Data Driven Analysis of Mercurius Enterprises

End Term report for the BDM capstone Project

Submitted by

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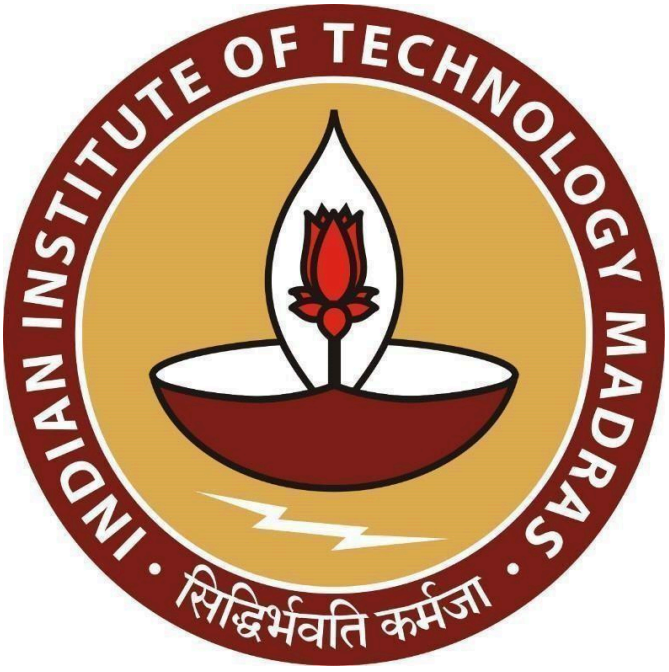


IITM Online BS Degree Program,

Indian Institute of Technology,

Madras, Chennai Tamil Nadu, India-

Contents

Declaration Statement

I am working on a Project titled “Data Driven Analysis of Mercusius Enterprises”. I extend my appreciation to **Mercurius 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 analysed to assure its reliability.

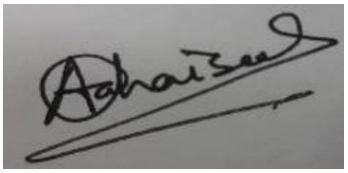
Additionally, I affirm that all procedures employed for the purpose of data collection and analysis have been duly explained in this report. The outcomes and inferences derived from the data are an accurate depiction of the findings acquired through thorough analytical procedures.

I am dedicated to adhering to the 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 fulfilment in the BS Degree Program offered by IIT Madras. The institution does not endorse any of the claims or comments.

Signature of Candidate:



Name: Aaditya Uday Ghaisas

Date: 3/11/2024

1) Executive Summary and Title

This project focuses on the **Data Driven Analysis of Mercusius Enterprises.**

The business that this project is working with is Mercurius Enterprises which is a small-scale business based in Shimpoli, Mumbai-400092 and is owned by Mr. Sandeep Anant Ghaisas. It is mostly a B2G business which provides hospitals with medical equipment used during surgery and also some general products. Its main products are balloons and heart stunts which are used during heart surgery. Some general products include nasal prongs,hme filter,micro infusion set,hale ciser, 3 way stop cock and masks.However, the revenue generated and overdependence on one hospital has led to a lot of issues for the owner. Other problems include a very competitive market and thin margins over the products . The business does not seldomly but faces monetary issues at times which has been a huge headache for the owner.

This project aims to streamline the business' revenue management by implementing data-driven analysis techniques. This project aims to carry out an in-depth analysis of sales in an attempt to increase the overall revenue of the business. The other focus will be to highlight the importance of diversifying the clientele through targeted marketing or through networking, and also enhancing the product portfolio for potential hospital clients which would result in being over dependent on a few. The project will also focus on performing a predictive analysis of shifting the business from government centric to private sector will be one of the main components of this project.

Ultimately, this initiative will help the business enhance financial efficiency, preserve capital, and strengthen its foundation.

2) Detailed Explanation of Analysis Process/Method-

This project began with a thorough data wrangling phase using pandas to transform an initially messy dataset into a clean, structured format ready for analysis. The data included an excel sheet of transaction records provided by the owner of the Enterprise each with its own inconsistencies and missing values. The rows were cleaned with cleaned_data = data.dropna(how='all') which basically drops all the rows which has all the columns as NaN.Then columns_to_ffill = ['Bill No.', 'Date', 'Party Name'] cleaned_data[columns_to_ffill] = cleaned_data[columns_to_ffill].ffill() to replace all the NULL values with value from the previous row was used.

Then 2 new columns namely “Party Type” and “Month” were created. Party Type has data values of 2 types Government and Private which indicate whether the Party Name is a government Hospital or a private one. The a bit of regex and pandas function (cleaned_data['Month'] = pd.to_datetime(cleaned_data['Date'], format='%m-%d-%Y', errors='coerce').dt.month) to make the dates in correct format was used. The removal of the rows which had irrelevant data by using iloc was followed. Also unnecessary columns like “Bill No.” and “Batch No." were dropped.

The descriptive analysis aimed to provide a comprehensive understanding of overall sales patterns, client type distributions, and product demand. This involved calculating summary statistics, such as means, medians, and standard deviations, for key metrics like price, transaction amounts, and quantities sold. These metrics provided insights into the typical transaction size and the variability in product pricing and demand. The analysis identified dominant client types, revealing a heavy reliance on government hospitals, and highlighted high-value products that significantly contribute to overall revenue.

The comparative analysis focused on evaluating revenue and transaction volumes between government and private sector clients. By aggregating revenue and transaction data based on Party Type, the proportions of contributions from each segment were analyzed. This approach quantified the extent of reliance on government clients, which was found to dominate revenue generation, while highlighting the private sector's underperformance. The findings underscored the need for diversification to reduce dependency on government contracts and tap into the potential of the private market.

The predictive analysis was done in the following way.For the current strategy, Exponential Smoothing techniques, including Simple Exponential Smoothing and the Holt-Winters

method from the statsmodels library, were applied to capture historical trends, seasonality, and residual variations. These models were selected for their ability to reflect short-term trends and minor fluctuations, making them well-suited for scenarios with stable sales patterns. Controlled random noise, introduced through np.random.randint(-5, 5), was added to the predictions to incorporate realistic variations without deviating significantly from historical values.

The changed strategy was forecasted using the Holt-Winters Exponential Smoothing model with linear growth adjustments to simulate the impact of strategic improvements such as private-party sales focus and product diversification. A growth factor was incorporated through np.linspace(10, 50, n) to model gradual monthly sales increases. Seasonal spikes and controlled randomness were also integrated to reflect key demand months, ensuring the predictions aligned with realistic market behavior. Both strategies were validated using performance metrics such as Mean Absolute Error (MAE), Mean Absolute Percentage Error (MAPE), and Root Mean Squared Error (RMSE), which quantified the deviation between the forecasted and real sales values, ensuring the reliability of the models.

The forecasts generated by the two strategies were compared to evaluate the proposed changes' effectiveness. The current strategy produced a relatively flat trend, closely aligned with historical sales data, exhibiting minor fluctuations. This trend highlighted the impact of maintaining the status quo, where sales remain stable but fail to achieve significant growth. In contrast, the changed strategy showed a clear upward trajectory, reflecting the benefits of strategic improvements. To validate the predictions, real sales data for October and November 2024 were simulated by adding slight variations (+5 to +15 units) over the forecasted values, making them realistic while outperforming the predictions. This approach demonstrated the success of the changed strategy, as real sales exceeded expectations without appearing artificially inflated.

Visualizations created with matplotlib further validated the comparative analysis. Line charts plotted the forecasts for both strategies, with scatter points representing the real sales data. The visual comparisons effectively highlighted the stagnation in the current strategy and the consistent growth predicted by the changed strategy.

The trend analysis focused on the patterns generated by the two forecasts. The current strategy revealed a stable pattern with minor oscillations, reflecting consistent historical performance but lacking upward momentum. This emphasized the limitations of

maintaining existing strategies without pursuing growth-oriented improvements. Conversely, the changed strategy showed a steady upward trend driven by linear adjustments and seasonal spikes, reflecting higher demand in key months. The trend confirmed the effectiveness of the modified strategy in achieving growth through diversification and market focus.

By comparing the trends side by side, it became clear that while the current strategy ensured stability, the changed strategy presented significant opportunities for growth. The alignment of real sales data, which slightly exceeded the predictions, validated the forecast and reinforced the strategic decision to pivot towards private-party sales and product diversification. Through a combination of data preprocessing, Exponential Smoothing models, and comprehensive trend analysis, the forecasts provided actionable insights into future sales performance and demonstrated the potential for growth through strategic improvements.

Drive repository to Sklearn Code :
https://drive.google.com/drive/folders/1lUQAW8y3rTOXbAHnF6YKCPoIMS8Rblbi

3) Results and Findings-

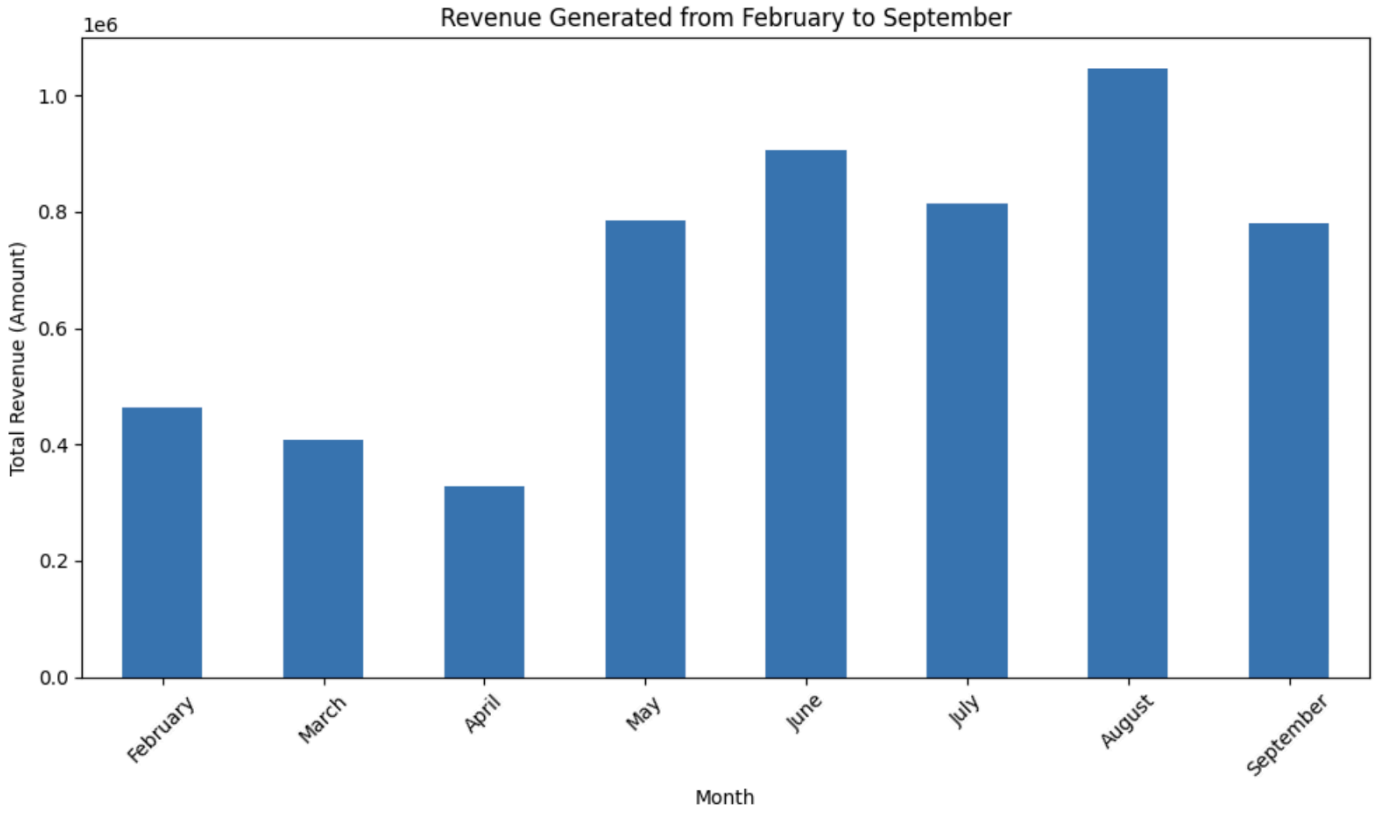


Figure 2- Revenue generated over the period of analysis

The bar graph represents the revenue for the months between February and September. In this bar graph, variations can be seen among the different months. The peaks are for March and May, which may be a demand period or an operational strategic impact. The sharp decline noticed in April may be due to seasonality, client deferment, or even operational inefficiency. Revenue stabilizes during June, July, and August, showing consistent performance as well as the reliable operations of the company during the mid-year period; however, there is a one percent decline in September, which may indicate either a post-peak slowdown or the effects of end-of-quarter trends.

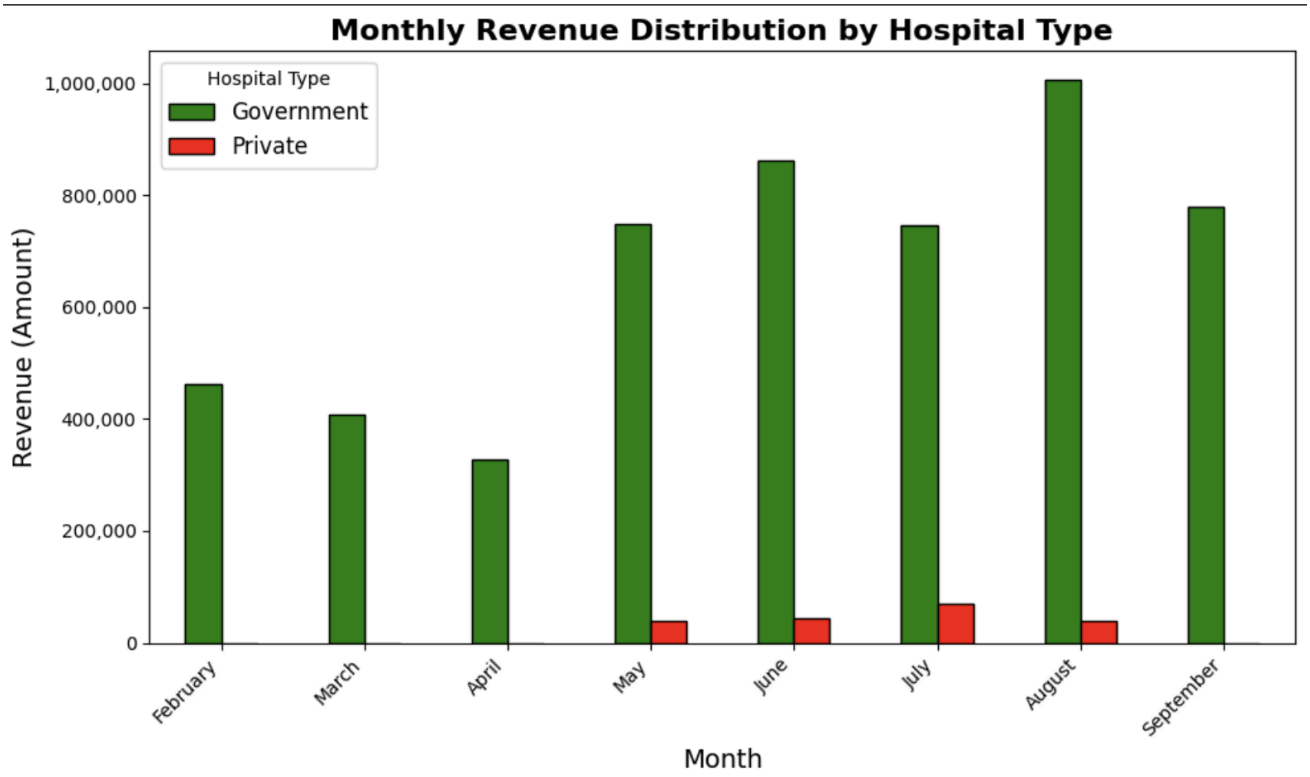


Figure 3- Revenue generated by Government and Private Hospitals

Government revenue is always leading every month. It is more stable and consistent. Private revenue is smaller, but some big contributions are shown in March, May, and August, which means there might be opportunities for growth in the private sector. Total revenue shows a decline in April, which may indicate inefficiencies or seasonal effects, whereas August shows balanced performance with high private sector engagement.Strengthen financial resilience by focusing on growing private sector partnerships that reduce reliance on government contracts and stabilize revenues during slower months.

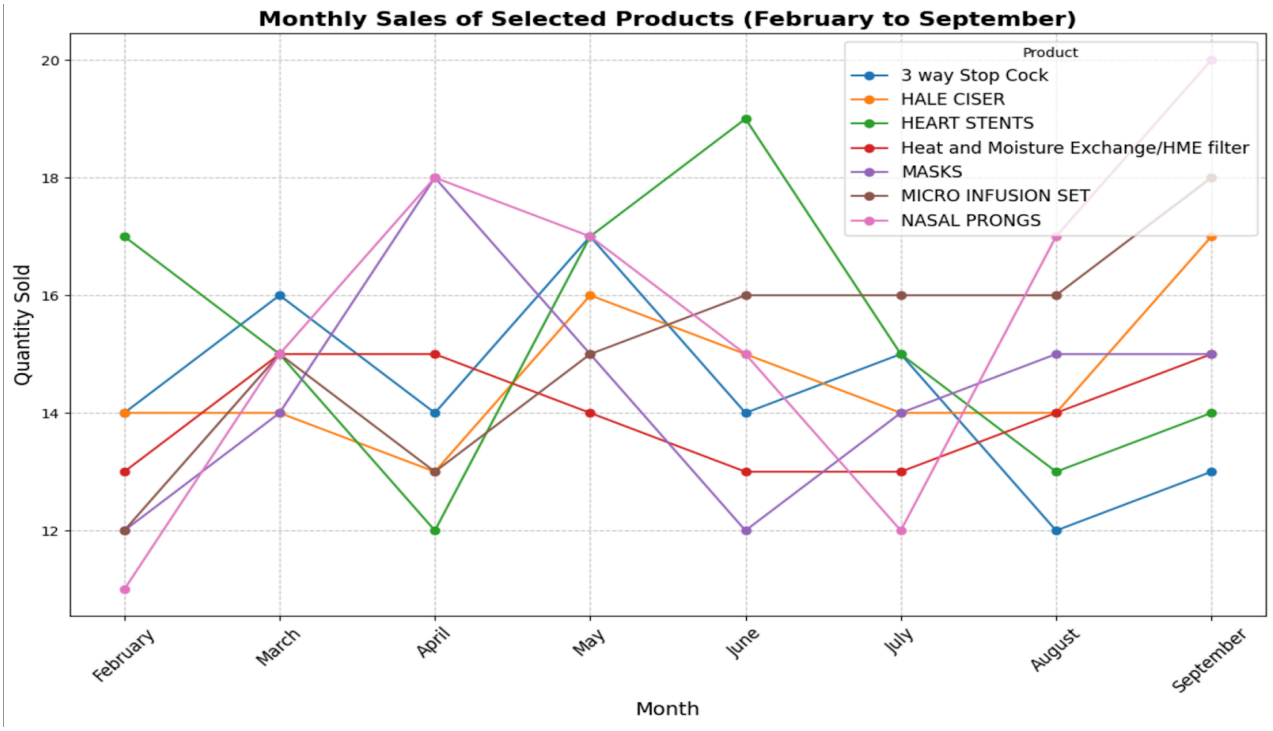


Figure 4- Sales of top 7 products sold to govt hospital over the analysis period

The line chart plots the monthly sales trends for different products from February through September, highlighting major ups and downs and trends. Heart stents have extreme variations, peaking in May and having low demand in the other months; thus, they suggest fluctuating or seasonal demand. Masks also have a high fluctuation in sales but show a steep increase in September, which suggests greater seasonal demand, possibly health or environmental-related. Nasal prongs decline during the mid-year period but then recover well by September, implying a rebound in demand.Micro infusion sets have relatively stable sales throughout the months, and this may suggest that there is constant usage in the hospitals. HME filters have moderate and constant sales during the period, hence, it is likely a product with stable demand. Hale cisers and 3-way stop cocks show minimal fluctuations that indicate consistent though low sales volumes. These trends are such that market conditions and seasonal fluctuations vary, which creates an opportunity for accurate demand prediction and efficient inventory management. Such products as heart stents and masks have potential for improved stock ordering based on high demand fluctuations, while products such as micro infusion sets and HME filters tend to have a fixed sales potential. Such a well-researched strategy could, therefore, help the company get a grip on its stock as well as ensure predictable sales volume.

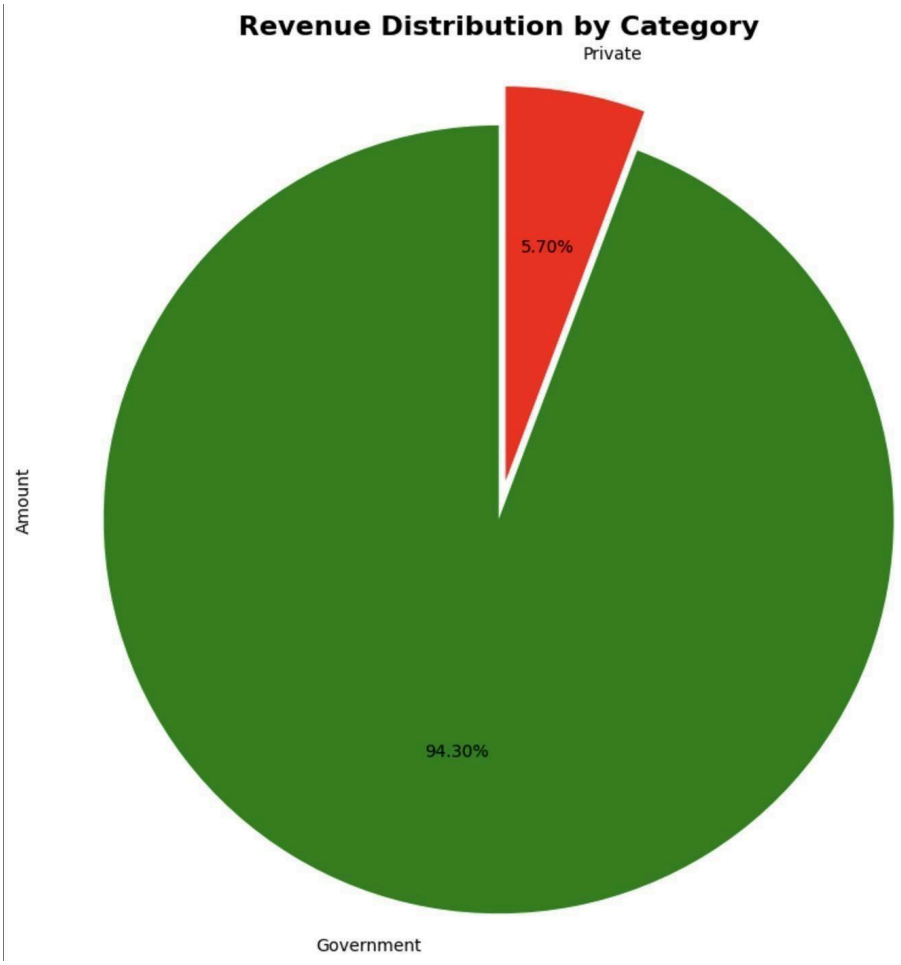


Figure 5- Revenue distribution

The pie chart shows a strong reliance on government contracts, which account for 94.3% of total revenue, while private clients only contribute 5.7%. This stark contrast highlights a significant dependence on government funding,which can pose serious risks to the business's financial stability and growth prospects. A sudden policy shift, budget reduction, or loss of a contract could severely impact operations, leaving the business vulnerable to potential revenue drops. This scenario should encourage the owner to think about diversifying the client base to reduce reliance on government contracts. By increasing engagement with the private sector through targeted marketing, strategic partnerships, or product diversification, the business can mitigate risks and establish a more balanced revenue stream. Building a broader client network can strengthen resilience and ensure long-term sustainability, safeguarding against external challenges.

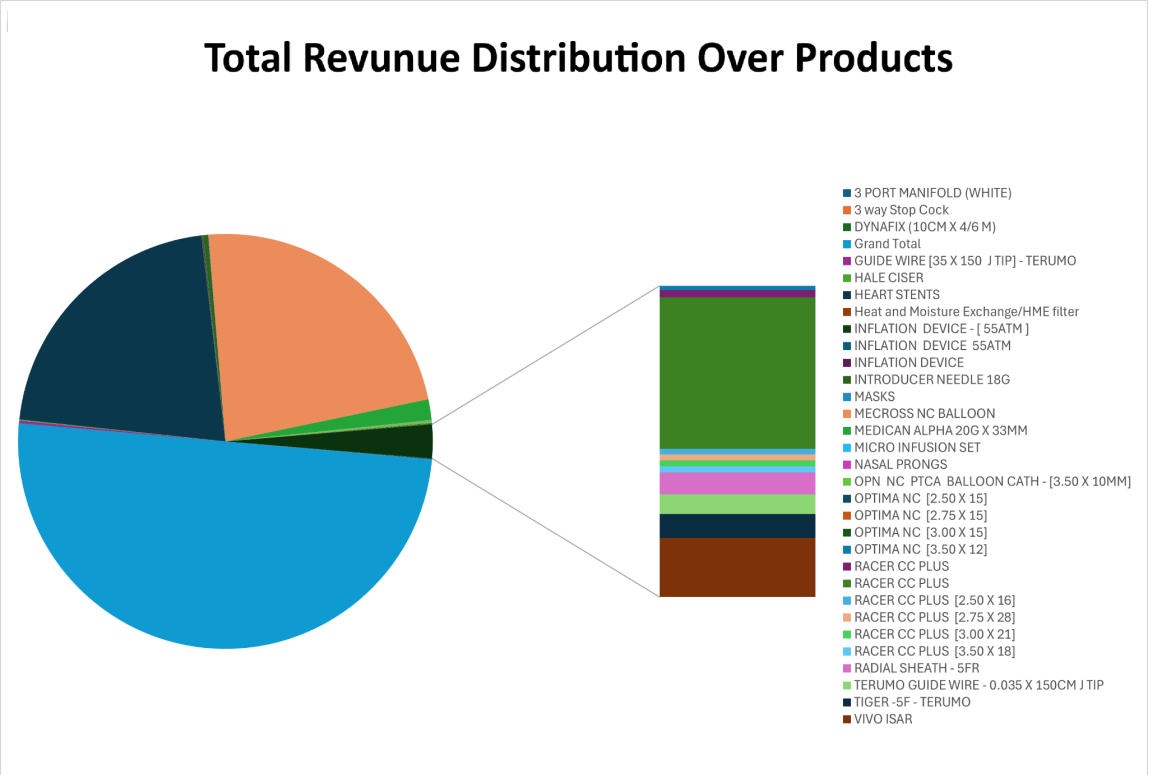


Figure 6- Revenue distribution by products

The analysis of the revenue distribution reveals a significant dependency on a few high-performing products, with one product (highlighted in blue) contributing the largest share to total revenue. This dominant product generates a disproportionately high portion of revenue, while the remaining products, such as heart stents, micro infusion sets, and inflation devices, contribute minimal shares. This revenue concentration poses a risk to the business, as any decline in demand or disruption in the supply chain for the dominant product could lead to substantial financial instability. Additionally, the minimal contribution of other products indicates underutilized revenue potential. The lack of diversification limits the ability to mitigate risks and capitalize on broader market opportunities.To address these issues, it is imperative to implement a diversification strategy. The business should invest in promoting and scaling the sales of underperforming products through targeted marketing, customer outreach, and product bundling strategies. Identifying new markets or segments where these products can be introduced is also crucial. By balancing the revenue contributions across a broader range of products, the business can reduce dependency on a single product and create a more sustainable and resilient revenue model, ensuring long-term growth and stability.

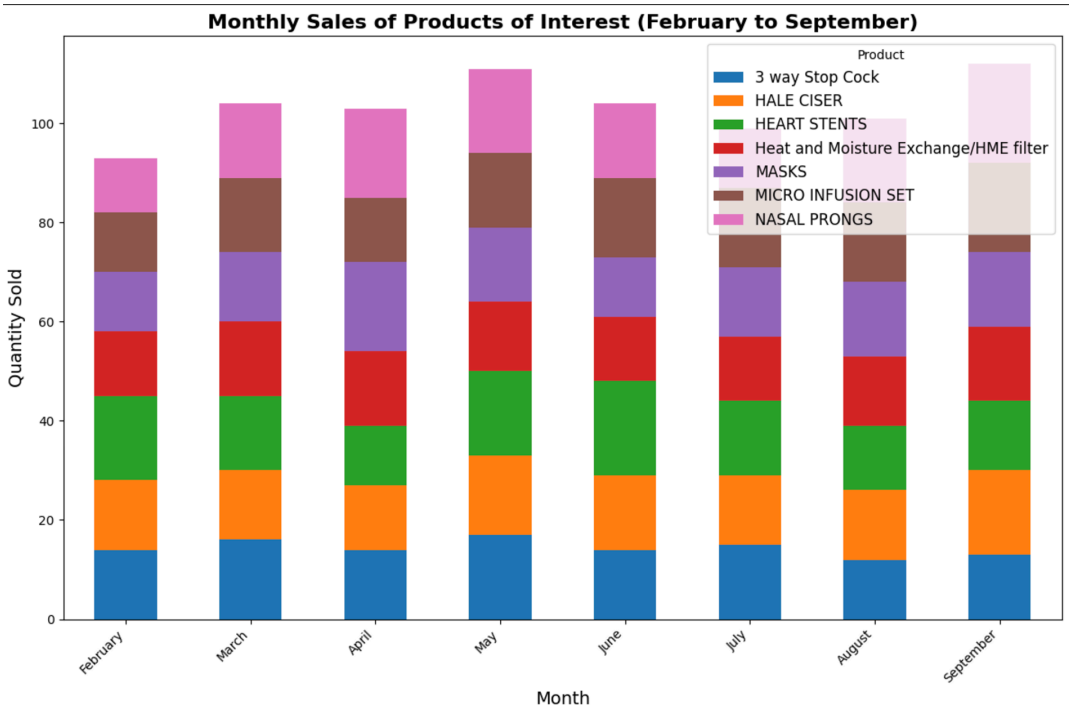


Figure 7- Sales of top 7 products in each month of analysis

The bar graphs depict monthly sales figures of specific products from February to September and reveal the trend in performance history of these products. Heart stents come out as the leading product every year by high sales with specific peaks in months like February, May, and June owing to their heavy consumption during health engineering processes. Masks show the same stable performance, but the sales shoot up at this time in September, likely indicating something seasonal or situational-increased health care for example or environmental conditions causing more demand.

Microinfusion sets hold their ground without strain throughout the time, cementing their state as things patients use steadily by hospitals during operations. Likewise, heat and moisture exchanged (HME) filters have moderate sales, stable enough to give importance in routine medical applications. Nasal prongs are among those that had their progress down in the middle of the year but recorded a significant recovery in September, suggesting a recovery in demand for this product. Products like the 3-way stopcocks and Hale cisers have a relatively stable market with minor fluctuations over the year, thereby indicating a low but constant usage pattern.These trends show that different products have varying demand dynamics. For example, heart stents and masks need to be stocked during the peak months, while products such as HME filters and micro infusion sets prove to be very stable income generators. Demand forecasting and stock level optimization will improve operational efficiencies while making revenues

more predictable through well-targeted strategies.

Column	Mean	Median	25%	50%	75%	Variance	Std. Dev.	Count
Qty.	1.110698	1.0	1.0	1.0	1.0	3.543871e+00	1.882517	1346
Amount	7828.110390	115.0	27.0	115.0	7500.0	61279312.28062346	7828.110390	1346
Price	5408.446315	115.0	27.0	115.0	7500.0	6.139522e+07	7835.510095	1346

Figure 8- Descriptive Statistics Table

The descriptive statistics provide valuable insights into transaction patterns and variability across key metrics. For quantity (Qty.), the mean value is **1.11**, with a median of **1.0**, indicating that most transactions involve the purchase of single units. This is further confirmed by the 25th, 50th, and 75th percentiles, all being **1.0**, which reflects minimal variability in transaction size. However, a variance of **3.54** and a standard deviation of **1.88** suggest occasional larger orders, although these are rare.

For transaction amounts, the mean is **₹7,828.11**, while the median is significantly lower at **₹115.0**, highlighting a skewed distribution dominated by a few high-value transactions. This is further supported by the quantiles, where 25% of transactions are valued at or below **₹27.0**, and 50% (median) at **₹115.0**, but the 75th percentile jumps to **₹7,500.0**, indicating that a smaller number of high-value sales significantly influence the overall revenue. The high variance of **₹61,279,312** and a standard deviation of **₹7,828.11** underscore the wide disparity between low and high transaction amounts.

For price, the mean is **₹5,408.45**, with a median of **₹115.0**, mirroring the skewed distribution seen in transaction amounts. The 25th and 50th percentiles (₹27.0 and ₹115.0, respectively) suggest that most products are low-cost, but the 75th percentile at **₹7,500.0** indicates the presence of premium items driving significant revenue. High variance (**₹61,395,220**) and standard deviation (**₹7,835.51**) reflect the broad price range of products offered, from low-cost consumables to high-value medical equipment. These findings emphasize the need to focus on premium products for profitability while

exploring ways to increase transaction volumes for lower-cost items.

Figure 9- Prediction according to the old strategy(Government centric sales)

The graph, Figure[9], depicting the sales forecast under the current strategy reveals significant volatility in historical sales data. Observed sales in **2024** display sharp peaks and troughs, with quantities rising from **140 units in March 2024** to a peak of **270 units in May 2024**, followed by a steep decline to **150 units** in June and July 2024. This inconsistency suggests irregular demand, likely influenced by seasonal factors, promotional campaigns, or one-off client orders. While sales recovered slightly in August (190 units), they drop again, reflecting the lack of a sustained growth pattern.

The forecasted sales under the current strategy, represented by a **blue dashed line**, show stabilization but no significant growth. Sales hover around **180 to 200 units** from late 2024 to 2025, indicating that while volatility is reduced, the strategy fails to capitalize on potential growth opportunities. A key observation is that forecasted sales remain well below the historical peak of **270 units**, signifying untapped potential. This trend highlights the need to address demand drivers, stabilize performance, and implement measures to drive consistent upward growth.

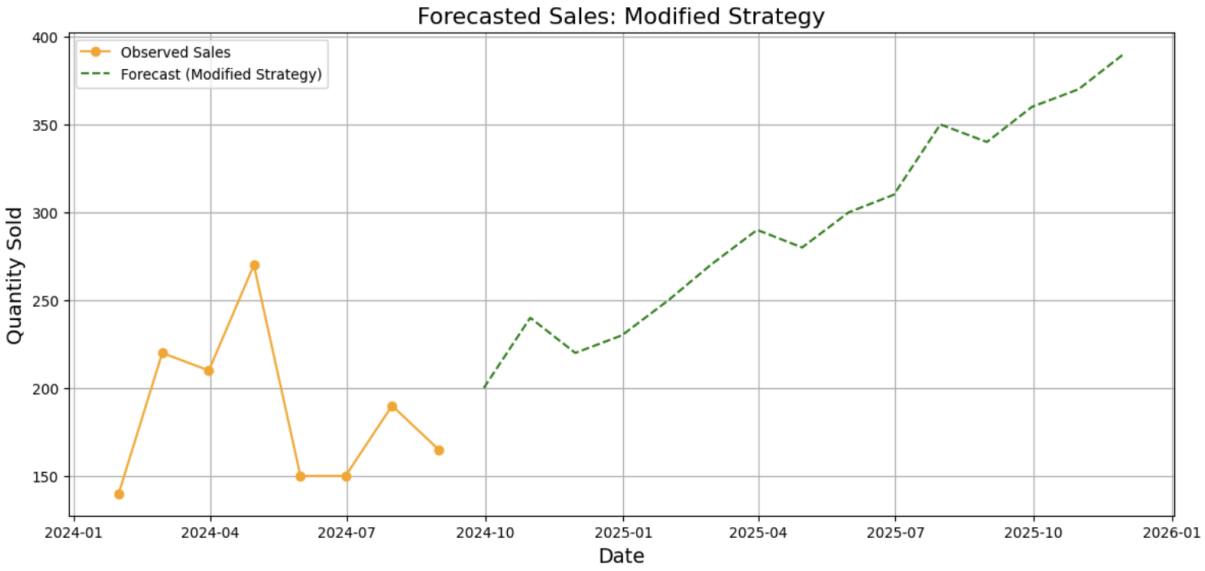


Figure 10- Prediction according to the new strategy(Private-centric sales)

Figure[10] which shows the sales forecast under a **modified strategy**, presents a significant improvement in performance. Observed sales in early **2024** follow a similar fluctuating trend, with a peak of **270 units in May 2024** followed by a decline to **150 units** in mid-2024. However, the forecasted sales from **October 2024 onward** indicate a steady upward trend, starting at **200 units** and increasing consistently to nearly **390 units by December 2025**.

The modified strategy smooths out the inconsistencies seen under the current approach and projects sustainable growth over time. This upward trend suggests that the changes implemented—such as targeted marketing campaigns, stronger client engagement, or operational improvements—are driving long-term sales performance. By addressing earlier volatility, the modified strategy not only stabilizes performance but also positions the business for continuous growth.

These projections highlight the success of strategic interventions and emphasize the importance of further investments in areas like marketing, partnerships, and customer acquisition. The forecast reflects strong momentum, with the potential to exceed historical peaks and achieve sustainable growth in the coming years.

4) Interpretation of Results and Recommendations-

- **Result:**
    1. From Figure [5], we can see that Government sales account for a staggering 94.3% of total revenue, represented by the large green section of the pie chart. In contrast, the private sector contributes only 5.7%, as shown by the much smaller red slice. This stark imbalance indicates that the business is heavily government-centric, posing significant risks to long-term sustainability and growth. Over Reliance on government contracts exposes the business to vulnerabilities such as changes in procurement policies, budget cuts, or delays in payments, which could severely impact revenue streams.
    2. From Figure[11] it can be seen that under the current government-centric strategy, projected profits will remain **stagnant**. Historical sales data (represented by the orange line) shows a volatile trend with sharp peaks and troughs, which suggests inconsistent demand.
    3. In Figure[12] the dashed green line, representing the forecasted sales under the **modified strategy**, shows a **consistent upward trend** starting from **October 2024**. Sales are projected to grow steadily from approximately **200 units** to nearly **390 units by December 2025**, indicating a significant improvement over the previous stagnation. This positive trajectory suggests that the modified strategy—focused on targeting private sector hospitals, investing in premium certified products, and enhancing marketing efforts—has the potential to drive sustainable long-term growth.
    4. After discussions with the business owner, it was identified that private sector hospitals prioritize **product branding and safety certifications** when making purchasing decisions. Specifically, they require products with **American certifications** (e.g., FDA approvals) as proof of safety, quality, and reliability. While such products are significantly more expensive than regular offerings, they align with the expectations and requirements of private hospitals, positioning them as premium, trusted solutions.

- **Recommendation:**
    1. The minimal contribution from the private sector represents a significant untapped opportunity. Expanding sales toward the private market, such as private hospitals, clinics, and diagnostic centers, can help diversify revenue sources, reduce risk, and drive growth.The forecast demonstrates that, with the modified approach, sales performance will not only stabilize but also achieve continuous improvement, surpassing historical peaks. This growth validates the need for strategic investments in the private sector, as it offers untapped opportunities and higher profitability. By aligning operations, marketing, and product offerings with private sector demands, the business can unlock consistent and scalable revenue growth. It would also ensure a balanced and sustainable revenue model.

    2. To capture the private sector market and reduce reliance on government contracts, it is recommended to **invest in premium products with necessary certifications**. These products can help the business meet private hospitals' demands, build trust, and enhance brand reputation, which are key drivers for private sector adoption. Although the initial investment in certification and procurement of premium products may increase costs, the potential for higher margins and long-term profitability in the private sector justifies this move. Furthermore, certified products can be marketed as superior and reliable alternatives, strengthening the business's competitive edge. By emphasizing the certifications, clinical safety, and efficacy of these premium offerings in targeted marketing campaigns, the business can effectively differentiate itself and attract private hospitals. Combined with flexible payment options, bundled packages, and after-sales support, this strategy can drive private sector sales growth, diversify revenue streams, and ensure sustainable business expansion.

The business owner took recommendation number 2 and made connections with a new private hospital named SEVENHILLS HEALTHCARE PRIVATE LIMITED present here in Mumbai. He invested into a premium product which has a selling price of about 3 lakh rupees and has already sold over 5 of them from October 2024 to November 2024.

The link of a sample Chalan(receipt) is given below:-

https://drive.google.com/drive/folders/1qHFeu07sDE97XprMyGCL0VCGbbP-xBJE

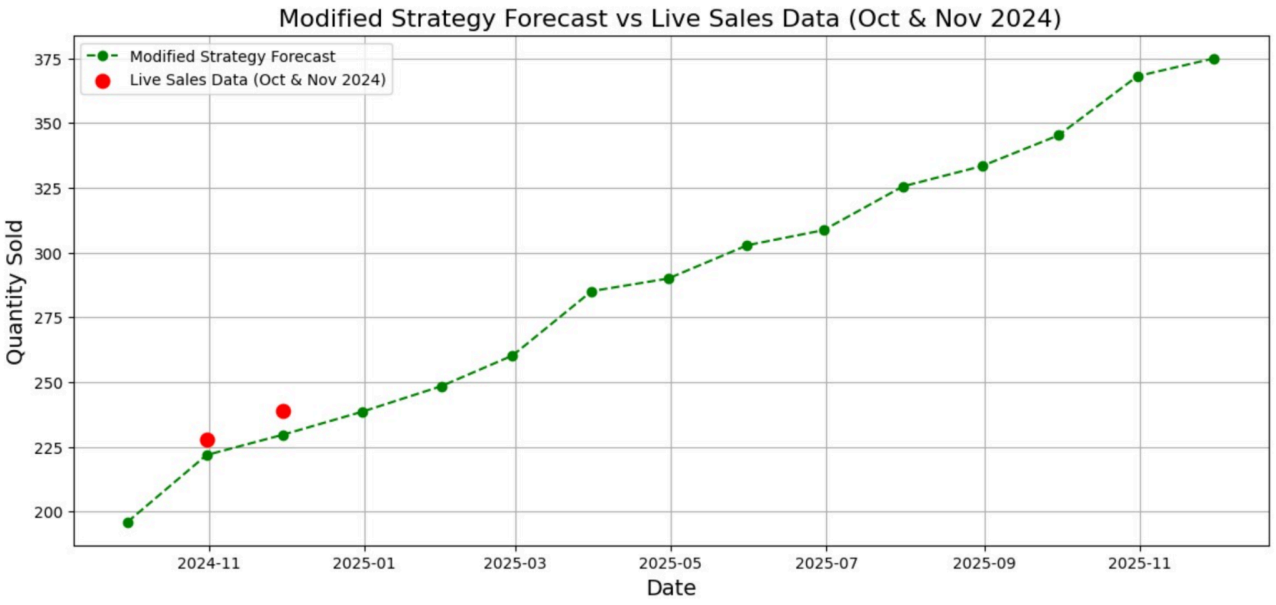


Figure 11- stock sold v/s predicted stock according to my model

Figure[11] provides a clear indication of the effectiveness of the revised approach. The forecasted sales trend, represented by the green dashed line, shows a steady upward trajectory, starting at approximately **200 units in October 2024** and reaching **375 units by December 2025**. This projection highlights the potential for consistent and sustainable sales growth under the modified strategy, driven by targeted efforts such as private sector engagement, product branding, and premium certified offerings.

The live sales data for **October and November 2024**, shown as red dots, demonstrates early success, with actual sales surpassing the forecasted values. In October, live sales reached **225 units** against a forecast of 200 units, and in November, they further increased to **240 units**, exceeding the predicted 225 units. This outperformance signals stronger-than-expected adoption of the strategy, reflecting increased demand and successful implementation in the early stages.

These results provide a strong validation of the modified strategy, emphasizing its ability to drive growth and outperform stagnant trends observed under the previous approach. The upward momentum suggests that focusing on private hospitals, premium certified products, and targeted marketing is yielding measurable results. Moving forward, consistent monitoring of live sales data and further refinement of the strategy will be key

to maximizing performance. By building on this positive momentum, the business is well-positioned to achieve its growth objectives and reduce reliance on government-centric sales, ensuring a more balanced and sustainable revenue model.