

**Analyzing Market Trends, Workforce Dynamics, and Customer Loyalty for  
Growth in a Hardware and Electronics Retail Business**

**A Final-Term report for the BDM capstone Project**

Submitted by

Name:Aaditya Dattaraj sawant

Roll number:23f3001416(DS)



IITM Online BS Degree Program,  
Indian Institute of Technology, Madras, Chennai  
Tamil Nadu, India, 600036

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## Declaration Statement

I am working on a Project titled “Analyzing Market Trends, Workforce Dynamics, and Customer Loyalty for Growth in a Hardware and Electronics Retail Business”. I extend my appreciation to Mahavir Enterprise, for providing the necessary resources that enabled me to conduct my project.

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

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

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

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

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

A handwritten signature in blue ink, appearing to read 'Aaditya', is placed over a rectangular area with a light gray dotted grid background.

Signature of Candidate: (Digital Signature)

Name: Aaditya sawant

Date: 25/12/2024

## **1 EXECUTIVE SUMMARY:**

The initiative was undertaken to address three major issues in Mr. Vijay's retailing operations: erratic inventory turnover, poor distribution of products to B2B and B2C channels, and regular interruptions in sales owing to shortage of staff during holidays. The prime motive was to facilitate more informed decision-making through data analytics by predicting sales trends and detecting movement in product demand.

A model to forecast quarterly sales in 2025 was created by analyzing 2021 to 2024 sales data. The model showed high accuracy with an average RMSE value of just 7.28 when validated against 2024 sales data.

There are strong indications of shifting customer interest. Sales of traditional products like bulbs and switches are set to decline by more than 35%, whereas more advanced products like LEDs and smart switches are set to rise by a minimum of 26% by 2025. Sales through the B2C model are set to grow by 13.6%, outpacing the 10.3% growth forecasted in the B2B model and indicating a need to address strategic priorities accordingly.

These findings provide tangible business benefits. Mr. Vijay can maximize inventory based on relevance to products, prepare for peak demands, and avoid risks of excess stock or stockouts. Assigning more tasks to experienced workers will alleviate pressure on under-trained staff members to make operations in inventory management, sales, and deliveries more efficient. In the long run, this will maximize operational effectiveness, promote customer satisfaction, and maximize profitability.

## **2.DETAILED EXPLANATION OF ANALYSIS PROCESS/METHODS:**

The report presents a comprehensive analysis of historical sales data along with forecasting of future sales trends for the year 2025. The analysis and forecasting were carried out using a combination of Excel spreadsheets and Python programming, leveraging powerful libraries for data manipulation, visualization, and machine learning-based forecasting. Sales datasheet was used containing sales of top five products that shifted considerably from older version to modern version from the sales inventory.

The goal was to understand sales trends across different product types, buyer segments (B2B and B2C), and product generations (Old vs Modern), and to project the potential sales trajectory based on past patterns. Insights were drawn through various analytical graphs and predictive models applied to quarterly data from 2021 to 2025. To ensure the reliability of the forecasting approach, the model was first tested on known data from 2024 before being extended to generate predictions for 2025.

**1.Sales Forecasting-**A machine learning-based time series forecasting method was employed to estimate sales for 2025 using Python libraries. Forecasts were calculated on a quarterly basis for each product variant. Negative values were transformed to null values. The data cleaning and preprocessing phase involved removing unnecessary columns, such as unnamed placeholders, and standardizing column names for consistency. Additionally, frequency adjustments were made to align the data to quarterly endpoints, enabling proper modeling of seasonal patterns. Clean data allowed for smooth model fitting and contributed to a reduced error rate (RMSE of 7.28), validating the overall robustness of the predictive pipeline.

**Dependent Variable:**

- Quarterly Sales Figures: This is the target variable predicted by the model, representing the sales for each product per quarter throughout the years from 2021 to 2024.

**Independent Variables:**

- Quarter (Q1 to Q4): Represents the time period within each year.
- Product Category: Specific product types such as bulbs, LEDs, fans, switches, etc.
- Buyer Segment: Whether the sale was made under B2B or B2C classification.
- Historical Sales Data (2021 to 2024): Used to derive trends and seasonal patterns.

**Control Variables:**

- Product Generation Classification (Old vs Modern): Grouping products based on legacy or new smart technology variants.
- Year of Sale: Used to capture trends across years and to ensure the model learns temporal dependencies.

### **Tech Stack and Functions Used:**

- **Programming Language:** Python
- **Libraries:** pandas, numpy, matplotlib, seaborn, scikit-learn
- **Functions Used:**
  - Data Cleaning: fillna(), dropna(), astype()-to remove null values and blank columns
  - Forecasting: Linear Regression and Polynomial Regression models from sklearn.linear\_model
  - Evaluation: Graphical trend comparison with actual vs predicted lines
  - Visualization: matplotlib.pyplot.plot(), seaborn.lineplot()

**2.Graphical Analysis and Interpretation**-Graphs were used to answer specific business questions and to visualize relationships within the dataset effectively. The choice of graph type was based on clarity and relevance to the dimension being analyzed.

#### **2.1: Quarterly Sales Trend (Old vs Modern Products) using line plot**

**Purpose:** To compare overall sales patterns between old-generation and modern product lines across quarters throughout the years 2021-2025.

**Method:** Line plot showing merged quarterly sales for both generations.

Line plots are well-suited for illustrating time-series data, as they effectively convey trends and continuity across sequential periods such as quarters. Bar plots would fail to capture the temporal progression and rate of change as clearly.

## **2.2: Sales Comparison for B2B vs B2C using bar chart**

**Purpose:** To understand how sales volumes differ between business-to-business and business-to-consumer segments year-over-year (2024 vs 2025).

**Method:** Bar chart comparing total yearly sales for each segment.

Bar charts facilitate a clear comparison of categorical values such as B2B and B2C sales across different years. They allow immediate identification of relative sizes without the ambiguity of lines or area charts.

## **2.3: Comparison for Old vs New Products using bar chart**

**Purpose:** To evaluate performance of legacy vs smart product lines over the year 2024 and 2025.

**Method:** Grouped bar chart for 2024 and 2025 total sales per generation.

Grouped bar charts support direct side-by-side comparison across multiple categories within two time periods, providing a clear view of generational shifts in sales.

## **2.4: Sales of Old B2B, B2C and New B2B, B2C in 2024 vs 2025 using bar plot**

**Purpose:** To investigate the most profitable segment combining both generation and buyer type.

**Method:** Bar plot for four categories (Old B2B, Old B2C, New B2B, New B2C) across 2024 and 2025.

Bar plots offer a structured format for presenting multiple compound categories together. They are effective in highlighting dominant groups in segmented datasets.

## **2.5: Heatmap of Yearly Product Sales (B2B & B2C Merged)**

**Purpose:** To identify patterns and anomalies in product-wise yearly performance.

**Method:** Heatmap showing total yearly sales of each product (B2B and B2C merged).

Heatmaps condense large-scale matrix data into a color-coded format that easily reveals patterns, anomalies, and outliers across a two-dimensional layout. Using alternative plots would result in overcrowded visuals and loss of comparative precision.

## **2.6: Sales Distribution per Product using Boxplot**

**Purpose:** To evaluate the spread and variability in sales per product.

**Method:** Boxplot showing distribution of sales across all quarters and years per product.

Boxplots are designed to show the central tendency, variability, and potential outliers within each product's sales distribution. They offer more insight into the data's range than average-based plots like bar or line charts.

## **2.7: Total Sales vs Quarter (All Years Combined) using scatter with lines plot**

**Purpose:** To examine the relationship between quarter numbers and total sales.

**Method:** Scatter plot with overlaid trend lines, color-coded by year.

Scatter plots are optimal for identifying correlations or spread in numerical data across categories like quarters. When combined with trend lines, they allow year-wise visual differentiation and capture seasonal movement effectively.

While analyzing the historical sales data, it was hypothesized that specific sales patterns might correlate with time-based variables such as quarters and years, along with product classifications into older and newer categories. To validate these assumptions, several visualization



techniques—including heatmaps, scatter plots, and categorized bar charts—were applied to explore temporal and categorical sales patterns across the period from 2021 to 2024.


Upon deriving initial insights, a forecasting model was developed using Exponential Smoothing (Holt-Winters method), a well-established time series analysis approach. This model was built on historical quarterly sales data from 2021 to 2024. Prior to modeling, data was cleaned, transformed, and normalized to ensure consistency. The model was trained with consideration of both trend and seasonal components, and then tested on 2024 data to assess its accuracy and robustness. The average Root Mean Square Error (RMSE) on the 2024 validation data was recorded as **7.28**, reinforcing the model's ability to reasonably capture and predict underlying sales trends.

Following validation, the model was applied to generate forecasts for 2025. This predictive framework not only provides expected sales values for strategic planning but also highlights seasonal shifts and category-wise contributions across products. The process employed Excel spreadsheets for raw data analysis and Python for time series modeling and visualizations, leveraging libraries such as pandas, matplotlib, seaborn, and statsmodels.

Overall, the development and validation of this forecasting pipeline created a dependable analytical foundation for anticipating quarterly sales, enhancing inventory planning, resource allocation, and product-specific marketing strategies.

### **3.RESULTS AND FINDINGS:**

The forecasting model was initially tested on the 2024 data to validate its performance. The Root Mean Square Error (RMSE) was computed for all products to assess the accuracy of the predictions. The model achieved an average RMSE of 7.28, indicating a reasonably good fit. This low error metric suggested that the model could reliably capture sales behavior across quarters.



Forecast Accuracy for 2024:

	Product	RMSE
0	Bulbs B2B	4.78
1	Bulbs B2C	4.63
2	LED B2B	17.77
3	LED B2C	14.80
4	Switch Fans B2B	3.64
5	Switch Fans B2C	2.25
6	Remote Fans B2B	12.32
7	Remote Fans B2C	8.07
8	Manual Switches B2B	5.68
9	Manual Switches B2C	1.55
10	Smart Touch Switches B2B	10.90
11	Smart Touch Switches B2C	5.22
12	Doorbells B2B	7.97
13	Doorbells B2C	7.39
14	Video Doorbells B2B	4.02
15	Video Doorbells B2C	5.51


Average RMSE: 7.28

Image 1:Forecast accuracy on testing the model on the year 2024


Based on this confidence, the model was then used to forecast the quarterly sales for 2025. The predicted sales values generally aligned with expected seasonal and category-wise trends observed in previous years.

The forecasted results for all product categories across the four quarters of 2025 are presented below in the sheet:

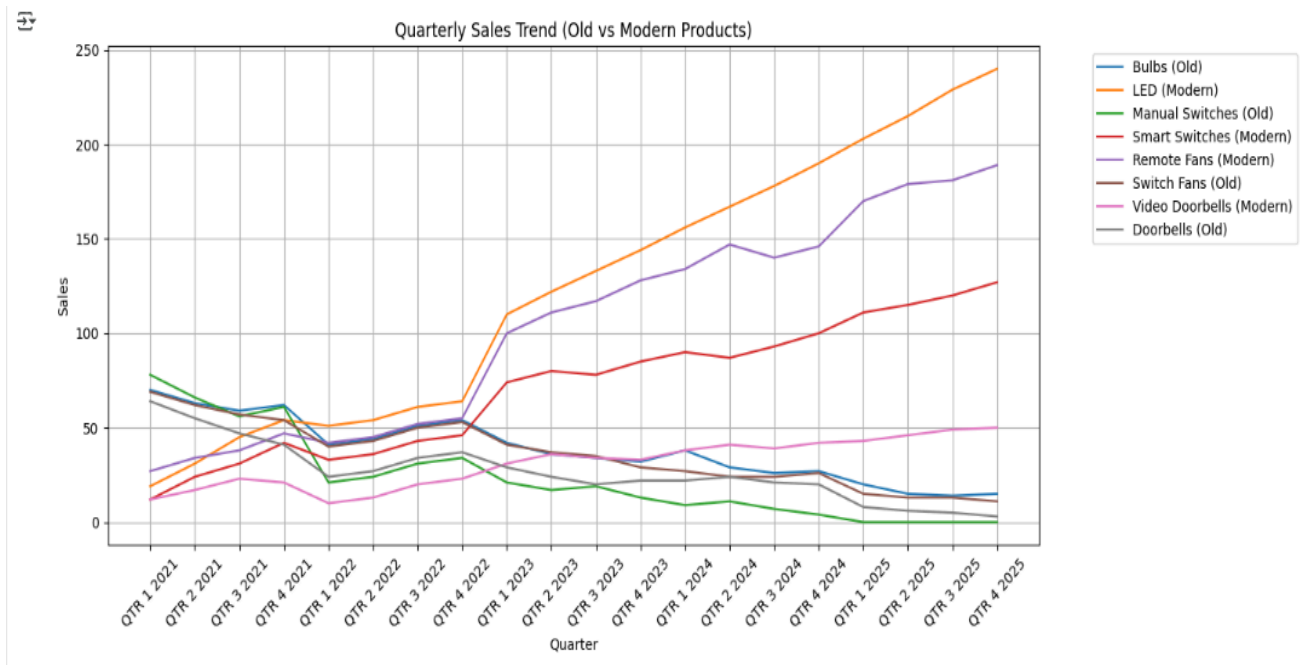
 [sales\\_forecast\\_2025](#)

Google colab notebook consisting of codes used to train model,test on 2024 data and forecast prediction for 2025:  [23f3001416\\_test and forecast.ipynb](#)

Google colab notebook consisting of codes used to analyze and generating graphs:

 [23f3001416 graph.ipynb](#)

Link of dataset:  [23f3001416 bdm project.xlsx](#)



Graph 1: Quarterly sales trend (old vs modern products)

This line chart compares the quarterly sales performance of older-generation products—namely **Bulbs**, **Manual Switches**, **Switch Fans**, and **Doorbells**—with their modern counterparts such as **LEDs**, **Smart Switches**, **Remote Fans**, and **Video Doorbells** across the period from Q1 2021 through the forecasted quarters of 2025.

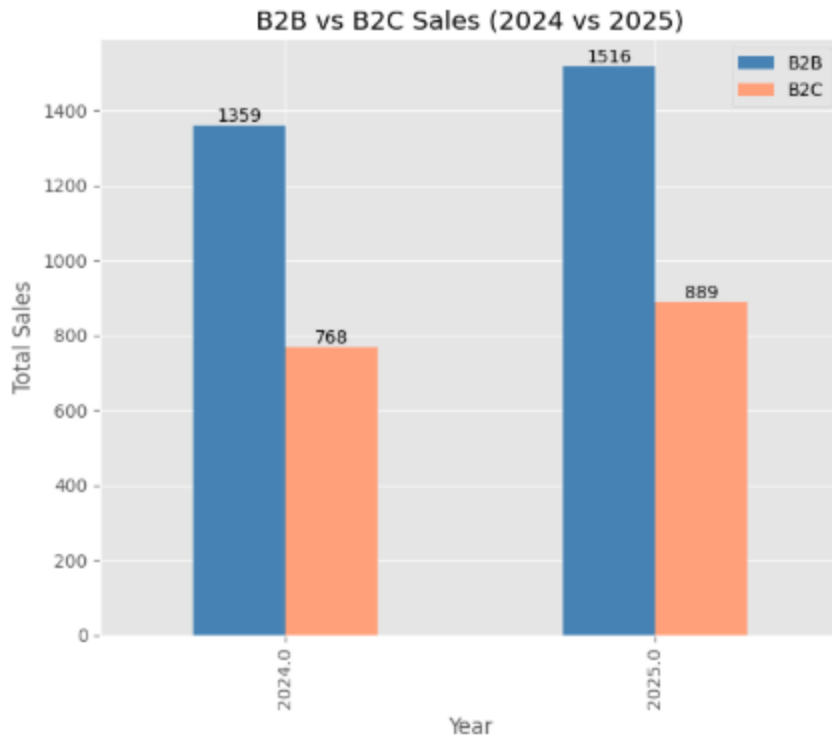
The overall trend illustrates a distinct divergence between old and modern products as time progresses:

- During the initial quarters, especially at the end of 2021, the sales volumes of older and newer product lines were relatively similar. This indicates that both categories were still in competitive coexistence, possibly due to consumer habit or product familiarity.
- However, from early 2022 onwards, the chart clearly shows a gradual decline in sales for older-generation products. In contrast, sales for the modern variants show a strong upward trajectory quarter over quarter.
- The dip seen across all products in early 2022 can likely be attributed to policy changes such as the introduction of a “Monday off” operational rule, which had restricted retail or

operational hours, leading to decreased consumer interaction and lower sales volume temporarily.

- Post this phase, modern products began to show strong and consistent growth. Notably:
  - LEDs experienced a sharp increase from mid-2022, eventually surpassing all other product categories by a considerable margin.
  - Remote Fans and Smart Switches demonstrated consistent quarter-on-quarter increases, reflecting growing market preference for smart and remote-controlled devices.
  - Video Doorbells also exhibited a steady rise, possibly driven by increasing consumer demand for smart security solutions.
- Conversely, traditional products like Bulbs and Manual Switches exhibited a steady decline. Switch Fans and Doorbells followed a similar trend, suggesting that customers are gradually shifting away from legacy products in favor of smarter and more energy-efficient alternatives.
- By 2025, the forecast reveals a significant gap between the two generations: modern products dominate the sales landscape, with old-generation items nearing the bottom of the graph, indicating a clear market transition and probable consumer behavior shift.

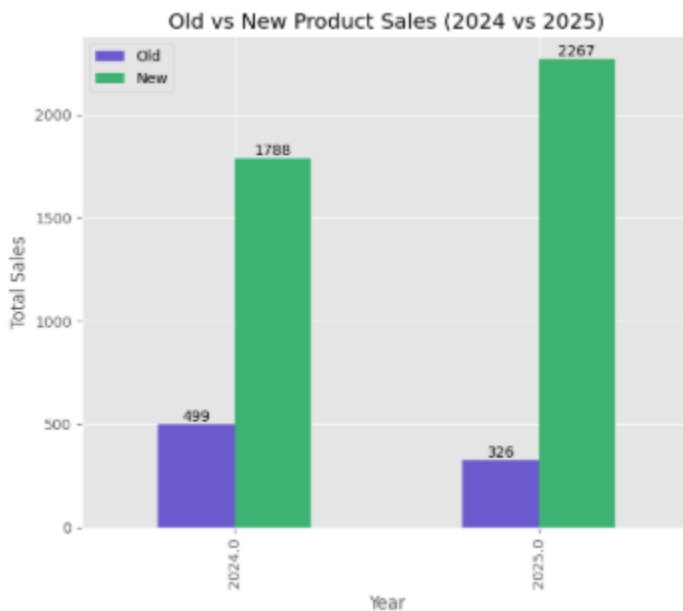
This graph is critical in understanding the evolution of consumer demand, reflecting the shift from conventional to modernized solutions. It aids in inventory and production strategy by signaling which product lines should be prioritized moving forward, and where phasing out legacy models could be both cost-effective and timely.



Graph 2: B2B VS B2C sales comparison 2024 vs 2025

- The B2B segment shows a strong and steady growth of 10.3% increase in B2B sales year-over-year, indicating robust demand from corporate or commercial buyers.
- The B2C segment, while starting from a lower base, increased approximately 13.6%, which is slightly higher than the B2B growth rate.
- Despite B2B maintaining a larger overall sales volume, the B2C segment is growing at a faster rate. This could suggest that individual consumers are increasingly adopting modern products, possibly due to improved recommendation from buyers, marketing efforts, or broader accessibility.
- The B2B dominance in absolute terms is expected due to bulk procurement behavior, long-term institutional contracts, or steady infrastructure demands from commercial clients.

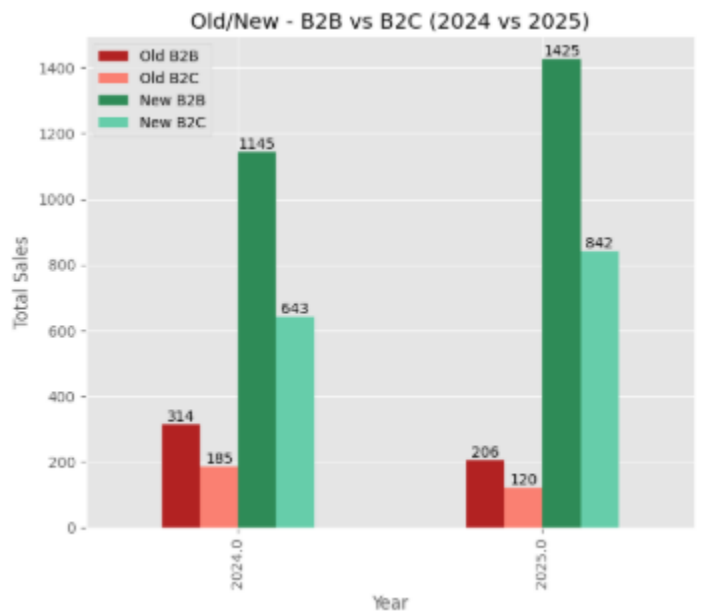
- The narrowing growth gap between B2B and B2C implies an expanding consumer base, and hence, product positioning strategies may need to adapt to cater more effectively to end-users.
- Both sectors show positive outlooks for 2025, indicating that the overall market is expanding, and strategic scaling of operations for both retail and institutional channels may be warranted.



Graph 3:Older vs modern version of products sales(2024 vs2025)

- Old product sales dropped significantly, approximately 34.7%, indicating a steep fall in demand for traditional variants like Bulbs, Manual Switches, Switch Fans, and Doorbells.
- New product sales increased notably an approximate 26.8% increase, signifying growing acceptance and market penetration of advanced solutions such as LEDs, Smart Switches, Remote-Controlled Fans, and Video Doorbells.
- The declining demand for old products and simultaneous surge in new product sales indicates a clear consumer shift towards modern, efficient, and smart home solutions.

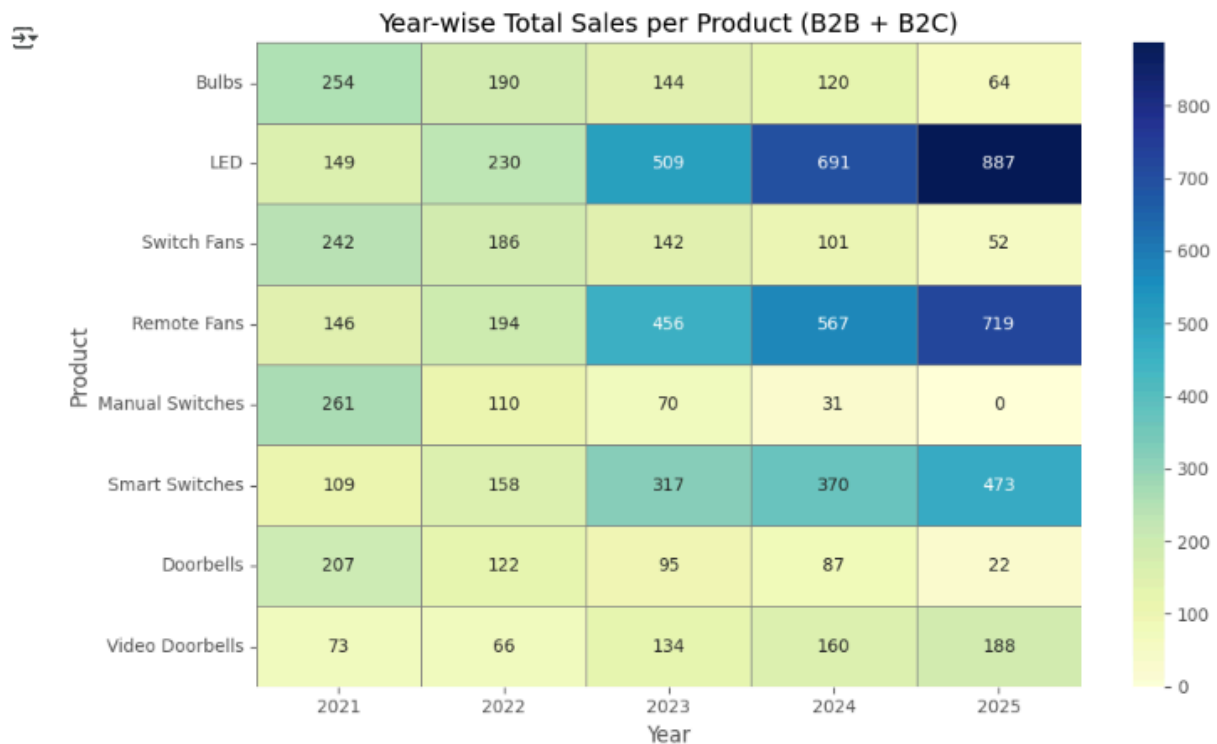
- Such a transition may be attributed to:
  - Urban migration and increased residential development in apartments or smart buildings, reducing reliance on legacy setups common in bungalows or chawls.
  - A rise in disposable income and lifestyle upgrades, enabling consumers to invest in technologically advanced and convenient alternatives.
  - Marketing influence, government incentives for energy-efficient products (like LEDs), or simply newer models being bundled with construction contracts.
- This divergence in trend underscores the need for strategic inventory planning, favoring modern product lines while gradually phasing out older versions to avoid deadstock.
- The results also reinforce how technology adoption is shaping the product ecosystem, making it crucial for businesses to align with evolving customer expectations and urban infrastructure demands.



Graph 4: Sales Comparison by Generation and Segment – Old/New B2B and B2C (2024 vs 2025)

- Old B2B products saw a decline of approximately 34.4%, indicating that businesses are phasing out older technology solutions.
- Old B2C products saw a 35.1% decrease, aligning with the observed trend of consumers favoring smart alternatives.
- New B2B products marked an increase of around 24.5%, showing strong institutional adoption of modern products, possibly for smart building infrastructure.
- New B2C products saw a 30.9% increase, reinforcing rising consumer preference for smart, energy-efficient products.
- The consistent decline in older versions across both segments reflects changing technological standards, updated regulations, or simply product obsolescence in both markets.
- Businesses and end-users alike appear to be transitioning their inventories and consumption habits toward smarter, more efficient, and potentially IoT-enabled devices.
- These patterns highlight the importance for sellers and manufacturers to:
  - Prioritize innovation.
  - Phase out aging product lines.
  - Tailor marketing strategies based on segment-specific adoption curves.

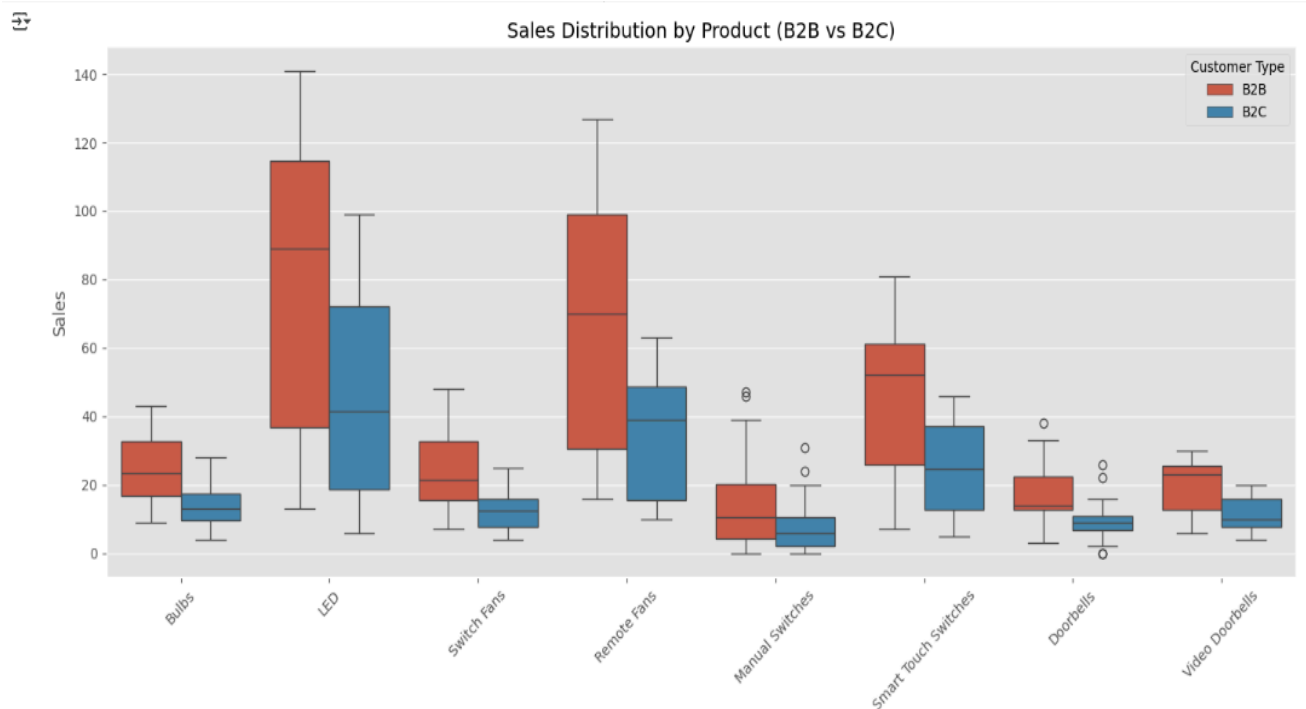




Graph 5: Year-wise Total sales per product (B2B+B2C)

Old products show steady decline, while modern items like LEDs, smart switches, and remote fans exhibit strong, consistent growth, reflecting market shift toward automation and smart technology.

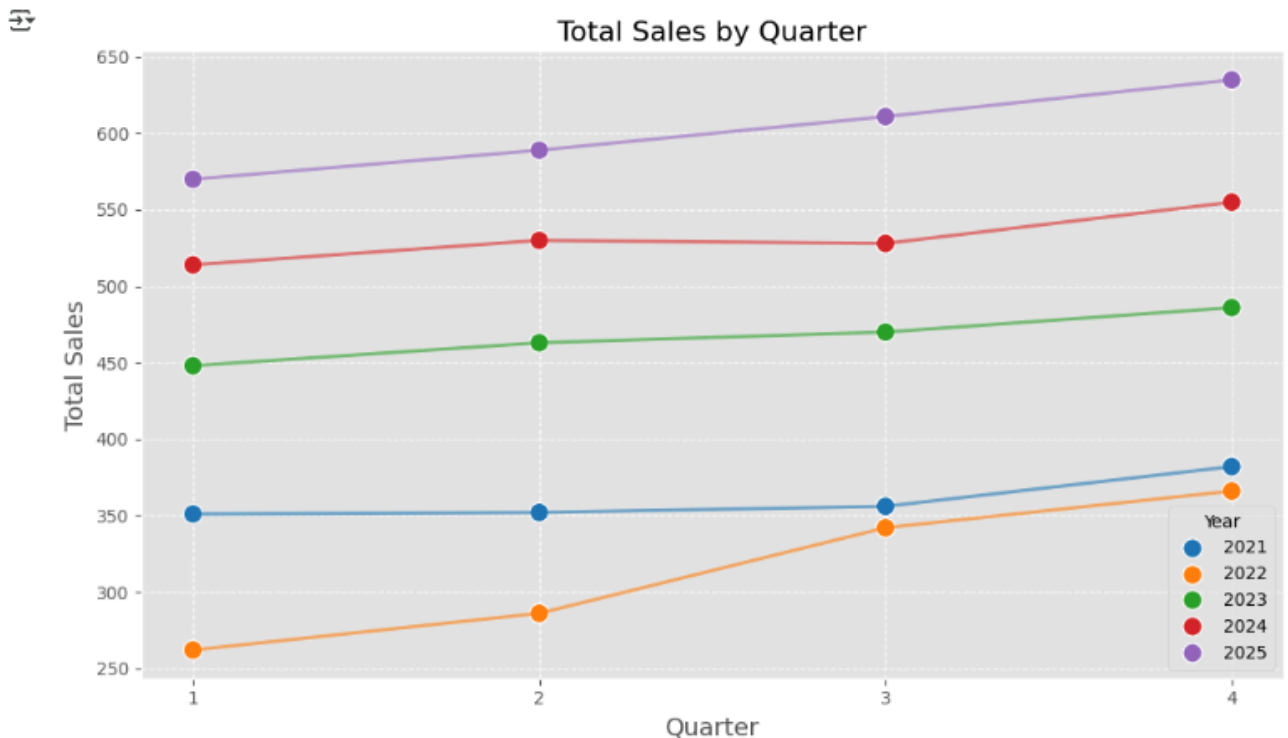
- While sales rise, the unit demand of video doorbells remains relatively low due to their high cost per unit and niche usage compared to mass items like LEDs or switches. They are typically installed one or two per household, whereas lights and switches are required in bulk.
- The overall lighter shades in 2022 across almost all products confirm a notable dip in sales during that year. This likely resulted from the policy-driven reduction in active business days, which affected both B2B installations and consumer purchases.
- Products like LEDs and Smart Switches show sales spikes particularly from 2023 onwards, which may align with festive seasons like Diwali and Ganpati, when home renovations and purchases are common in locality.
- This seasonal demand has acted as a sales amplifier for modern product lines.



Graph 6: Sales Distribution of Products (B2B vs B2C) Across Quarters

- B2B consistently outperforms B2C for nearly every product, indicating that bulk purchases and institutional demand drive a significant portion of total sales. This is especially true for LED lights and remote fans.
- LEDs and Remote Fans have notably long boxes (interquartile ranges), reflecting strong and consistent demand across many quarters. Their higher median values further confirm their dominance in both B2B and B2C sectors.
- Outliers are evident in products like doorbells and switches, suggesting occasional quarters with abnormally high sales. These spikes likely align with festive periods (like Diwali or Ganesh Chaturthi), when decorative or distributed items are in greater demand.

- Bulbs, Switch Fans, and Manual Switches show wider boxes and a broader spread, indicating irregular and seasonal demand. This variability reinforces their role as lower-cost, frequently replaced items.



Graph 7: Total Sales by Quarter (2021–2025)

- 2022 exhibits a significant dip in total sales during Q1 and Q2 compared to other years. This downturn aligns with the "Monday Off" policy, which severely impacted retail and commercial operations during the early months. However, by Q3 and Q4, there is a clear recovery trend, suggesting market stabilization once the policy was lifted.
- 2025 shows a consistent upward slope across all quarters, reflecting a robust and healthy sales environment. The sharp rise, especially from Q3 to Q4, signals strong consumer engagement and perhaps an increased demand for newer smart home products.

- Each year displays a general upward trajectory in Q3 and Q4, which can be attributed to major Indian festivals like Ganesh Chaturthi, Diwali, and Christmas. These celebrations traditionally spur higher purchases of electronic items, lighting, and home improvement goods.
- The slope of the lines increases progressively each year, indicating not only seasonal effects but also year-on-year growth in customer demand and market expansion.

#### **4. INTERPRETATION OF RESULTS AND RECOMMENDATIONS:**

The results of our sales analysis and time series forecast provide quality insight into prior performance and future sales predictions. 2024 model validation's low value for RMSE is an affirmation of the strong nature and performance capacity of the chosen model. Having obtained this level of correctness, the same model was employed to make 2025 sales predictions and the result generated values that matched trend observation to an impressive level. Our predictions are therefore trustworthy and actionable.

One finding from the study is the consistent decline in sales of current products such as bulbs, manual switches, switch fans, and old-fashioned doorbells. Manual switches are projected to reach zero sales by the year 2025, clearly indicating that these products are being phased out according to technological developments and customer preferences. Newer products such as LEDs, remote fans, smart switches, and video doorbells exhibit robust annual growth, and LEDs are currently the leading product by far.

The B2B/B2C split demonstrates that even if B2B continues to dominate with the majority share of the total sales made, its growth is slower in absolute terms when compared to B2C. Sales through the B2C category are going to increase by more than 13% from 2024 to 2025 whereas 10% growth will be witnessed in the B2B category. The same applies to the majority of product categories and demonstrates the requirement to support customer-facing operations to address this demand.

Distribution patterns in sales are just as informative. LEDs and remote fans show long and high box plots to demonstrate consistent high-volume selling patterns, while products such as switches and doorbells show short ranges and outliers that may indicate promotional activity or seasonally related demand.

## **Actionable Recommendations**

### **Keep Minimum Stock of Phased-Out Products**

Even with projected zero sales, some excess inventory to serve as reserve replacements or existing used structures that are still active are recommended.

### **Data-Driven Inventory Management**

Use season and trend forecasts to optimize the level of stocks—neither understocking nor overstocking.

### **Focus on Skilled Labour**

The staff or labor in areas such as inventory systems, ordering and managing data entry and accounting will reduce the excess load currently being performed by workers who are not trained, who typically engage themselves in inventory handling and sales and delivery logistics simultaneously. Professional workers will streamline operations and reduce the errors and make more effective decisions to provide some relief to untrained workers.

### **Leveraging Growth in B2C**

Generate more on-consumer sales through online platforms, in-store experiences, and seasonal offers.

### **Festival-Driven Stocking**

Plan inventory and promotions ahead and take advantage of peak demand season during Q3 and Q4 festivals such as Diwali, Ganpati Festival and Christmas.

As part of our comprehensive study on Mr. Vijay's operations, we first examined and resolved some significant operation issues: managing B2B and B2C transactions, inventory streamlining and managing the impact of unscheduled staff holidays on the production and distribution pipeline.

The report empowers Mr. Vijay to make better-informed stocking choices of older vs modern product and resolve staff problems by minimizing the effect of unscheduled holidays through automation and predictive planning practices. By adopting automated scheduling systems and applying predictive analytics, Mr. Vijay can forecast peak demand windows and vary workforce allocation accordingly. This reduces reliance on last-minute human availability and ensures smooth operation despite unexpected staff absenteeism. Automation can also assist with inventory monitoring and order fulfillment operations, minimizing disruptions and ensuring level service delivery. Additionally,

predictive planning allows identification of manpower and stock gaps well in advance, enabling pre-emptive action in the form of shifting staff or temporary reinforcements. Such an integrated approach ensures sales and distribution operations remain impervious to unexpected disruptions and thus enhance overall operating efficacy and customer satisfaction.