

Data-Driven Optimization: Analyzing Operations in a Bengali Cloud Kitchen

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Introduction

This project focuses on the comprehensive analysis and optimization of Bengali Cloud Kitchen operations through database-centric methodologies. The primary objectives revolve around enhancing order processing efficiency, refining inventory management strategies, and optimizing staff allocation protocols. By leveraging the Bengali Cloud Kitchen database, a rich source of operational data, this project aims to extract actionable insights and implement data-driven solutions to improve overall performance.

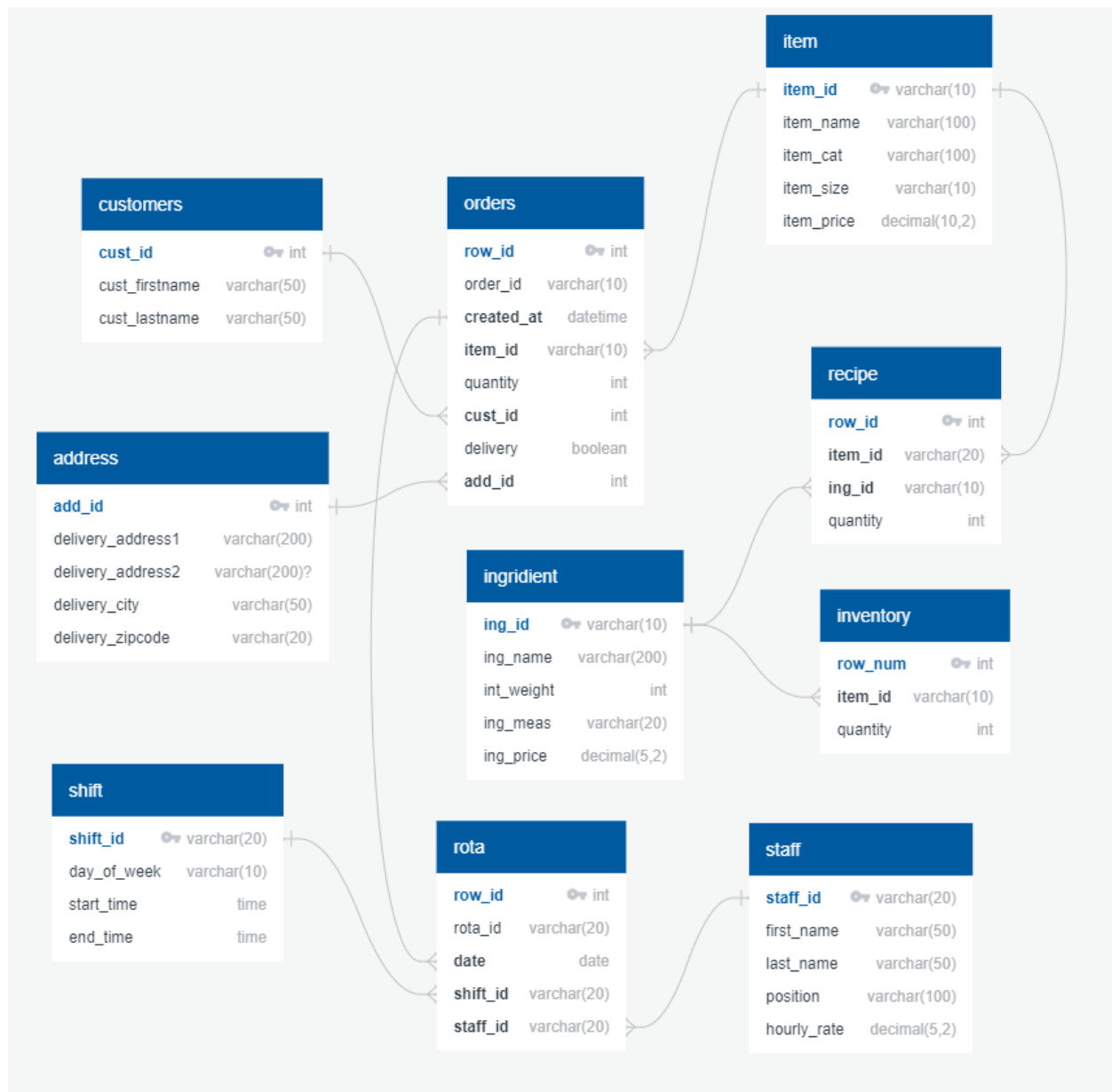
The significance of this endeavor lies in its potential to streamline key operational aspects, ultimately leading to increased customer satisfaction, cost savings, and operational efficiency. The Bengali Cloud Kitchen database serves as a valuable resource, offering granular insights into order activity, inventory levels, customer behavior, and staff performance. Through rigorous analysis and optimization techniques, this project seeks to harness the power of data to drive informed decision-making and foster continuous improvement within the cloud kitchen ecosystem.

Methodology

This project adopted a meticulous approach to analyze the Bengali Cloud Kitchen data. Extensive data preprocessing ensured data quality and readiness for analysis. Steps included data cleaning, transformation, feature engineering, handling missing values, outlier detection, normalization, and standardization. These techniques addressed inconsistencies, null values, and scaling issues, providing a reliable foundation for further analysis.

The analysis phase leveraged MySQL queries and DAX expressions to extract insights and metrics aligned with project objectives. MySQL queries aggregated and summarized data related to order activity, staffing, stock control, and customer behavior, retrieving key metrics like total orders, sales, top items, staff shifts, ingredient costs, and inventory levels. Simultaneously, DAX expressions in Power BI facilitated complex calculations and derived additional metrics for in-depth visualization and analysis. Considerations were given to scalability, efficiency, and interpretability, ensuring meaningful and actionable insights to drive strategic decision-making and continuous improvement.

Entity Relationship Diagram



This image represents the Entity-Relationship (ER) diagram for the Bengali Cloud Kitchen database. This diagram illustrates the structure of the database and the relationships between its various entities. Let me explain each entity and its relationships:

- **Customers:** This entity stores information about the customers, including their first name (`cust_firstname`), last name (`cust_lastname`), and a unique customer ID (`cust_id`).

- Address: This entity contains address-related information, such as delivery address lines (``delivery_address1``, ``delivery_address2``), city (``delivery_city``), and zip code (``delivery_zipcode``). It is linked to the ``Customers`` entity through the ``add_id`` foreign key.
- Orders: This entity represents the orders placed by customers. It contains attributes like order ID (``order_id``), creation timestamp (``created_at``), item ID (``item_id``), quantity (``quantity``), and customer ID (``cust_id``), which establishes a relationship with the ``Customers`` entity. The ``add_id`` attribute links the order to the delivery address from the ``Address`` entity.
- Item: This entity stores information about the menu items, including item ID (``item_id``), name (``item_name``), category (``item_cat``), size (``item_size``), and price (``item_price``).
- Recipe: This entity holds the recipe details for each item. It has attributes like recipe ID (``row_id``), item ID (``item_id``), ingredient ID (``ing_id``), and quantity (``quantity``). The ``item_id`` establishes a relationship with the ``Item`` entity.
- Ingredient: This entity contains information about the ingredients used in recipes, such as ingredient ID (``ing_id``), name (``ing_name``), weight (``int_weight``), measurement unit (``ing_meas``), and price (``ing_price``).
- Inventory: This entity tracks the inventory levels of items. It includes attributes like row number (``row_num``), item ID (``item_id``), and quantity (``quantity``). The ``item_id`` links this entity to the ``Item`` entity.
- Rota: This entity represents the shift schedule or rotation. It contains attributes like rotation ID (``rota_id``), date (``date``), shift ID (``shift_id``), and staff ID (``staff_id``). The ``shift_id`` establishes a relationship with the ``Shift`` entity, and the ``staff_id`` links to the ``Staff`` entity.
- Shift: This entity stores information about the shifts, such as shift ID (``shift_id``), day of the week (``day_of_week``), start time (``start_time``), and end time (``end_time``).
- Staff: This entity holds information about the staff members, including staff ID (``staff_id``), first name (``first_name``), last name (``last_name``), position (``position``), and hourly rate (``hourly_rate``).

The relationships between these entities are established through foreign keys, which ensure data integrity and enable efficient data retrieval and manipulation. For example, the ``Orders`` entity has a foreign key ``cust_id`` that references the ``Customers`` entity, allowing the retrieval of customer information for each order.

This ER diagram provides a comprehensive overview of the database structure, entities, and their relationships, enabling efficient data modeling and querying for the Bengali Cloud Kitchen operations.

Data Exploration

Summary Statistics:

- The dataset consists of 147 total orders, resulting in total sales of ₹54,170.
- There are 40 unique items in the dataset, contributing to an average order value of ₹368.50.

Top Selling Items by Revenue:

- The top-selling items by revenue include Dol Mach, Bhetki Paturi, Kosha Chicken, Mutton Biryani, and Kosha Mutton.

Order Trends:

- Sales exhibited peaks in early March and late March, with a slight dip in mid-March based on the time series chart.

Key Visualizations:

- Fish and Vegetable Dish categories were the top-selling, followed by Rice and Meat.
- Specific top-selling items like Dol Mach, Bhetki Paturi, and Kosha Chicken were highlighted in the horizontal bar chart.
- Orders were concentrated in certain areas like Park Street, Rashbehari, and Ballygunge based on the map visualization.
- Wheat flour and milk were identified as the highest cost ingredients based on the treemap.
- Delivery staff comprised the most hourly workers, contributing to a total labor cost per rotation of ₹25,920.

Patterns & Anomalies:

- Sales exhibited a wave pattern, suggesting periodic peaks corresponding to busier periods.
- While fish and vegetable dishes were top categories, specific top items included meat dishes like chicken and mutton biryani.
- The data suggests certain neighborhoods generate more orders than others, indicating potential target areas for marketing efforts.
- Staple ingredients like wheat flour and milk contribute significantly to ingredient costs.
- The presence of multiple delivery staff working hourly shifts indicates a high volume of delivery orders.

Insights and Findings

Order Activity Insights:

- **Sales Cyclicality:** Analysis of the time series chart reveals discernible peaks in sales, suggesting cyclical patterns within the data. These fluctuations likely correspond to specific days or periods characterized by heightened customer demand. Understanding and leveraging these sales cycles is pivotal for effective resource allocation, inventory management, and promotional planning.
- **Delivery Order Volume:** Examination of staffing data underscores the substantial volume of delivery orders, evident from the presence of multiple personnel working hourly shifts. This observation underscores the critical importance of optimizing delivery operations to accommodate fluctuating demand, ensuring timely and efficient service delivery during peak hours.
- **Concentrated Order Locations:** Geospatial analysis highlights clustering of orders within specific neighborhoods such as Park Street, Rashbehari, and Ballygunge. This spatial distribution of customer demand presents an opportunity for targeted marketing initiatives and strategic expansion of service coverage to capitalize on localized consumer preferences.

Customer Behavior & Menu Insights:

- **Popular Dish Categories:** While fish and vegetable dishes emerge as top-selling categories, individual best-sellers notably include meat-based offerings such as Kosha Chicken and Mutton Biryani. This diversity in consumer preferences underscores the importance of maintaining a well-balanced menu selection catering to varied dietary inclinations.
- **Best-Selling Items:** Granular analysis of sales data identifies flagship menu items like Dol Mach (fish curry), Sheko Patur (vegetable dish), and Kosha Chicken as consistently high performers. Elevating the visibility and availability of these crowd favorites presents an opportunity to drive incremental revenue and enhance overall customer satisfaction.
- **Seasonal Specials Impact:** Analysis of sales patterns may reveal seasonal fluctuations in demand for certain dishes or menu categories. Offering seasonal specials or promotions aligned with customer preferences during specific times of the year can capitalize on these trends, drive customer engagement, and further boost revenue streams.

Inventory & Stock Control:

- **High-Cost Ingredients:** Noteworthy allocation of costs towards staple ingredients like wheat flour and milk is evident from the treemap visualization. Proactive management of inventory levels and exploration of cost-efficient procurement strategies for these core ingredients are imperative to mitigate operational expenses and safeguard profitability margins.
- **Perishable Ingredient Monitoring:** Inclusion of perishable items such as prawns, fish, and cottage cheese underscores the importance of vigilant inventory monitoring and demand forecasting. Implementing robust protocols for perishable item management is essential to minimize waste and uphold product quality standards.
- **Supplier Diversification:** Considering the potential risks associated with supply chain disruptions or price fluctuations, exploring alternative supplier options for critical ingredients could prove beneficial. A diversified supplier base not only mitigates supply chain risks but also fosters competitive pricing and ensures a consistent flow of ingredients.

Staffing Insights:

- **Labor Cost Allocation:** Detailed examination of staffing data facilitates precise assessment of labor costs across various roles and shifts. This actionable insight serves as a cornerstone for optimized staff scheduling, cost containment initiatives, and ensuring adequate staffing levels to meet fluctuating demand dynamics.
- **Cross-Training Opportunities:** The presence of multi-skilled personnel across different operational roles presents an opportunity for cross-training initiatives. This strategic approach not only enhances operational flexibility but also mitigates risks associated with staffing shortages and absenteeism, thereby bolstering overall operational resilience.
- **Performance-Based Incentives:** Incorporating performance metrics into staff compensation structures can foster a culture of excellence and motivate employees to consistently deliver high-quality service. By aligning incentives with key performance indicators (KPIs) such as customer satisfaction, productivity, or sales targets, the business can cultivate a results-driven workforce.
- **Employee Training and Development:** Investing in continuous training and skill development programs for staff members can yield long-term benefits. By equipping employees with up-to-date knowledge and techniques, the business can enhance operational efficiency, improve customer service, and foster a culture of continuous improvement within the organization.

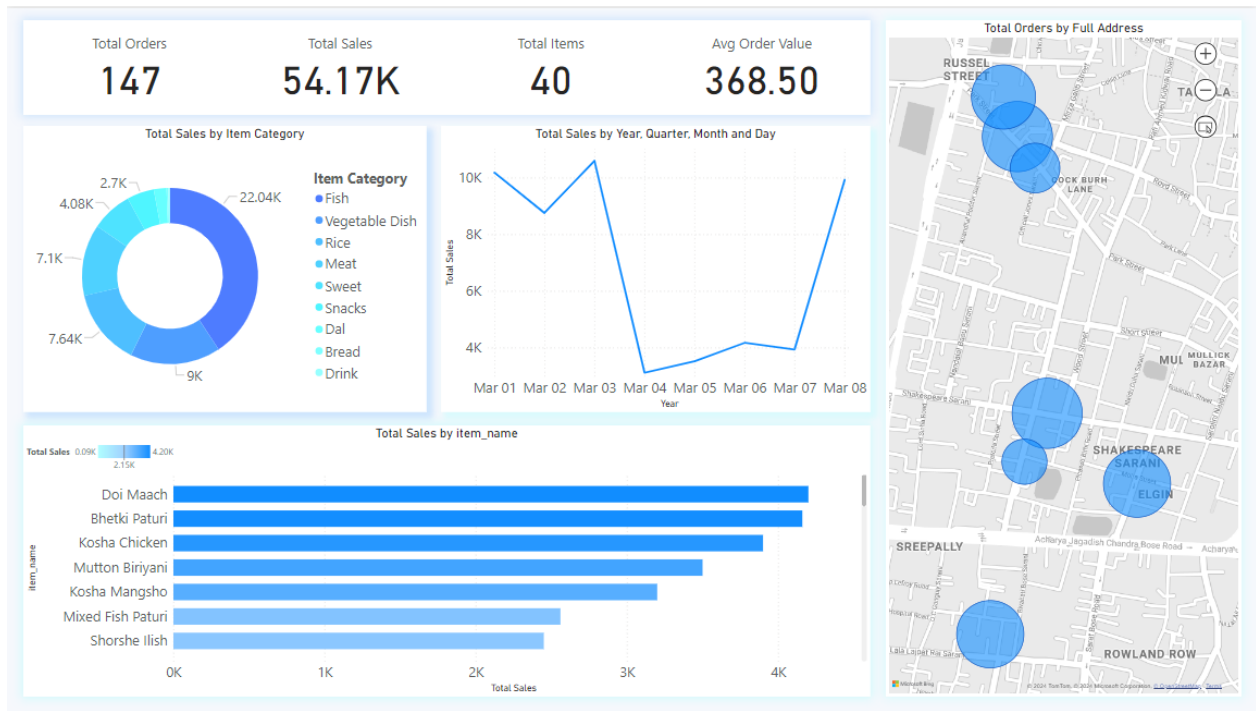
Dashboards

Dashboard 1: Order Activity

Purpose:

The Order Activity dashboard aims to provide a comprehensive overview of the order flow, sales performance, and customer behavior within the Bengali Cloud Kitchen. It serves as a central hub for monitoring and analyzing order-related metrics, enabling data-driven decision-making and operational optimization.

Layout and Key Metrics:



- Total Orders, Total Sales, Total Items, and Average Order Value: These top-line summary metrics offer a quick snapshot of the overall order and sales volume, enabling stakeholders to gauge the business's performance at a glance.
- Total Sales by Item Category: The pie chart breaks down sales by different food categories, highlighting the most profitable segments and guiding menu planning and inventory management decisions.
- Total Sales by Year/Quarter/Month/Day: The line chart visualizes sales trends over time, allowing the identification of cyclical patterns, seasonality, or potential outliers, which can inform staffing, marketing, and promotional strategies.
- Total Sales by Item Name: This horizontal bar chart ranks the top-selling individual items, providing insights into customer preferences and potential menu optimization opportunities, such as promoting popular dishes or introducing variations.

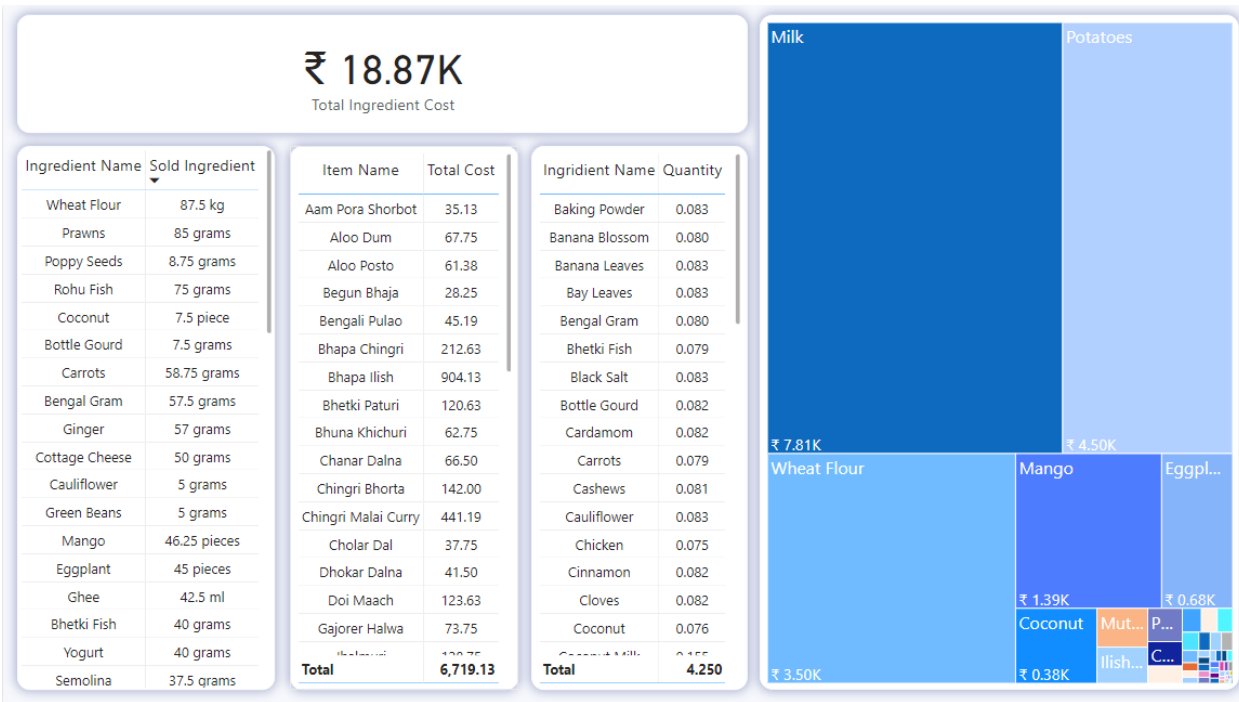
- Total Orders by Full Address: The map visualization plots order locations, revealing geographic concentrations that could inform targeted marketing efforts, delivery zone management, or potential new store locations.
- Orders by Hour: This bar chart showcases the hourly distribution of orders, enabling effective staff scheduling and resource allocation during peak periods.
- Sales by Hour: Similar to the previous chart, this visualization displays the hourly sales distribution, facilitating revenue forecasting and operational planning based on demand patterns.

Dashboard 2: Stock Control Requirements

Purpose:

The Stock Control Requirements dashboard focuses on monitoring and optimizing inventory levels, ingredient costs, and recipe management. It empowers stakeholders to make informed decisions regarding procurement, menu engineering, and cost control strategies.

Layout and Key Metrics:



- Total Ingredient Cost: This summary figure represents the overall cost of ingredients, providing a high-level view of inventory-related expenses and enabling cost monitoring and budgeting.
- Ingredient Name & Sold Quantity: These columns list the specific ingredients used and the quantities sold, facilitating stock level tracking, demand forecasting, and inventory replenishment planning.

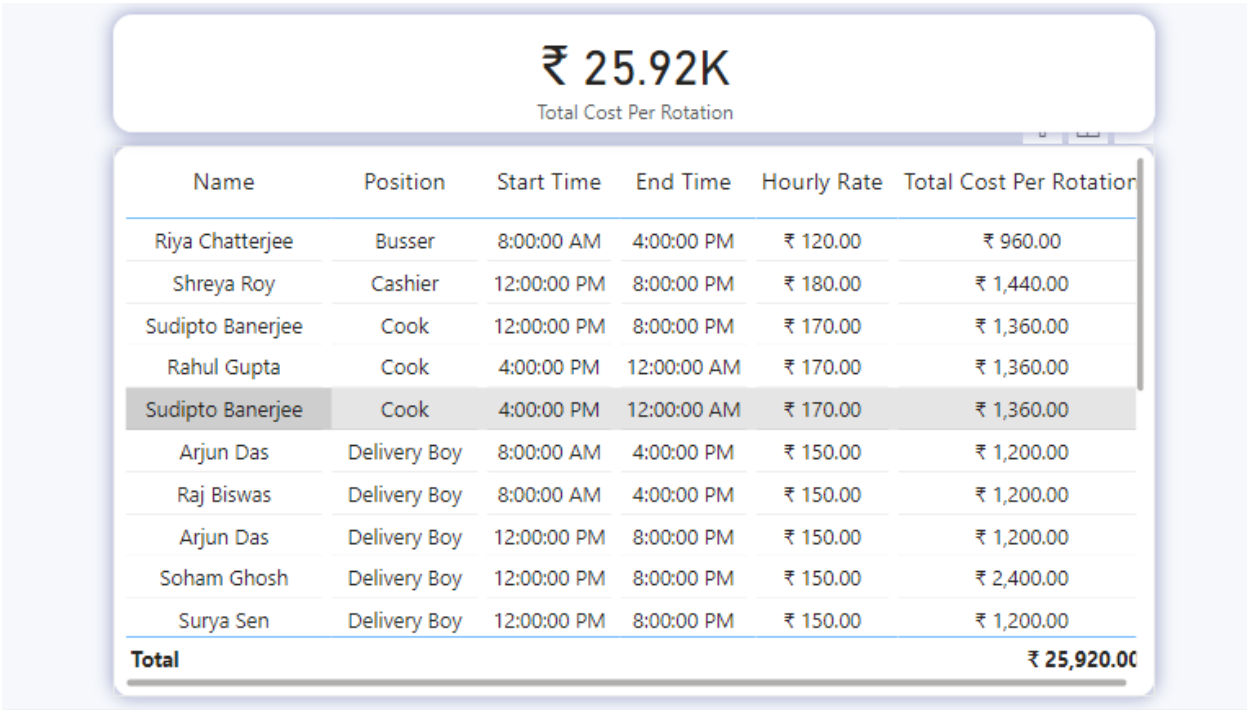
- Item Name & Total Cost: These columns show the menu items and their associated ingredient costs, allowing for cost analysis, menu pricing adjustments, and identifying opportunities for cost optimization through recipe modifications or ingredient substitutions.
- Ingredient Name & Quantity: This section displays the individual ingredients and their respective quantities used in each dish, providing valuable information for recipe standardization, portion control, and ensuring consistent quality across menu items.
- Treemap Visualization: The treemap graphically represents the cost contribution of different ingredient categories, quickly highlighting the most significant cost drivers and enabling targeted cost control measures.
- Top Selling Items: This chart showcases the best-selling menu items, guiding inventory planning and ensuring sufficient stock levels for popular dishes.

Dashboard 3: Staff Data

Purpose:

The Staff Data dashboard focuses on labor costs, staffing requirements, and workforce optimization. It provides visibility into staff schedules, shifts, and associated costs, enabling effective workforce planning, scheduling optimization, and cost control measures.

Layout and Key Metrics:



- Total Cost Per Rotation: This summary metric represents the total labor cost incurred during a specific operational period or shift rotation, enabling stakeholders to monitor and manage labor expenses effectively.

- Staff Name, Position, Start/End Time, and Hourly Rate: These columns provide detailed information about each staff member, their role, shift timings, and compensation rates, facilitating workforce planning, scheduling, and accurate labor cost calculations.
- Total Cost Per Rotation (by Staff): This column calculates the labor cost for each staff member based on their hourly rate and scheduled shift duration, allowing for granular cost monitoring and control at the individual level.
- Staffing Schedule: This visual representation, such as a Gantt chart or calendar view, provides a comprehensive overview of staff schedules, enabling efficient shift planning, identifying potential overlaps or gaps, and ensuring adequate coverage during peak periods.
- Labor Cost Breakdown: This chart or visualization showcases the distribution of labor costs across different staff positions or departments, highlighting potential areas for cost optimization or redistribution of resources.
- Staff Utilization: This metric or visualization illustrates the degree to which staff members are utilized during their scheduled shifts, identifying opportunities for cross-training, task redistribution, or workforce adjustments to maximize productivity and efficiency.

By presenting these dashboards with clear visualizations and relevant metrics, decision-makers can gain valuable insights into various aspects of the business, including order patterns, inventory management, staffing needs, and cost control measures. These dashboards serve as powerful tools for data-driven decision-making, enabling stakeholders to make informed choices and drive continuous improvement within the Bengali Cloud Kitchen operations.

Conclusion:

The data analysis conducted on Bengali Cloud Kitchen's operations has unearthed valuable insights and actionable recommendations to enhance business performance. By embracing data-driven decision-making, the organization can streamline processes, elevate customer satisfaction, and bolster profitability.

Key trends in order activity and customer preferences have been identified, providing avenues for targeted marketing and strategic menu planning. Vigilant inventory management, particularly for high-cost and perishable ingredients, can minimize waste and reduce operational expenses.

Insights into staffing reveal opportunities for workforce optimization through strategic scheduling and cross-training initiatives. Embracing these recommendations fosters a culture of excellence and continuous improvement.

Leveraging these findings, Bengali Cloud Kitchen can anticipate market demands, stay ahead of industry trends, and drive sustained growth. By embracing a data-driven approach, the business can solidify its position as an industry leader and achieve long-term success.