Optimization of A2B Restaurant Operations - Delivery Operations

A2B

INDIAN VEG. RESTAURANT

Introduction

Adyar Ananda Bhavan, often affectionately known as A2B, is a renowned chain of vegetarian restaurants and sweet shops that originated in India. This brand has carved out a niche for itself in the culinary world with its distinctive blend of traditional and modern flavors, mainly focusing on South Indian cuisine. Founded in the mid-20th century, Adyar Ananda Bhavan began as a modest establishment in Adyar, a neighborhood in Chennai, Tamil Nadu. It was the vision and dedication of its founders that propelled this small eatery into a major culinary brand, recognized not only in India but also internationally.

The hallmark of Adyar Ananda Bhavan is its commitment to quality and authenticity. The menu boasts a wide array of vegetarian delicacies, ranging from the famous South Indian staples like idli, dosa, and vada, to a variety of sweets and snacks that capture the essence of traditional Indian confectionery. What sets A2B apart is its dedication to preserving the authentic taste of these dishes while adapting to the evolving preferences of its diverse clientele. This ethos has helped it establish a loyal customer base that spans generations. Over the years, Adyar Ananda Bhavan has expanded its presence with 145+ outlets across India and 6 outlets in the US, bringing the taste of authentic South Indian cuisine to a global audience.

Optimization Problem:

A2B, a renowned quick-service restaurant, has set its sights on expanding its operations by venturing into online food delivery through popular food delivery apps. With their industrial-sized kitchen capable of serving up to 5000 customers a day, A2B aims to maximize revenue and minimize costs associated with food delivery aggregators. To test the waters, they decide to offer two of their most beloved food items - the iconic Masala Dosa and the delectable Medu Vada.

Objective:

The primary goal is to optimize the production mix of Masala Dosa and Medu Vada to meet the hourly demand, thereby maximizing revenue and minimizing the associated costs incurred through food delivery apps.

Key Variables:

- **Hourly Demand:** The anticipated demand for Masala Dosa and Medu Vada per hour.
- **Production Levels:** The decision variables representing the quantity of Masala Dosa and Medu Vada to be produced per hour.
- **Revenue Generation:** Determined by the sales revenue from Masala Dosa and Medu Vada, considering their respective rates and hourly demand.
- **Cost Minimization:** Including the cost of ingredients, preparation, and delivery fees charged by food delivery aggregators.

Constraints:

Production Capacity: The total production of Masala Dosa and Medu Vada cannot exceed the capacity of the industrial-sized kitchen.

Hourly Demand Constraint: The sum of Masala Dosa and Medu Vada production should meet the hourly demand while considering the limitations of the kitchen's capacity.

Interesting aspects of this problem:

This optimization problem becomes more interesting due to several factors:

1. Dynamic Nature: The demand for food items can vary throughout the day and week. Understanding the patterns of demand and optimizing production accordingly is a dynamic challenge. For example, there might be peak hours during lunch and dinner, and weekdays might have different demand patterns compared to weekends.

2. Limited Resources: The restaurant has a finite capacity in terms of kitchen space, cooking equipment, and staff. Balancing the demand with the available resources adds a layer of complexity to the optimization problem. It's not just about maximizing revenue but doing so within the constraints of the restaurant's capacity.

3. Delivery Logistics: Incorporating online orders through food delivery apps introduces a new dimension to the problem. Optimization needs to consider delivery time, distance, and the logistics of handling a mix of dine-in and online orders efficiently.

4. Customer Satisfaction: Timely delivery and maintaining food quality are crucial for customer satisfaction. The optimization should consider not only the quantity of each item but also the speed at which they can be prepared and delivered without compromising on quality.

5. Price Sensitivity: The optimization should consider the pricing strategy for online orders. It's not just about maximizing the number of orders but also ensuring that the revenue generated from online orders covers the costs, including the fees charged by food delivery aggregators.

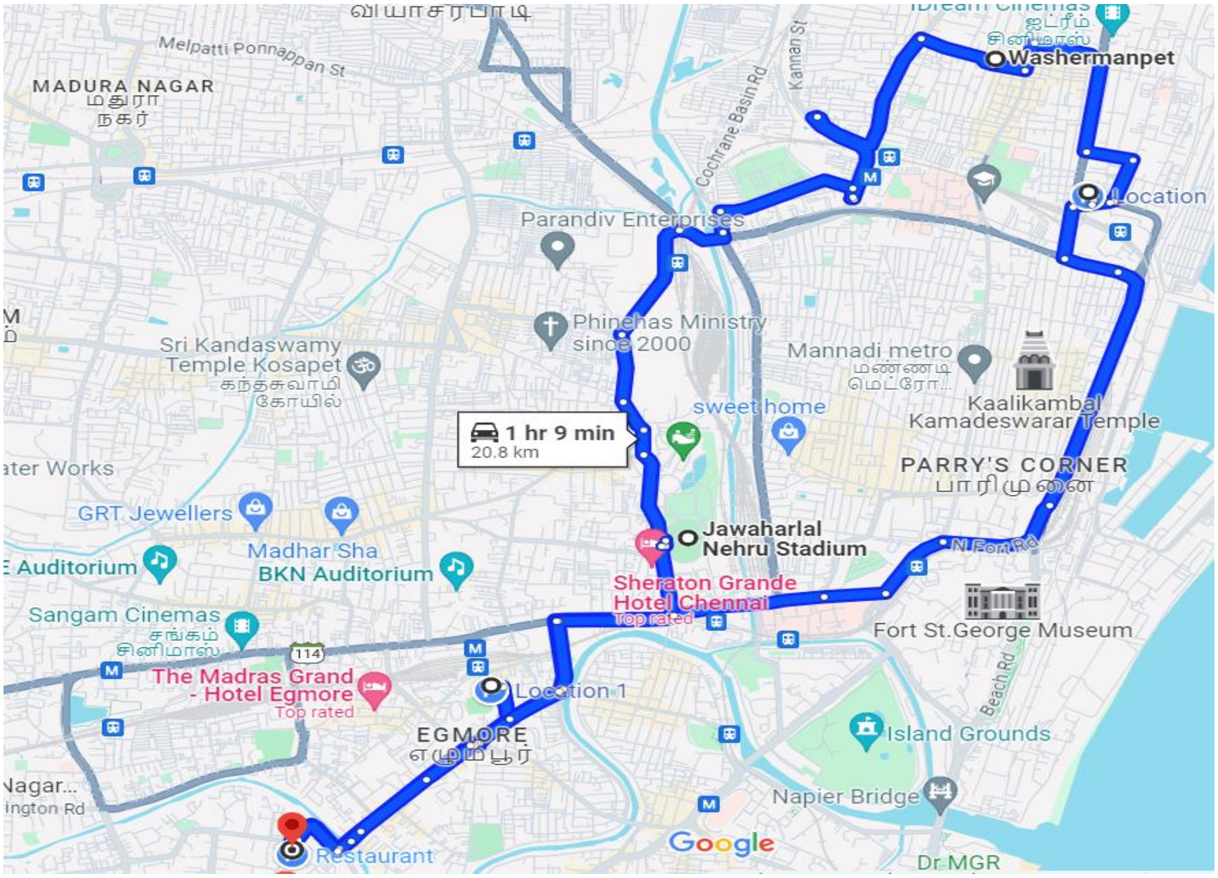
6. Adaptability: The optimization strategy needs to be adaptable to changing conditions, such as unexpected spikes in demand, changes in customer preferences, or variations in ingredient availability.

7. Competition: The online food delivery market is competitive. A2B needs to analyze what other restaurants are offering, their pricing strategies, and how to differentiate themselves to attract more customers.

8. Data Analysis: The restaurant can leverage data analytics to track customer preferences, popular ordering times, and other relevant metrics. Incorporating this data into the optimization model can enhance its accuracy and effectiveness.

In summary, the optimization problem is not just about finding the right mix of products to maximize revenue but involves dynamically managing resources, adapting to changing conditions, and ensuring a positive customer experience in the competitive landscape of online food delivery.

Directions Covered:



Model Assumptions:

In our focused exploration, we narrowed our lens to the vibrant city of Chennai, specifically homing in on the esteemed restaurant A2B (Periamet). Our interest extended beyond the restaurant itself to unravel the extensive geographic reach it boasts across the city. Given that the coverage areas were delineated by coordinates, our next step involved crafting a Python script to efficiently calculate the distances from the central hub of A2B Periamet to the diverse array of locations that this gastronomic haven proudly serves. This computational endeavor not only provided us with a quantitative measure of proximity but also facilitated a comprehensive understanding of the expansive delivery network radiating from A2B (Periamet).

Exploratory Data Analysis

Source: Delivery Data

Data Preprocessing Notebook: Pre-processing Notebook

Derived Data : Delivery Data (Distance Calculated from the Co-ordinates)

Introduction:

The dataset in focus serves as a treasure trove of information, capturing the essence of delivery operations across 22 diverse cities in India. With an expansive array of variables, including delivery personnel details, geographic coordinates, temporal factors, and external conditions, our exploration takes on added significance. Notably, this dataset encapsulates the nuances of delivery in a vast and varied landscape, encompassing over 10,000 unique restaurant locations.

Delivery Personnel Profile:

Our journey begins by delving into the intricacies of the delivery personnel. Each delivery person's unique identifier, age, and ratings provide a glimpse into the human element driving the delivery process. The ratings, reflective of customer satisfaction, become a pivotal metric as we traverse the diverse cultural and culinary tapestry that spans these 22 cities.

Geographic Coordinates and Temporal Factors:

The geographic coordinates, spanning 22 cities and over 10,000 unique restaurant locations, offer a panoramic view of the delivery landscape. Spatial analyses may uncover concentration clusters or regional trends, illuminating potential logistical challenges or opportunities. Meanwhile, temporal factors such as order dates and times introduce a dynamic layer to our exploration, allowing us to discern patterns and optimize delivery operations based on city-specific temporal dynamics.

Environmental and Traffic Variables:

Acknowledging the diversity of the Indian subcontinent, the dataset incorporates external factors like weather conditions and road traffic density. The impact of these variables on delivery times gains significance across varied terrains and climates. By scrutinizing correlations with the time taken for delivery, we aim to unearth insights that can be harnessed to enhance operational efficiency tailored to the specific challenges presented by each city.

Vehicle Insights:

As we navigate the dataset, insights into the condition of delivery vehicles and the types utilized emerge as critical components. Understanding the distribution of vehicle types and their conditions across a myriad of locations becomes a key pillar in optimizing delivery strategies tailored to the diverse landscapes of the 22 cities.

Order Characteristics and City-wise Dynamics:

The dataset also unveils characteristics unique to each order and city, such as special requirements and the involvement of multiple deliveries. A city-wise breakdown facilitates a comparative analysis, enabling us to discern variations in delivery performance across different locations. This granular understanding becomes indispensable in adapting strategies to the cultural, logistical, and operational idiosyncrasies inherent in each city.

Model

Inputs

- $i \in \{1,34\}$: Latitude coordinates of different locations in the City of Chennai.
- $j \in \{1,34\}$: Longitude coordinates of different locations in the City of Chennai.
- $k \in \{1,2\}$: Index represents types of food.
- R_{ij} : Restaurant location represented in terms of latitude and longitude.
- L_{ij} : Delivery location represented in terms of latitude and longitude.
- n_k : number of food products k made within an hour.
- t_k : time required to make a food product k.
- p_k : price per food product k.
- c_k : cost per food product k.
- c_d : delivery cost by distance.

Derived Parameters

- d_{ij} : distance between restaurant and delivery location (i, j).

Decisions

- n_k : number of food product k made within an hour.

Objective Function

- $\Sigma\, n_k * p_k - n_k * c_k - d_{ij} * c_d$ (Maximize profit).

Constraints

- Non-negative decision.
- $\Sigma\, t_k$ <= 60 where k ∈ {1, 2} (Time taken to prepare the food).
- d_{ij} <= 25 (Distance from restaurant to delivery location must be less than or equal to 25) where i ∈ {1, 34}, j ∈ {1, 34}.

Results

Note: The Highlighted columns are the results

Time taken to make vada (Minutes)	Time taken to make dosa. (Minutes)	Total time (Minutes)
2	3	60
Cost of making vada (INR)	**Cost of making dosa (INR)**	
20	40	
Per Plate of Vada selling price (INR)	**Per Dosa selling price (INR)**	
120	150	
Cost of Delivery per Kilometer in (INR)		
5		
Number of Vadas to be Made (per Hour)	**Number of Dosas to be Made (per Hour)**	
27	2	
Cost of vada (INR)	**Cost of dosa (INR)**	
540	80	
Vada selling price (INR)	Dosa selling price (INR)	
3240	300	
Vada profit (INR)	**Dosa profit (INR)**	**Total profit (INR)**
2700	**220**	**2920**

Conclusion

1. Time and Cost Analysis:

- Vada takes 2 minutes to make, and dosa takes 3 minutes.
- The total time available is 60 minutes.
- The cost of making 27 vadas is INR 20 each, totaling INR 540.
- The cost of making 2 dosas is INR 40 each, totaling INR 80.

2. Selling Price and Profit Analysis:

- The selling price per plate of vada is INR 120, and for dosa, it's INR 150.
- The number of vadas that can be made in an hour is 27, and dosas is 2.
- The total selling price for vadas is INR 3240 (27 plates * INR 120 per plate).
- The total selling price for dosas is INR 300 (2 plates * INR 150 per plate).
- The profit for vadas is INR 2700 (INR 3240 - INR 540).
- The profit for dosas is INR 220 (INR 300 - INR 80).
- The total profit is INR 2920 (INR 2700 + INR 220).

3. Delivery Cost Analysis:

- The cost of delivery per kilometer is INR 5.

4. Conclusions and Recommendations

- The vada preparation is more profitable than dosa preparation, with a higher profit margin.
- The total profit from both vadas and dosas is INR 2920.
- The cost of making vadas is higher than dosas, but the selling price per plate for vadas is also higher.

It's important to note that the profitability may vary based on factors such as market demand, competition, and additional costs not accounted for in the provided data. If delivery distances are known, the impact on profitability can be further analyzed.

Future Scope of Scope and Improvements

1. Market Research:

Conduct thorough market research to understand customer preferences, emerging food trends, and the competitive landscape. This will help in identifying potential opportunities for menu expansion or adjustments.

2. Menu Diversification:

Explore the possibility of introducing new food items or variations to attract a wider customer base. This could involve experimenting with different types of vadas or dosas, or even introducing entirely new dishes.

3. Efficiency Improvements:

Analyze and optimize the cooking process to reduce the time taken for preparation. This could involve investing in better equipment, streamlining workflows, or implementing time-saving techniques to increase overall efficiency.

4. Delivery Optimization:

Determine the average delivery distance and analyze the impact on delivery costs. Explore options such as setting delivery radius limits, partnering with third-party delivery services, or implementing a tiered pricing structure based on distance to optimize delivery expenses.

5. Cost Management:

Continuously monitor and manage ingredient costs, exploring bulk purchasing options or negotiating with suppliers to reduce expenses. This can contribute to improving overall profit margins.