Enhancing Taxi Operations : Advanced Demand Forecasting and Dynamic Pricing Strategy Development

A Proposal report for the BDM capstone Project

Submitted by

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Declaration Statement

I am working on a Project titled “Enhancing Taxi Operations : Advanced Demand Forecasting and Dynamic Pricing Strategy Development”. I extend my appreciation to Sugam Sawaari, for providing the necessary resources that enabled me to conduct my project.

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

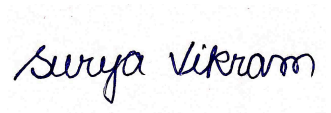
Additionally, I affirm that all procedures employed for the purpose of data collection and analysis have been duly explained in this report. The outcomes and inferences derived from the data are an accurate depiction of the findings acquired through thorough analytical procedures.

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

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

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

Signature of Candidate:



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1 Executive Summary and Title

This BDM Capstone Project aims to streamline the operations of Sugam Sawaari, a small taxi service business that caters mostly to the demands of people around Masaurhi, Patna. Sugam Sawaari currently operates in the B2C segment, providing convenient and reliable transportation solutions for local commuters.

The business faces several challenges that affect profitability. Inefficient demand forecasting and static pricing strategies lead to underutilized resources and missed revenue opportunities. Moreover, high operational costs, including those for fuel and maintenance, along with the absence of route optimization, further strain the profit margin.

These challenges will be addressed by analyzing data using methods like time-series analysis for predicting demand, machine learning for dynamic pricing, and route optimization techniques. Implementing predictive maintenance schedules will help prevent unexpected vehicle breakdowns.

The goal is to improve how efficiently the business operates, use resources better, and make more profit.

2 Organization Background

The company that I am working with is Sugam Sawaari, a for-profit B2C taxi service based in Masaurhi, Patna. It was launched in 2018, by Manjesh Kumar and plays a crucial role in the commute of many residents in the area. The company has steadily grown its customer base by offering dependable services and understanding the unique transportation needs of its community. Sugam Sawaari operates offline, requiring passengers to book their journeys in advance by contacting the owner via phone. It offers an SUV vehicle suitable for families or groups of friends, with a full-time driver employed by the owner to operate the vehicle. The company experiences peak demand during the marriage seasons, known as lagan in Bihar.The competition is primarily with other small taxi businesses, as Ola and Uber services are not available in the outskirts of Patna where Sugam Sawaari operates. The owner, Manjesh Kumar, plans to add more vehicles depending on the success of the business and aims to connect with customers online in the future.

3 Problem Statement

3.1 Improve Demand Forecasting Accuracy:

The current manual demand forecasting makes it difficult to predict when and where customers will need rides, leading to long idle times or missed opportunities.

3.2 Optimize Pricing Strategy:

Setting optimal fares that balance demand and supply is challenging. Static pricing may not reflect current market conditions, leading to less revenue.

3.3 Reduce High Operational Costs:

Managing operational costs like fuel and maintenance is critical. Inefficient route planning increases fuel costs. Optimizing routes can cut fuel expenses and boost efficiency.

4 Background of the Problem

The current demand forecasting methods are ineffective, leading to suboptimal resource allocation and low profitability. This inefficiency arises from outdated methods and the lack of advanced analytical tools to predict customer demand accurately. Consequently, the business often finds itself with idle vehicles or unable to meet peak demand.

The static pricing strategies used by Sugam Sawaari result in underutilization of resources. The fixed pricing model does not adapt to varying demand levels, leading to inefficiencies during off-peak times and revenue loss during high-demand periods. This rigidity prevents the business from optimizing its pricing to maximize revenue and customer satisfaction.

Inefficient route planning and the absence of maintenance schedules increase the business's challenges. Without sophisticated route optimization, drivers take longer, less efficient routes, increasing fuel consumption and reducing productivity. Additionally, unexpected vehicle breakdowns due to a lack of predictive maintenance lead to customer dissatisfaction and higher repair costs, further impacting operational efficiency and profitability.

5 Problem Solving Approach

5.1 Details About the Methods Used with Justification

To improve demand forecasting accuracy, we will use time-series analysis methods such as ARIMA, SARIMA, and Exponential Smoothing to model and predict demand based on historical ride data, weather conditions, and special events, including holidays and marriage seasons. Machine learning algorithms such as regression models, Random Forest, and Gradient Boosting Machines (GBM) will optimize dynamic pricing strategies to ensure fares align with real-time demand and maximize revenue. For route optimization, we will focus on optimizing the most traveled routes to popular destinations using Dijkstra's algorithm to reduce fuel consumption and increase driver productivity. Manual maintenance schedules will be employed to predict maintenance needs based on vehicle usage data and historical records, complementing our proactive maintenance approach.

5.2 Details About the Intended Data Collection with Justification

The intended data collection involves gathering historical ride data (date, time, locations, duration, distance), excluding the pandemic period as an anomaly. Weather conditions will be sourced from an API to enhance demand forecasting. For dynamic pricing, we will gather historical pricing data, ride demand data, fuel pricing, and ride duration. Route optimization will require GPS coordinates of pickup and drop-off points, historical trip data, and traffic conditions for the most traveled routes, including timings of road congestion. Implementing maintenance schedules will involve collecting vehicle usage logs, maintenance records, and historical breakdown data. This comprehensive data collection provides the necessary insights to identify patterns, optimize operations, and mitigate issues.

5.3 Details About the Analysis Tools with Justification

Initial data analysis will involve using spreadsheets to identify common patterns and perform basic feature engineering. Python libraries such as Pandas, NumPy, and statsmodels will be used for time-series analysis, while Matplotlib and Seaborn will assist in plotting figures to analyze trends. Scikit-learn, TensorFlow, and PyTorch will support machine learning models for dynamic pricing. For route optimization, custom Python scripts and libraries available in Google Colab, including networkx for graph-based operations, will be utilized. These tools will leverage their capabilities to handle, analyze, and optimize large datasets effectively for implementing proposed solutions, including shortest path algorithms. For creating manual maintenance schedules, Excel seems to be a viable option.

6 Expected Timeline

6.1 Work Breakdown Structure:

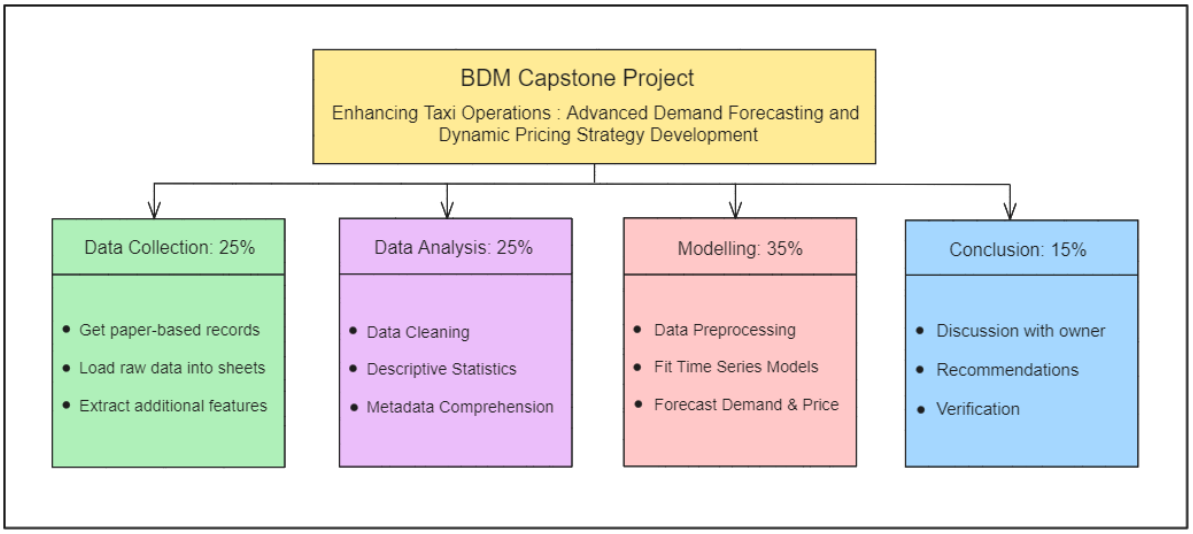

Figure 1: Workflow for completion of project.

6.2 Gantt chart:

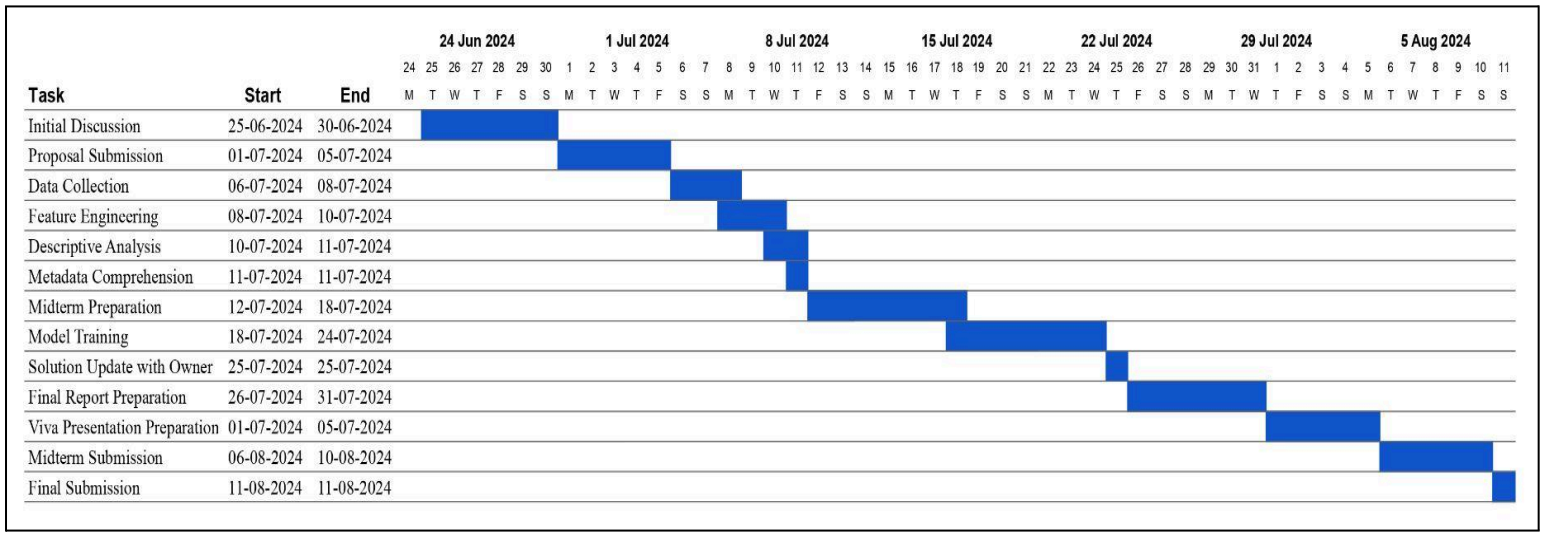

Figure 2: Expected timeline for completion of project.

7 Expected Outcome

7.1 The expected outcome of implementing the proposed solutions at Sugam Sawaari is a significant improvement in operational efficiency, resource utilization, and profitability. By enhancing demand forecasting accuracy, the business can optimize its vehicle and driver scheduling, leading to reduced idle time and improved service availability.

7.2 Implementing dynamic pricing strategies will enable Sugam Sawaari to maximize revenue during peak demand periods and attract more customers during off-peak times. This flexible pricing model can also help in better managing resources and increasing overall profitability.

7.3 Efficient route planning using optimization techniques will reduce fuel consumption, minimize travel time, and enhance driver productivity. Implementing maintenance schedules will reduce unexpected vehicle breakdowns. This will lead to cost savings and improved service quality.