Stakeholder Temporal Needs: Food Delivery Optimization in Urban Areas

Temporal analysis provides valuable insights for a variety of stakeholders, including customers, delivery service providers, and restaurant owners.

- **Restaurant Owners:** To understand hours of high demand, such as lunch and dinner rush hours or seasonal spikes during holidays, rely on hourly and daily trends. These insights support promotional planning, management of supplies, and staffing decisions. For instance, if the analysis shows that delivery times are longer during winter months, businesses can plan ahead by factoring in weather conditions and adjusting delivery routes accordingly.

- **Delivery Service Providers:** Focus on real-time and weekly trends to enhance operational efficiency by identifying congestion periods, optimizing delivery routes, and reducing delays. By examining delivery times across different times of the day, they can allocate resources effectively and improve service reliability.

- **Customers** benefit from tracking order delivery times and service consistency over daily or weekly patterns, enabling them to choose optimal times for placing orders with shorter wait times. Additionally, seasonal trends help customers anticipate delivery delays during high-demand periods like holidays or weekends.

These stakeholders leverage temporal data to improve decision-making in optimizing delivery operations, managing customer expectations, and ensuring timely service delivery.

Data Assessment: Food Delivery Optimization in Urban Areas

The data for this analysis is sourced from the publicly available **Food Delivery Dataset** on Kaggle. This dataset provides detailed records of food delivery transactions, including timestamps for order placement and delivery, restaurant types, customer locations, delivery status, and cost-related factors. The availability of time-stamped data at granular levels (hourly and daily) enables the analysis of temporal trends such as peak ordering times, delivery performance, and seasonal demand fluctuations. This level of granularity allows stakeholders to aggregate trends across various timeframes (e.g., weekly, monthly, or seasonal) to support strategic decision-making and operational planning.

Despite the richness of this dataset, several challenges must be addressed. One key challenge is the variation in order processing times across different regions, which requires data normalization to ensure consistent analysis across urban and suburban areas. Additionally, missing or incomplete data, such as gaps in delivery status or inconsistent timestamps, may necessitate the use of data cleaning techniques like interpolation or imputation to maintain consistency in temporal trends. Integrating this dataset with external sources, such as weather conditions and traffic data, can provide a more comprehensive understanding of delivery performance and operational challenges.

The temporal representation in this dataset includes:

- **Point-in-time snapshots:** Each order is recorded with timestamps for placement and delivery, allowing stakeholders to analyze bottlenecks in the delivery process and optimize service timelines.
- **Time series measurements:** Aggregated order counts and delivery times can be used to observe trends such as daily peaks, weekend surges, and seasonal demand patterns.
- **Cyclical patterns:** The dataset allows for identifying recurring trends, such as increased demand during lunch and dinner hours, and order surges during weekends and special occasions.

While the available dataset offers valuable insights, additional temporal context could enhance the analysis. Overlaying the order data with **e**xternal factors such as local events, traffic congestion, and weather conditions could provide a deeper understanding of delivery delays and demand fluctuations. Similarly, incorporating customer sentiment data from online reviews and social media platforms could offer insights into service satisfaction trends over time.

By addressing these challenges and leveraging integration opportunities, stakeholders can derive actionable insights. Delivery service providers can optimize logistics by predicting demand surges and improving delivery routes, restaurants can plan staffing and inventory based on peak hours, and customers can benefit from improved service transparency with more accurate delivery time estimates. A well-integrated analytical approach ensures that, despite potential data inconsistencies, the analysis remains robust and valuable for enhancing operational efficiency in urban food delivery.

Initial Design Exploration: Food Delivery Optimization in Urban Areas

Visualization 1: Line Chart for Delivery Time Trends

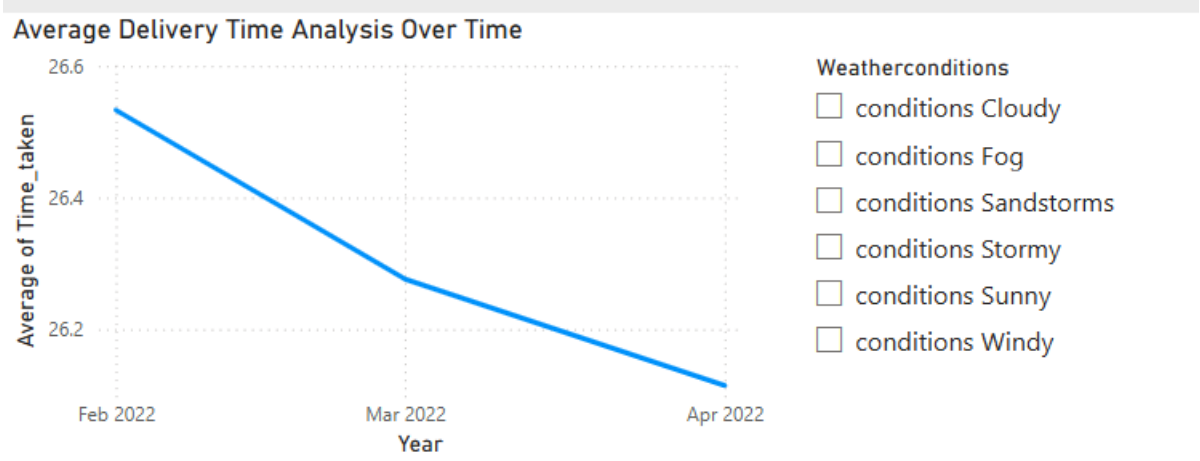
1. Description:
The line chart shows how average delivery time changes over different months. It helps to identify trends such as delays during certain seasons and how delivery efficiency improves or worsens over time.

2. How it interacts with other data:

- **Weather conditions:** Helps understand if bad weather conditions (e.g., rain, fog) contribute to longer delivery times.

3. Sketch Idea:

- X-axis: Time (monthly or weekly)
- Y-axis: Average delivery time
- Filters: Weather conditions.



4. Why this visualization is useful:

- It helps fleet managers make decisions about scheduling deliveries.
- Restaurants can plan better based on peak delay times.
- Customers can understand what times of the year may have longer wait times.

Visualization 2: Heatmap for Order Volume by Hour and Day

1. Description:

The heatmap shows how many orders are placed at different times of the day and on different days of the week. It helps identify the busiest hours and days when delivery services need to be well-prepared.

2. How it interacts with other data:

- **Weather conditions:** Provides insights into whether bad weather affects order volume and delivery times.

3. Sketch Idea:

- Rows: Days of the week (Monday to Sunday)
- Columns: Hours of the day (0 to 23)
- Values: Count of orders
- Color: Darker colors show high demand, lighter colors show low demand

4. Why this visualization is useful:

- Helps restaurants plan staff schedules for busy periods.
- Delivery services can allocate more drivers during peak hours and adverse weather.
- Customers can place orders at less busy times to get faster delivery.

AI-Assisted Design Process

For this project, I used ChatGPT (GPT-4O) to generate ideas for visualizing food delivery data. Using prompts such as “Suggest temporal visualizations for food delivery trends,” I explored different visualization approaches, including line charts, heatmaps, and bar graphs to analyze delivery performance and demand patterns.

AI provided helpful suggestions such as using heatmaps for peak demand analysis and line charts to track delivery time trends. However, AI had limitations in understanding specific data structures and provided generic recommendations that required refinement. Missing timestamps and irregular order patterns were areas where manual intervention was necessary.

2. Implementation Plan

Data Preparation Steps:

Cleaning the data:

- Remove missing or incorrect values in date and time columns.
- Convert Order_Date and Time_Orderd into a proper datetime format.
- Extract key features like hour, day, and month for analysis.

Tools/Libraries to Be Used:

1. **Power BI** – For creating interactive dashboards and reports.
    - **Why Power BI?**
        - Easy to use for business users.
        - Supports interactive filtering and slicers.
        - Handles large datasets efficiently.
2. **Microsoft Excel** – For extracting and preparing data features (hours, days, dates).
    - **Why Excel?**
        - Simple and effective for quick data preprocessing.
        - Easy extraction of date-based features using formulas.

Interactive Features Considered:

- **Date range filters:** Allow users to select specific periods for analysis.
- **Dropdown filters:** For weather conditions.