are the main sales driver for Tiwari Vastralaya and require aggressive inventory planning, especially ahead of festivals. Suits and bed sheets support steady, year-round sales and are ideal for maintaining consistent revenue. Lehengas, while slower-moving, offer opportunity for targeted marketing during wedding seasons.

Understanding this sales cycle allows the shop to:

- Avoid stockouts during festivals.
- Reduce excess inventory during off-peak weeks.
- Plan purchases and shelf allocation more efficiently.

Festive Impact :
Saree sales during festive weeks were **40–50% higher than baseline weeks**, clearly validating the link between cultural festivals and demand spikes. This supports calendar-aligned stock planning and the use of seasonal promotions for high-selling items.

This weekly trend analysis forms the backbone of demand forecasting and aligns stocking decisions with real consumer behavior observed in the store's sales history.

4. Predictive Sales Forecasting (Exploratory Insight) :

To explore the feasibility of forecasting demand, we implemented a basic predictive analysis using weekly sales data for selected top-selling SKUs—SANGAM (Saree) and KISHAN (Suit). We trained a **Random Forest Regressor**, a flexible **machine learning model** capable of capturing non-linear trends, on 12 weeks of historical sales data. The model was then used to forecast unit sales for Week 13.

For SAREE – SANGAM, the model predicted sales of 105.74 units with an R^2 score of 0.76, indicating a moderately strong fit. The Mean Squared Error (MSE) was 199.44, which is reasonable considering short-term volatility. For SUIT – KISHAN, the predicted sales were 50.84 units with a higher R^2 score of 0.94, suggesting excellent model performance and relatively consistent historical demand. The MSE was 78.24, indicating high accuracy for near-term prediction.

These predictions were visualized using line plots, showing actual vs. predicted sales across weeks, with a forecast point for Week 13.

Data and Model Limitations :
Despite promising scores, it is important to emphasize that this model is built on **only 12 data points**, which limits generalizability and robustness. The forecast does not capture **broader seasonality, festival effects**, or external factors such as local events or promotions. The model's reliability diminishes for longer-term forecasts or items with erratic sales patterns.
Additionally, manual data collection introduces the risk of transcription errors, further limiting model precision.

This exploratory analysis highlights the potential of predictive modeling to enhance inventory planning. While not yet suitable for critical decision-making, the forecasts can still offer useful guidance—particularly for managing stock levels of consistent, high-selling items. When used cautiously, these insights can help minimize stockouts and improve overall customer satisfaction.

Results and Findings :

Volatility Analysis using Coefficient of Variation (CV) :

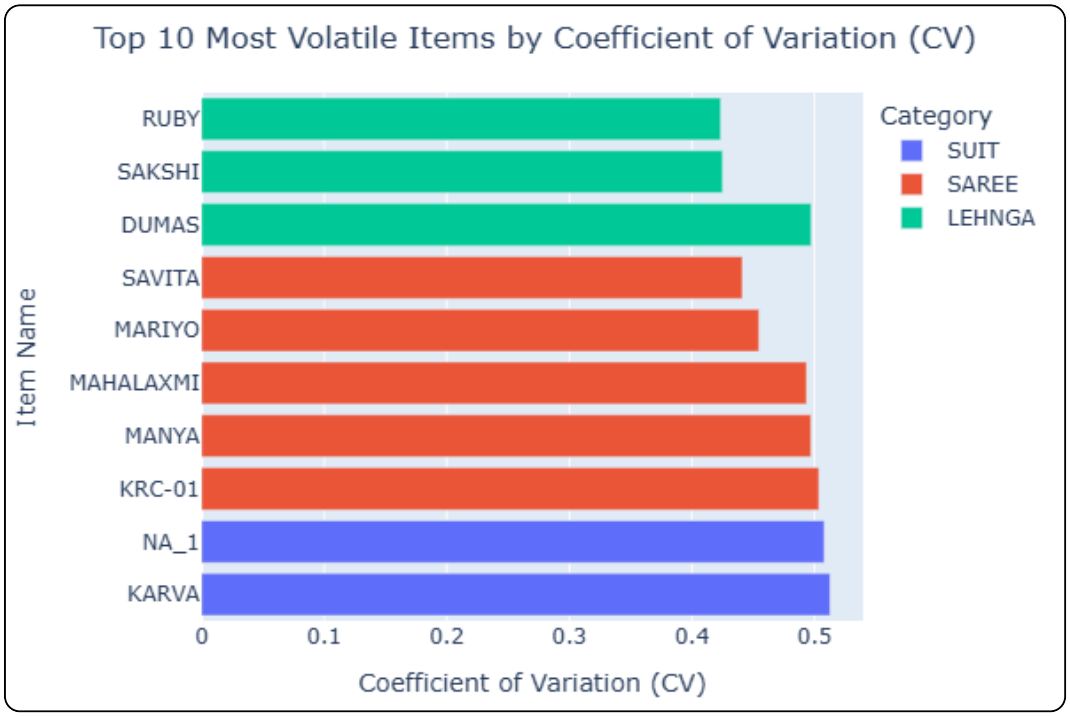

image 1 : Top 10 Volatile items (item vs cv bar plot)

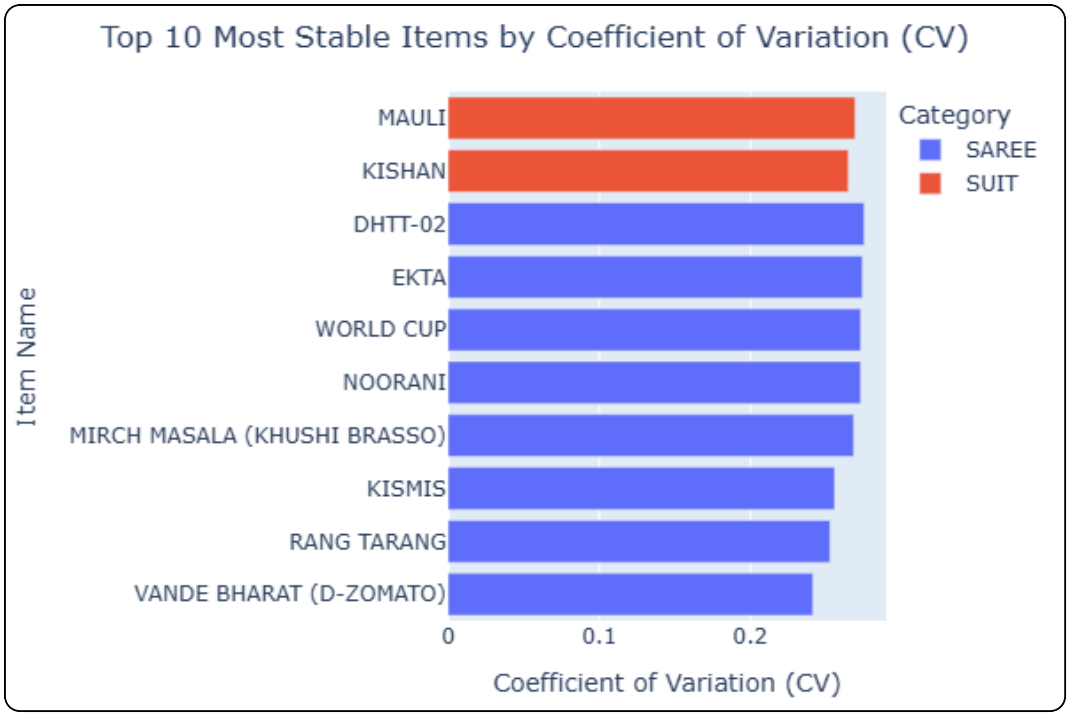

image 2 : Top 10 Stable items (item vs cv bar plot)

The bar chart of most volatile items by CV (*image 1)* reveals products whose sales varied the most relative to their average. These items show unstable or erratic sales patterns, often influenced by external factors like festivals, trends, or local events.

The highest CVs were observed in:

- KARVA and NA_1, both suits, with CVs of ~0.51.
- KRC-01, a saree, followed closely at ~0.50.
- Lehengas such as DUMAS, SAKSHI, and RUBY also ranked high in volatility.

In total, SAREEs dominated this list, with 5 out of the top 10 most volatile items. This suggests that saree sales are more likely to fluctuate depending on seasonal or cultural contexts.

Volatile items are riskier to stock in large quantities because their sales aren't predictable. Overstocking may lead to waste, while understocking during a sudden demand spike can result in missed sales.
At Tiwari Vastralaya, these volatile items should be:

- Monitored closely for seasonality or event-based trends.
- Stocked in flexible or limited quantities.
- Supported by timely marketing only when demand is expected.

Using local insights (e.g., wedding dates or festivals) can help time these items more accurately.

About Stable Items :
In contrast, the lowest CV values identify items that performed most consistently during the 12-week period. These items are the backbone of regular sales, with little weekly variation.

The most stable performers were (*image 2)* :

- VANDE BHARAT (D-ZOMATO) saree (~0.23 CV)
- RANG TARANG, KISMIS, and MIRCH MASALA sarees, all with CVs below 0.28.
- KISHAN and MAULI, both suits, also showed strong stability.

Notably, SAREEs again dominated the list, but this time as stable sellers — demonstrating that while some sarees are volatile, others consistently meet customer demand.

Stable items offer reliability and consistency, making them valuable assets for Tiwari Vastralaya. These products are suitable for bulk purchasing or packaging as combo deals, as the risk of unsold inventory is low. They help maintain steady revenue flow even during off-peak weeks, providing a financial cushion during slower periods. Their predictable sales patterns also make them well-suited for long-term stocking and regular shelf display. Additionally, their dependable performance allows them to be featured confidently in promotions or loyalty programs, where stability in demand ensures smooth execution and customer satisfaction.

ABC Analysis Plots And Findings :

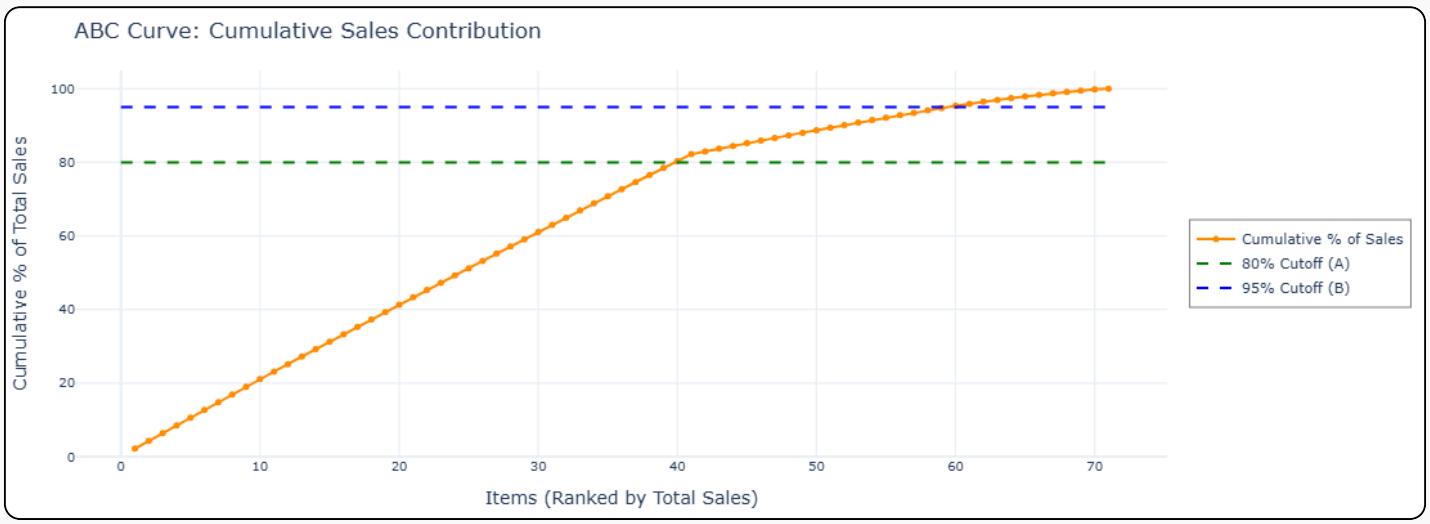

image 3 : ABC Segmentation Plot

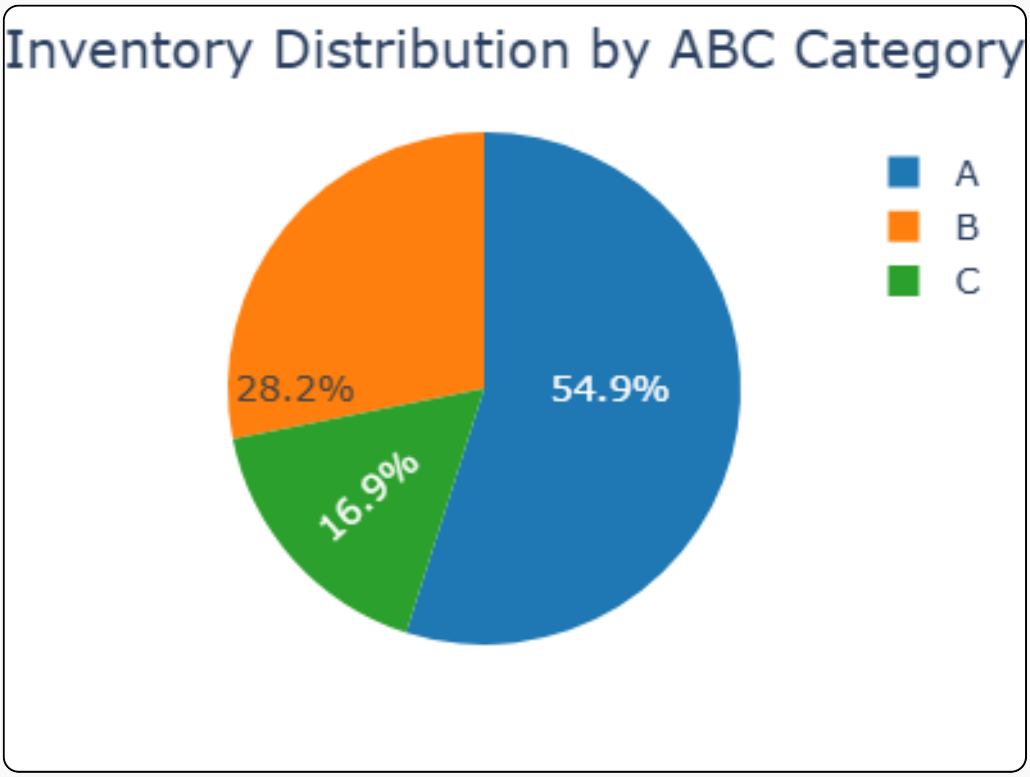

image 4 : Porportion View(Pie Chart)

Chart Conclusion (image 4) :

Category A (54.9%) :

Over half of the store's inventory items fall into this high-priority category. These products are the main revenue drivers, contributing the largest share of overall sales. Managing them effectively is critical — they should be kept well-stocked, frequently reviewed, and given priority during peak demand periods, especially around festivals or high-footfall weeks.

Category B (28.2%) :

Roughly a quarter of the items are categorized as B. These products play a supporting role — they contribute meaningfully to overall sales but not as significantly as Category A. They should be managed with consistent reviews and moderate attention, ensuring they stay in stock but without requiring intensive oversight.

Category C (16.9%) :

The remaining items contribute the least to sales and occupy the lowest priority in terms of stock planning. While some may be retained for variety or niche customer preferences, they can be reviewed less frequently and stocked in smaller quantities to avoid tying up capital in slow-moving inventory.

ABC Analysis Findings (*image 3)* :

To support smarter inventory planning and focus resources on the most impactful products, we conducted an ABC analysis based on total unit sales across a 12-week period. This approach classifies products into three tiers — A, B, and C — based on their cumulative contribution to overall sales volume.

At Tiwari Vastralaya, Category A consists of 39 items that together contribute approximately 80% of the total unit sales. These are the store's most critical products and include consistently high performers such as TOHFA, MAKHAN, and SANGAM. These items are essential for maintaining revenue flow and customer satisfaction, especially during peak seasons. They deserve close monitoring and should be prioritized in stocking and promotional decisions.

Category B includes 20 items, which collectively make up the next 15% of total unit sales. These items — including SAROJA, KISMIS, and YASHI — are moderately important. While they do not dominate sales charts, they contribute consistently and can be managed with regular reviews and stable restocking plans.

The remaining 12 items fall under Category C, contributing just 5% of total unit sales. These items, such as 21950, BED SHEET 3, and DUMAS, are the least impactful in terms of volume. They might be retained for variety or occasional demand but do not require aggressive inventory investment or management attention.

This ABC segmentation highlights how sales are heavily skewed toward a core group of fast-moving items. By focusing on Category A and B products — which together account for 95% of total sales — the store can optimize shelf space, streamline procurement, and avoid tying up capital in slow-moving inventory. Meanwhile, Category C products can be evaluated periodically to determine whether they should be retained, phased out, or promoted differently.

This structured approach provides a practical foundation for inventory decisions that are grounded in actual sales behavior observed over the quarter.

Weekly Sales Trend Analysis and Demand Insights :

Analyzing the weekly sales trends at Tiwari Vastralaya is essential for managing inventory and shelf space, especially given the store's limited space and seasonal variations in customer visits. This report examines sales over 12 weeks, across four primary product categories: **Sarees, Suits, Lehengas, and Bed Sheets**.

The analysis uses actual sales data from February to April 2025, grouped by category and week, and presents descriptive statistics for each category—including averages, volatility, and sales performance during regular and festive weeks.

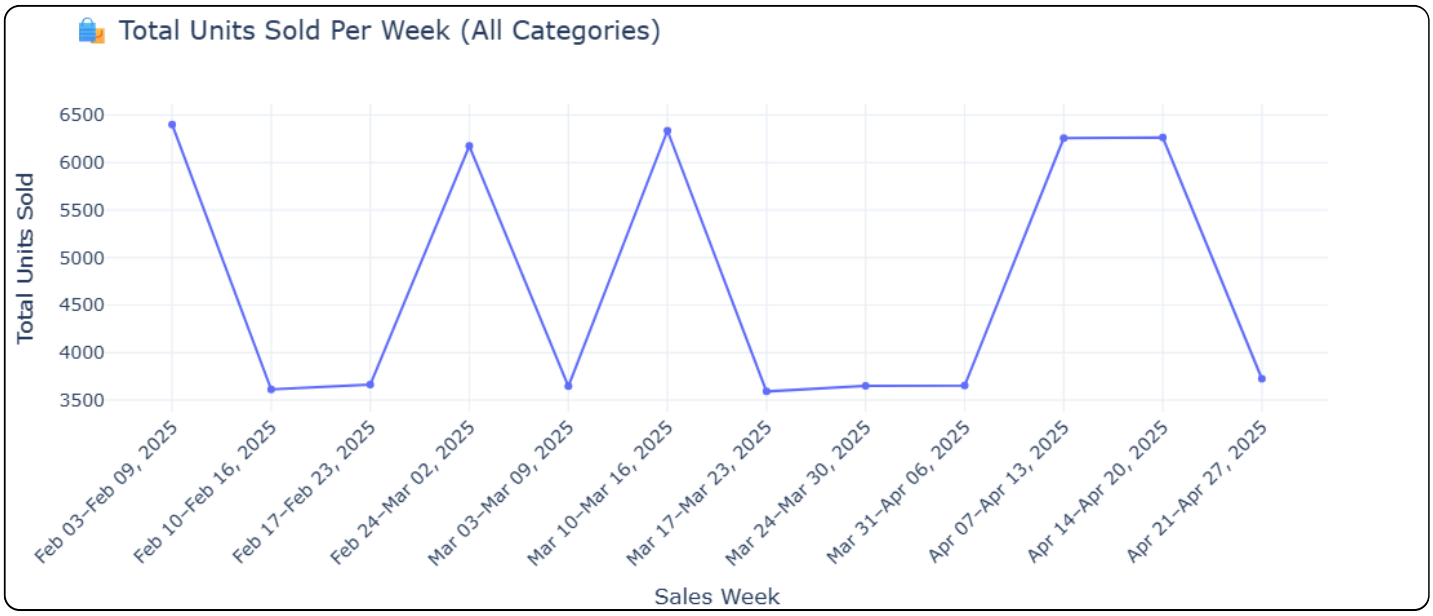

image 5 : Trend Analysis Plot(For Total Unit Sales)

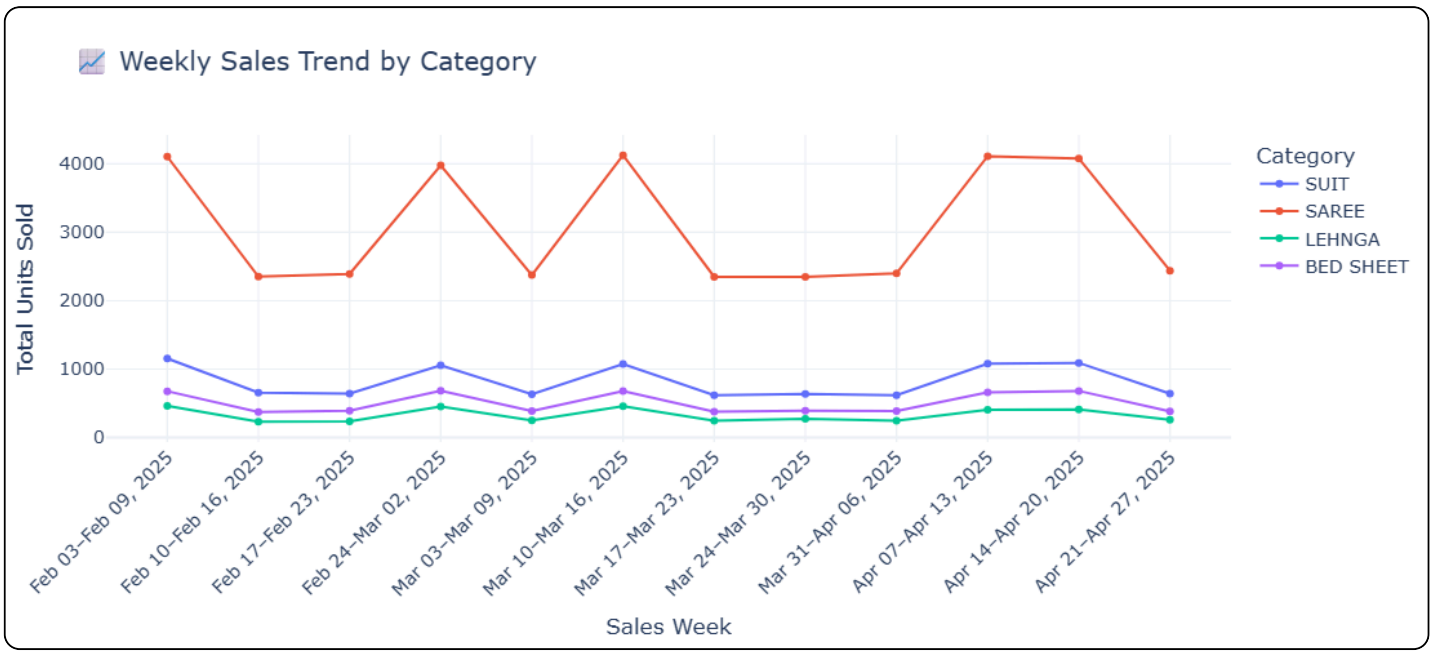

image 6 : Trend Analysis Plot(For Categorywise Total Unit Sales)

Weekly Pattern Insights (*images 5 & 6)*:

Sarees :

- Sarees dominated total weekly sales, with an average of 3,088 units/week. Sales spiked sharply in Weeks 1, 4, and 6—likely aligning with local festivals (e.g., Vasant Panchami, Maha Shivratri, Holi). High standard deviation (~877 units) demonstrates noticeable volatility and sensitivity to seasonal/cultural events.

Suits :

- Suits maintained steady, moderate sales—averaging 826 units/week. They too showed peaks during festive weeks but with less volatility (std ≈ 236). This steadiness makes Suits reliable for generating ongoing revenue.

Bed Sheets :

- Bed Sheets displayed stable demand, with an average of 506 units/week and low fluctuation (std ≈ 151). Weekly sales rarely varied drastically, making this a consistent, dependable stock-keeping category.

Lehengas

- Lehengas contributed the smallest share to total sales (328 units/week average) and showed the least variation (std ≈ 99). Their demand remains niche—likely occasion-driven (weddings/events)—but they also experienced peaks during festive weeks.

Quantifying the Festive Impact :

- Sarees: Festive week sales were 47% higher than in baseline (non-festive) weeks.
- Suits: Saw a 49% increase in festive week sales versus baseline weeks.
- Bed Sheets: Festive weeks averaged 52% higher sales than off-peak weeks.
- Lehengas: Peaked with sales 61% above baseline week averages.

These clear spikes prove the strong influence of festivals and events on customer buying patterns for all categories, most notably for Sarees and Lehengas.

conclusions :

Sarees are the principal revenue driver and require robust, proactive inventory management, especially before and during festival periods. **Suits** and **Bed Sheets** display steady demand and are well-suited for maintaining consistent year-round sales. **Lehengas**, while slower-moving, offer opportunities for targeted marketing and stocking during wedding and festive seasons.

Festive weeks drive sales in all categories—stock-outs can be prevented, and excess inventory reduced, by aligning purchase and marketing efforts with expected peaks.

Sales Forecasting Plots and Insights (Short-Term Demand Prediction) :

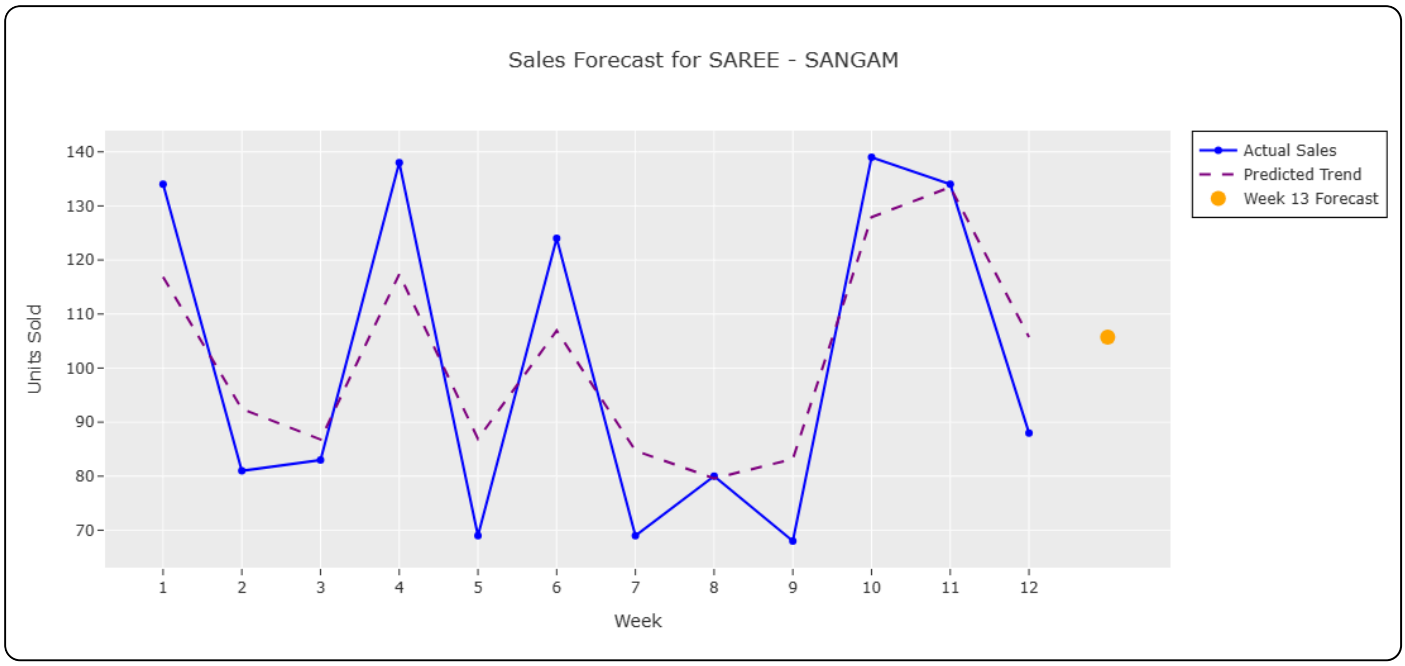

image 7 : Forecast Plot For SANGAM Saree

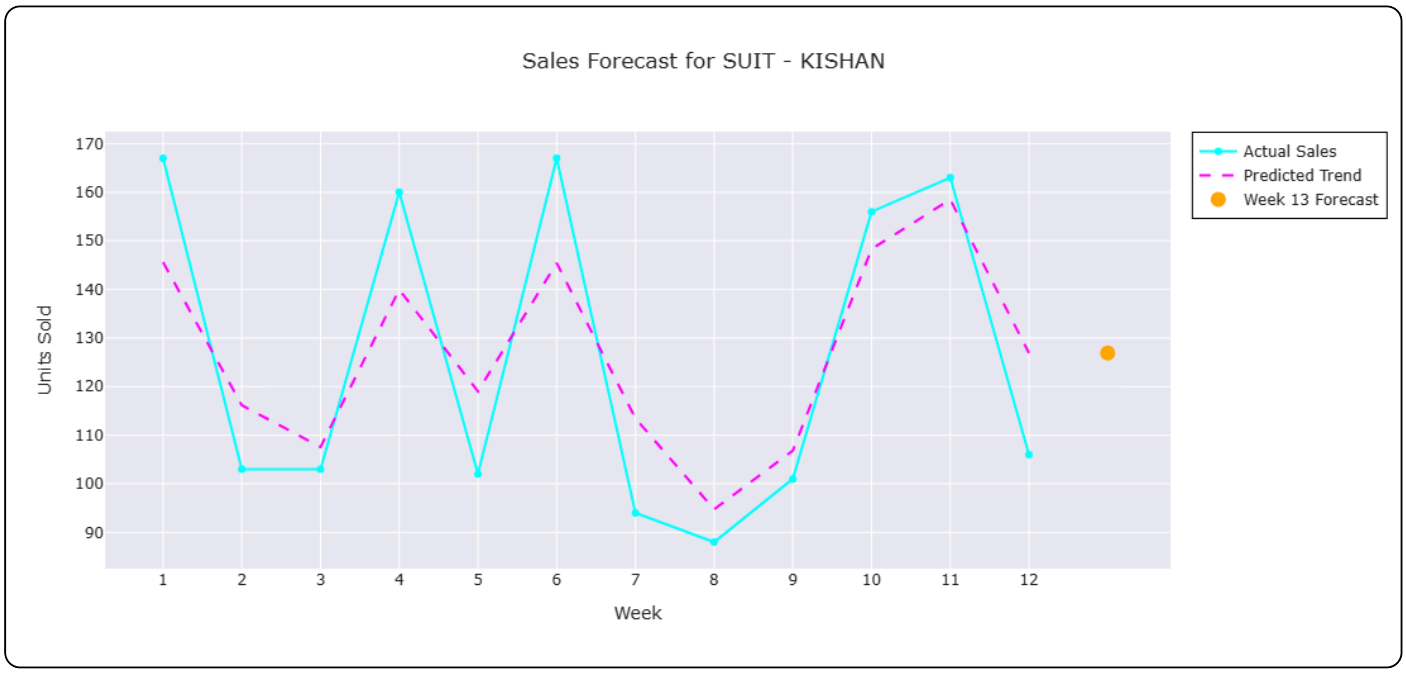

image 8 : Forecast Plot For KISHAN Suit

To explore whether we could improve inventory decisions at Tiwari Vastralaya, we selected two popular items — SANGAM from the Saree category and KISHAN from the Suit category. We used the past 12 weeks of sales data to train a simple machine learning model that could help predict what might sell in the following week.

The line graphs for both items show(*images 7 & 8)* :

- Actual weekly sales using solid dots, representing how many pieces were sold each week.
- A predicted trend line (dashed) that tracks how the model thinks sales behaved.
- An orange dot for Week 13, showing the model's forecast for next week's sales.

SANGAM (Saree) :
The model predicted that about 106 units of SANGAM might be sold in Week 13. While the actual and predicted sales didn't match perfectly every week, the model did a fairly good job, with an R^2 score of 0.76. This means the forecast explained most of the ups and downs in saree sales, which naturally vary due to festivals, demand spikes, or restock timings.

KISHAN (Suit) :
For KISHAN, the model forecasted around 51 units for Week 13. The suit's sales were much more stable across weeks, and the model captured this pattern very well. The R^2 score was 0.94, which is a very strong result. This suggests that suit sales are highly predictable under current conditions.

These short-term forecasts are not perfect, but they are very helpful for planning :

- For store staff, these predictions can guide how much stock to keep ready for the next week.
- Suit sales, in particular, are easier to predict. Saree sales, while a bit more variable, still follow a pattern that the model mostly catches.
- The graphs also make it visually easy to spot where actual sales were higher or lower than expected.

At the same time, the model still has limitations — it's trained on just 12 weeks of data and doesn't know about things like festivals or special events.

Interpretation of Results and Recommendation :

This section brings together the major findings from the analysis — including sales trends, ABC segmentation, product variability, and forecasting. Each problem identified during the study is explained based on data-backed insights, followed by practical and realistic recommendations that fit the current scale of the business. These suggestions aim to improve inventory planning, optimize storage use, and lay the groundwork for gradual business growth.

Problem 1: Limited Storage Space (Space Constraints)

Interpretation :

- The store operates with tight shelf space, making it challenging to accommodate all products efficiently.

- From the ABC analysis, many items fell under Category C, contributing less than 20% of total sales, yet taking up physical storage that could be better used.

- Items in Category A (like sarees and suits) generate most of the sales and need to be readily accessible.

Recommendations :

Focus Storage on A-Category Items :

- Give shelf priority to fast-moving products, especially sarees and suits.
- Store low-selling C-items in backstock or on-demand basis rather than occupying main display areas.

Utilize Extra Available Space :

- The unused front room can be repurposed as a dedicated storeroom, keeping rarely sold items or excess stock away from the main shop floor.

Product Rotation :

- For seasonal items (e.g., lehngas), limit display to peak demand periods based on trends from the sales data.

Problem 2: Uneven (Low) Sales During Non-Festive Weeks

Interpretation :

- The 12-week trend analysis shows a repeating pattern of high and low sales every 2–3 weeks. suggesting that festivals, local events, and special occasions play a strong role in driving customer demand

- CV values confirm that certain product categories (like sarees) have high sales volatility, while others like suits or bedsheets are more stable.

- These fluctuations lead to inventory mismatch: overstocking in slow weeks and potential shortages during demand spikes.

Recommendations :

Use Sales Trends for Planning :

- Plan purchases by matching inventory with the high-low sales pattern seen in the trend chart.
- Maintain steady stock for stable products, and apply buffer stock only during expected peak weeks for volatile items.

Avoid Overstocking C-Category Items :

- Items with low average sales and high variability should be stocked conservatively.

Mid-Cycle Offers :

- To reduce dips in sales during low weeks, consider running small in-store discounts or loyalty deals to balance weekly revenues.

Problem 3: Limited Business Scalability

Interpretation :

- The store currently relies on manual judgment and lacks tools for forecasting demand or adjusting stock ahead of time.

- The forecasting models developed for two key products—SANGAM (Saree) and KISHAN (Suit)—proved that short-term demand can be predicted fairly accurately, especially for consistent items like suits.

- The forecasting process offers a way to transition from reactive to proactive inventory management.

Recommendations :

Use Demand Forecasts Weekly :

- Refer to model predictions when deciding how much to stock for key items.
- Avoid guesswork by using data-backed estimates, especially for A-category products.

Digitally Support Expansion :

- As online shopping becomes more popular, consider pairing your store with a local delivery service or app-based ordering system.
- This can help expand customer reach without needing extra shop floor space.

Improve Sales Records :

- Continue capturing weekly sales data to improve future forecasting.
- Even simple records can feed into more accurate and useful predictions over time.

Important Links & References :

Google Sheet Link of Data	Tiwari Vastralaya Shop data
Interview Video	Recorded G - meet with shop owner
Google Colab Analysis	Working With Colab
Fore Casting Notebook	ML Forecast
Drive	More Shop Related Files
Declaration Statement & Auth Letter	Click Here
Reference 1	Course Live Sessions
Reference 2	Project Live Sessions