Analytical Study of Operational Efficiency and Financial Optimization in a Dental Clinic

A Mid-Term report for the BDM capstone Project

Submitted by

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1 Executive Summary

‘Aadya Family Dental Center’ is a dental clinic located at Aeces Layout, Bangalore, Karnataka. This dental clinic has been functioning for the last eleven years and provides consultations, restorative treatments, and preventive care based on ethical dentistry and an affordable price line.

There are three major hurdles: an ineffective appointment scheduling system, revenue loss as a result of outstanding payments, and lack of data-driven pricing strategies. The time taken in waiting during the course of consulting the patient creates long waiting queues, contributing to increased idle hours, unsteady revenues, and inefficient utilization of services-this translates to low patient satisfaction and poor patient retention.

The project will use two kinds of data for analysis-the inflow of patients, scheduling inefficiencies, and consultation time duration to provide better time slots for appointments and workflow management-and the financial records, including revenue streams, outstanding payments, and discounts, to enable organized payment plans and pricing strategies.

An analysis of these sets of information should elucidate paths to better operational efficiency, financial management, and sustainability. The main aim is to establish a data-driven solution with the goal of optimizing operations to minimize financial risk, manage administrative workload on staff, and enhance the patient experience in Aadya Family Dental Center.

2 Proof of originality of the Data

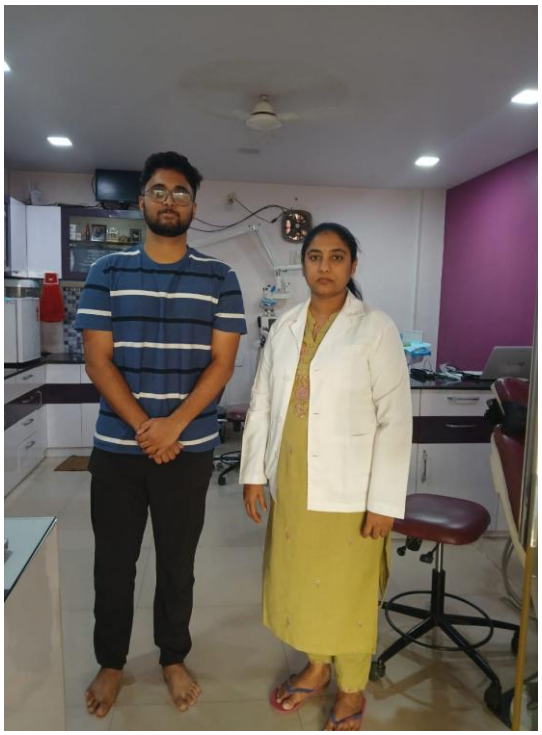
- Business Name: Aadya Family Dental Center
- Address: 3rd Main Rd, AECS Layout, Marathahalli, Bengaluru, Karnataka
- Owner's Name: Dr. Ragini Kiran Meka

Link for proof of originality (Pictures of the business):Drive Folder link with pictures,video and letter

Video of Interaction with Business Owner: video

Letter: Letter typed

written Letter



Me along with the owner at the place of business.

The business owner utilizes only one main method for Recording Data:

1. KiviHealth web application: it is a centralized web application for clinics and patients and is used for clinic management. It includes dashboards for the owners and inventory, invoice and receipt management for clinics. The data of the patients consultation, reports as well as consultants information and scheduled reminders etc are all in the web application. The clinic data is updated by either the front office (the nurse) or by the owner herself at the end of every month.

3 Metadata

- Data Format: Excel/Sheets (XLSX)
- Range: June 1, 2024, to December 31, 2024
- Units of Measurement for Features involving Money: Indian Rupee (₹)
- Link of the data : Clinic Data

Clinic Data:

Using the kivihealth web application I accessed the invoice, reports, consultation details and other important data and compiled it into one single excel sheet with all the relevant clinic Data to perform analysis.

Column name	Description
Invoice	**Invoice number for the transaction**
Date	**Date of the transaction**
Consultant	**Name of the consultant (doctor) handling the case**
Patient	**Name of the patient**
Procedures	**List or Description of procedures performed on the patient**
Total Amount Before GST	**Total bill amount before applying GST**
Total	**Final total amount after GST adjustments and discounts**
Received	**Amount received from the patient**
Pending	**Remaining amount yet to be paid**
Discount	**Discount provided on the bill**
Age	**Age of the patient**
Gender	**Gender of the patient**
Duration	**Time taken for consultation or for treatment**
Payment Method	**Mode of payment (Cash/Online)**
Procedure List	**List of Procedures Performed**
Prices	**Price of each procedure**

4 Descriptive Statistics

I have collected data for the past 7 months over a time period form 1st June,2024 to 31st December 2024.The Data for the month of January had not been updated in the system as they do it at the end of every month.

Link to the data is here: Clinic Data

I did some Basic EDA (Exploratory Data Analysis) on the data collected and represented the findings in a visual manner

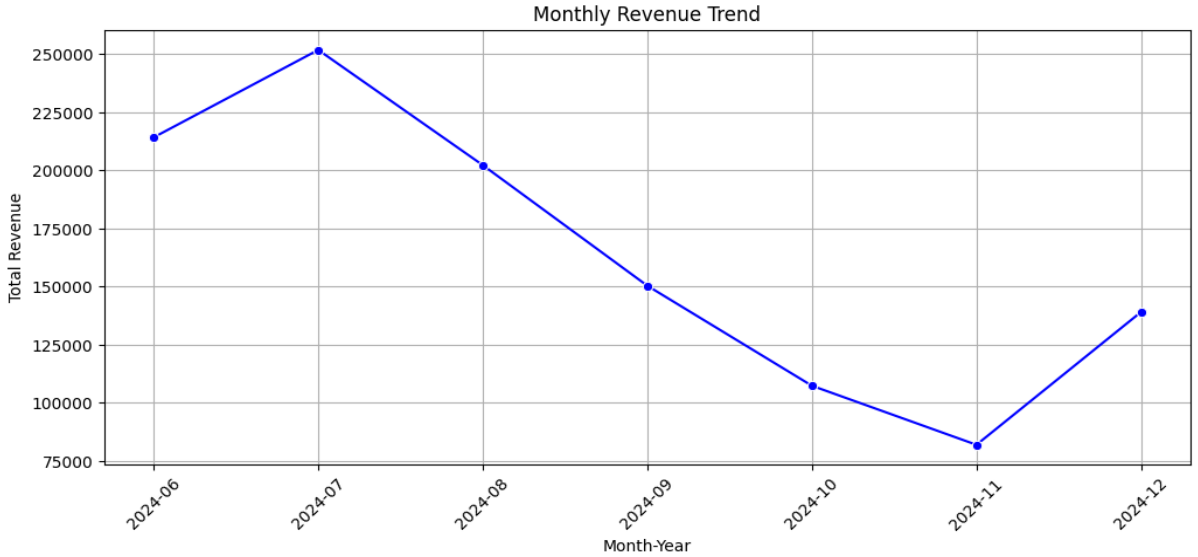


*Fig1: shows the **monthly revenue trends** over time to identify peak revenue periods.*

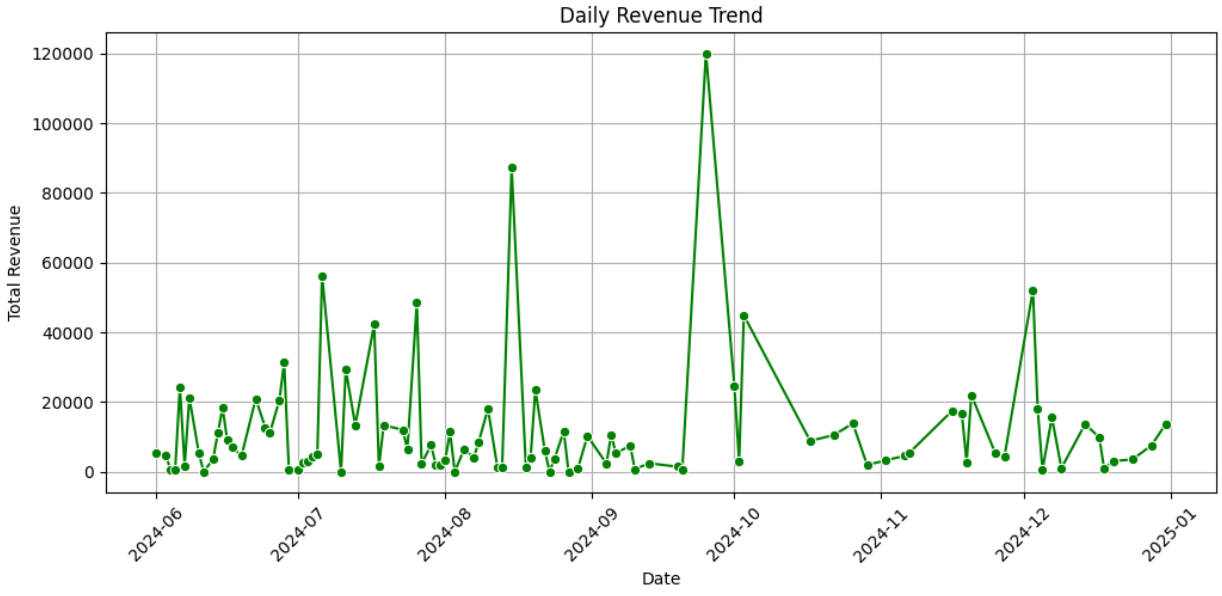


*Fig 2: shows the **daily revenue variation**, helping to observe high and low revenue days.*

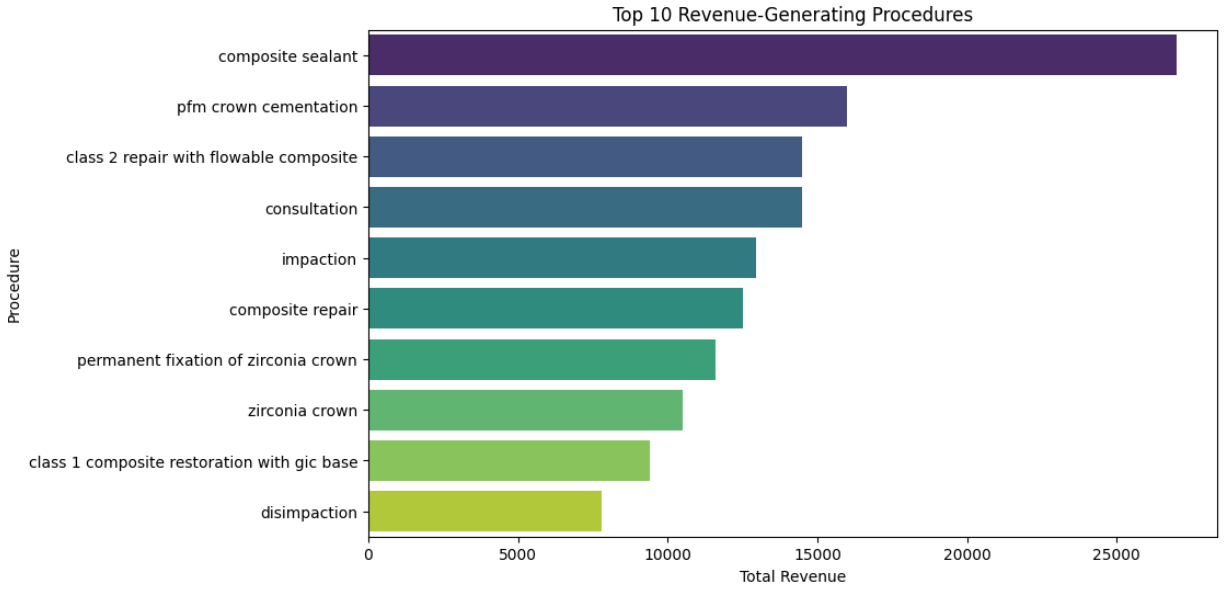


*Fig 3: shows **total revenue generated per procedure**, highlighting the most profitable services.*

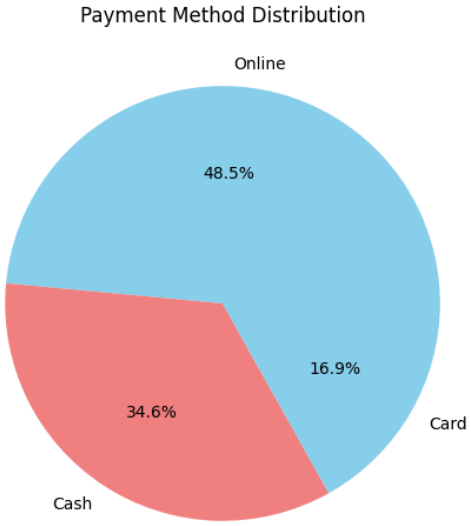


*Fig 4: **distribution of different payment Methods** (Cash, Online) used by patients*

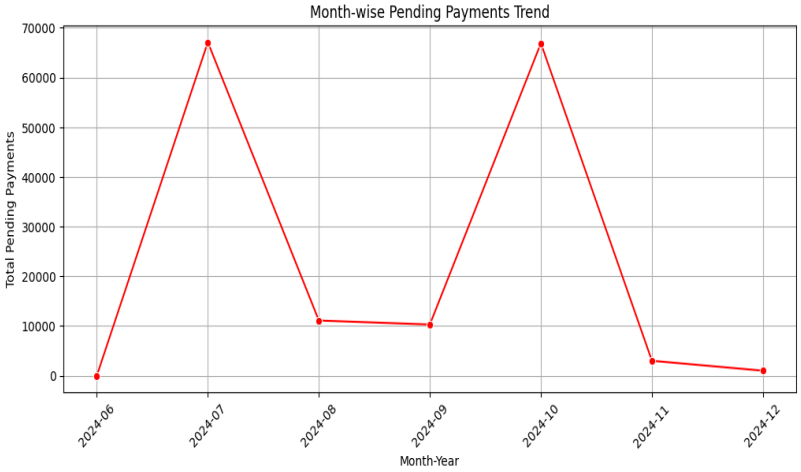


*Fig 5: **total pending payments per month**, helping identify trends in overdue payments.*

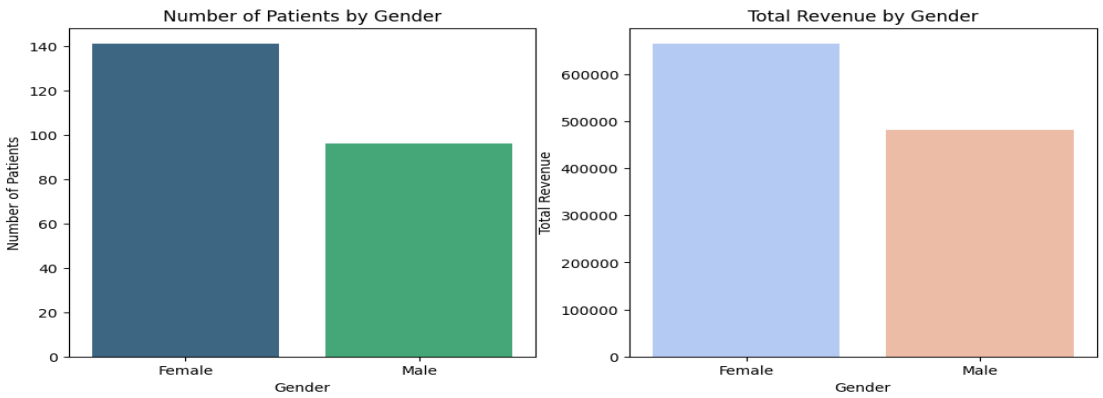


Fig 6: Distribution of patients according to Gender and Revenue by Gender

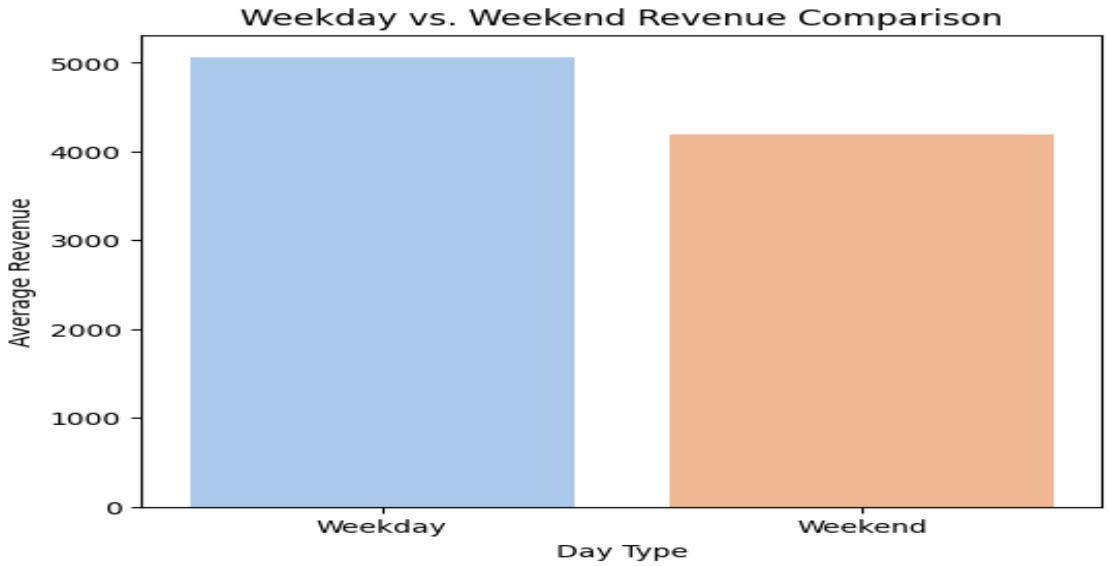


Fig 7: comparing ***average revenue on weekdays vs. weekends***

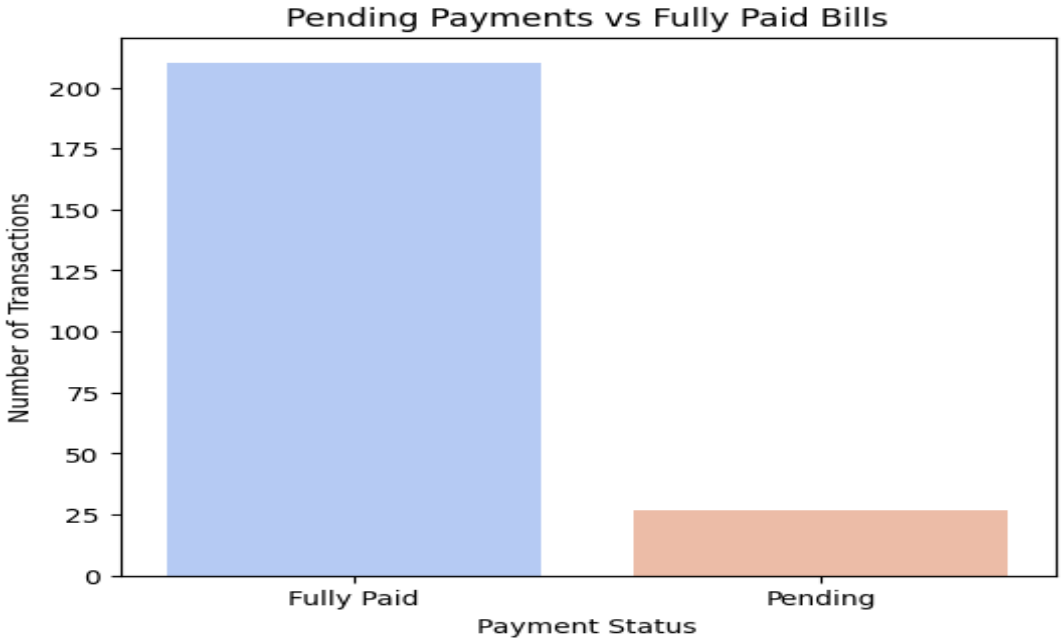


Fig 8 : pending vs fully paid payments

The data collected is directly linked to the problem statements as follows:

- **Appointment Records:** The dataset contains information about consultation duration and patient visiting patterns which aid the identification of constraints in slot scheduling with respect to unnecessary waiting times to optimize the appointment slots for patient flow management.
- **Revenue and Outstanding Payments:** This real-time data on total payments, amounts

pending, and discounts links to problem statement 2. This enables better tracking of overdue payments and, as a result, improved strategies for their collection and assessment of the financial risk a patient may pose due to the discounts given.

- Transaction data on the treatments given with their frequency and revenue has been practically compiled. This will directly have an impact on statement 3, as this summary will directly extract useful services, refining pricing strategies and developing targeted marketing, for the most lucrative procedures.

- Trends and Methods of Payment Analysis: Payments were assessed across two categories: cash and electronically; this clarified patients' payment tendencies on the part of the dataset and improved financial sustainability in revenue-collection strategies.

- Service Utilization Insights: The collected data will evaluate which dental treatments are provided most frequently and which are least known. This information is crucial to designing price and promotion strategies that drive towards the greatest return on investment.

5 Detailed Explanation of Analysis Process & Methods

First, I approached the owner and understood the process of how data entry was being done at the clinic. They were using a specialized web application called KiviHealth which organized the data and provided the data in excel sheets for doctor reports, patient records, invoices and consultant's details. Once I received the data I organized it according to the dates and also complied and removed all redundant or duplicate data, cleaned the data and kept only the relevant data to the problem statement by using pandas library of python in google colab.

Data cleaning was done in the main analysis to remove any inconsistency in values so as to gain accuracy and reproducibility in these analyses. It was first noticed that the Date column had observations with either missing dates or wrongly formatted dates-in particular, this was important if revenue trends were to be analysed on a time basis. During the data calculation, some fields were detected to have a missing value, which included Total Amount Before GST, Pending Payments, and Discounts. These particular missing fields had to be dropped out from the Initial Phase of Analysis in order to preserve the integrity of the final analysis results. In some instances of the categorical columns, like in Payment Method, variations in the same category would create irreconcilable results while aggregating; hence, standardization was done to ensure consistency across the data, even spelling out or using short forms for various names of consultants.With the data all set, the initial data analysis commenced. The first step taken was to look at the revenue trends on a month-to-month basis, where, for each month, the data were grouped and the total revenue measured. This was the main reason this work had to move fast, as it could flag seasonal revenue patterns and peaks and troughs of revenue; to later optimize better plans on financial forecasting along with resource allocation. A line chart was used to demonstrate the results since it was very effective in showing how the revenue changed across time (Fig 1).

With a view to understanding the revenue better, I shifted to an analysis of daily revenue trends. This computed revenue by day so high and low revenue days could be seen. This

analysis was useful to highlight revenue patterns and fluctuations in patient visits and consequently would allow for more optimal appointment scheduling and promotion efforts. Once again, the best option was to choose a line chart, as the clear representation allowed one to easily view short-term revenue fluctuations (Fig 2).
The total revenue generated by each procedure followed, where I grouped the data by treatment type and calculated each procedure's total revenue contribution. This very analysis was essential in determining the most profitable treatments that may serve as a guide to price strategies and marketing. The clinic can prioritize high-valued procedures and subsequently deploy resources better and faster by determining which service generated the most revenue. The visualization of a bar chart (Fig 3) was selected to facilitate the easy comparison of revenue contributions across various procedures so the financially most significant treatments could be highlighted.
In addition to this, I also looked into the payment behaviour by observing the use of different payment modes, breaking down transactions into cash vs. online payments. This was an important step to gauge the preferences of patients towards payments and also to check if there was any increase in the case of digital payments over the years. A pie chart was selected to represent this visualization as it perfectly indicates proportions and gives a good insight into the trends of payments (Fig 4).

Having then taken into account pending payments, dues-and other issues affecting the financial health of the clinic, I chose to analyse pending payment per month. I subtotalled the transactions by month to determine trends in overdue payments. This analysis contributed to the identification of time periods where the high outstanding balance occurred so as to see where improved collection strategies may be needed. The chart itself would show the pattern of ways in which overdue payments change over time by using a line chart (Fig 5).

Next was the analysis of patient demographics and revenue contributions, segmented by gender, so that I could analyse both patient distribution and total revenue generated per gender. This was useful to determine if the revenue skews towards a particular demographic and helps to target marketing strategies and service offerings better. A bar chart was selected as it gives a good graphical display in comparison of each gender category (Fig 6).

Next, I investigated if there was any impact on revenue from weekdays vs. weekends, studying whether weekend appointments generated relatively more income as compared to weekdays. Such insight was of utmost importance for scheduling, staffing decisions, and promotional strategies. The bar chart constituted the most fitting visualization, as it revealed visible revenue differences between weekdays and weekends and made the comparison actionable (Fig 7).

Lastly, it has shown the difference between pending and fully paid payments, categorizing each transaction on the grounds of whether or not they had an outstanding balance.
This made it easy to see what percentage of patients had completed their payments against outstanding balances. By visualizing the data, I could see the extent of outstanding payments and evaluate the financial risks that might be involved. I made use of the bar chart (Fig 8) in this comparison, and it successfully points out the difference between fully paid and pending payments thus providing an overview of cash flow stability.

Henceforth, I plan to collect and analyze the subsequent data, allowing further refining of the

appointment and payment tracking such that it yields optimal income. Such a step should result in lesser waiting times and improved cash flow through structured follow-ups while zeroing on high-revenue procedures that would herald better pricing and marketing strategies. The personal insights will promote better clinic efficiency, sound finances, and ER experience for patients, thereby enabling the clinic to stand ready for sustainable growth.

6 Results and Findings

1. One of the key observations is Chosen from the data are the top 10 most common procedures versus the top revenue-generating procedures. They are represented in Figure 3 and Figure 9:

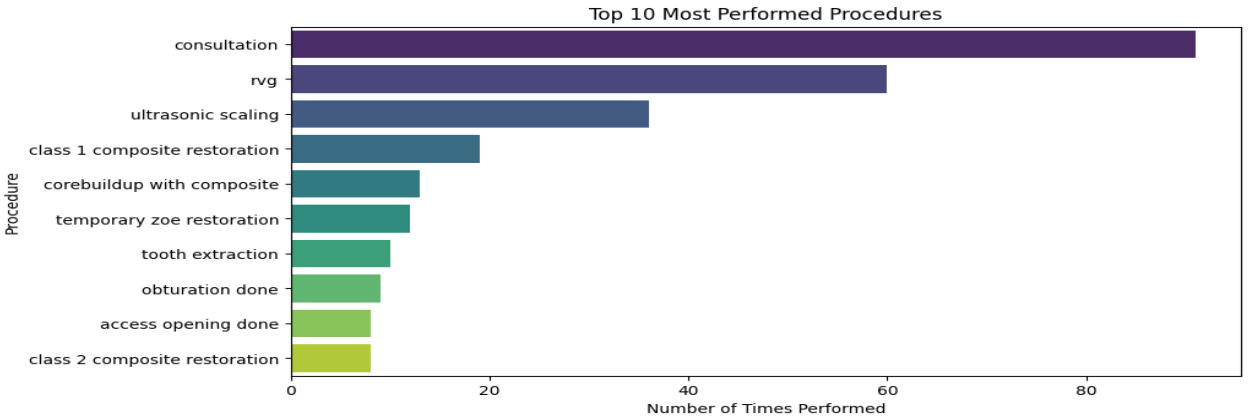


Fig 9: Top 10 most performed procedures in the clinic

- Procedural trends as shown in Fig. 9 reveal that consultations (91 times), RVGs (60 times) and ultrasonic scaling (36 times) are the procedures of most significant demand reflective of the high demand for diagnostic and preventive treatments. On the inverse of that spectrum, high-revenue procedures clearly stand out- among them, the least performed: full mouth open flap surgery at ₹120,000, zirconia crown fixation at ₹64,500, and fixed orthodontic appliances at ₹40,000-bring in significant revenues. So that suggests conceiving an opportunity of popularizing the high-value treatments while ensuring high-throughtput through routine procedure. Restorative treatments like Class-1 composite restoration (19 times) and core buildup with composite (13 times) among others also contributed to some volume whereas tooth extraction (10 times) and obturation (9 times) continued to justify a stable demand for emergency dental care. Given that consultations are the services typically rendered, the clinic may consider bundling consultations with advanced treatments or premium consultation services. Plans should be developed to educate and market accordingly for high-value treatments targeting orthodontics and prosthodontics for optimum income. Efficient time scheduling strategies should be devised that optimize the procedures in relation to their frequency and revenue.

2. Revenue Trends and Seasonal Patterns:

   In the month-wise analysis, the figures show a peak in June, July, and December and minima of close to March and September. Daily revenue showed a large variation, meaning there were days where the number of patients increased steeply, while other days had a very low inflow of patients; however, the second tended to match higher revenues because they tended to undergo higher-paying procedures. These

insights suggest opportunities for optimization in appointment scheduling, price strategy changes, or promotion during the months with lower revenues to guarantee a steady cash flow, along with taking advantage of the high-revenue procedures and a more personalized experience for the customers.

3. Payment Behavior and Outstandings:
   The pending payments compared to the fully paid transactions shown in Fig 8 indicated that a large portion of the transactions (around 20%) still bore outstanding balances. Alongside this, tracking pending payments showed that, in between July and October, delinquent amounts experienced peaks of risk. Proper follow-ups, reminders aligned with payment terms, and motivating prepayments may offset such dues and make cash flow steadier.

4. Patient Demographics and Revenue Contribution:

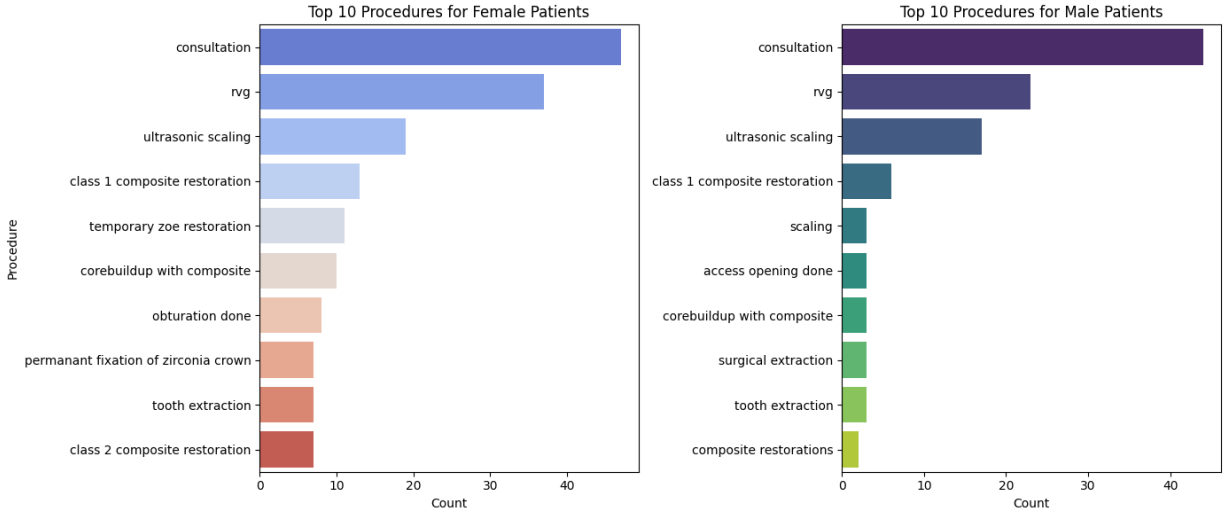


Fig 10: Male vs Female opted procedures

The analysis by gender shows that Figure 6 reveals that women were the bulk contributors to total revenue, particularly through cosmetic and preventive therapies such as teeth whitening and composite restorations. Meanwhile, in terms of surgical procedures, male patients accounted for a larger share according to Figure 10, which included procedures such as extractions and root canals. This finding made it possible to personalize service offerings and marketing strategies to attract more patients on the basis of demographic trends.

5. The Boxed plots illustrated in Fig 7 show the revenue from the weekend compared with that of the working weekdays: Weekend revenues tend to assume 40% higher values as compared to weekday revenue, indicating, perhaps, the greater preference shown by patients in making appointments lately for Saturdays and Sundays. This observation could trigger follow-up decisions on the part of clinics, perhaps expanding their hours of work on weekends, installing weekend specials, or adjusting employee hours to afford for the rise in patient demands.