Analyzing Key Factors Impacting Delivery Performance and Efficiency: Impact of Traffic, Weather, and Delivery Personnel on Delivery Time

Introduction :

Delivery performance in food services is influenced by various factors, both internal and external. This analysis focuses on key variables such as weather conditions, road traffic, delivery person ratings, and the time taken for deliveries. These factors are believed to have a significant impact on the efficiency of delivery operations. By utilizing data visualization tools in R, this study aims to identify the primary drivers of delivery delays and recommend targeted solutions for Zomato's operational improvements, benefiting both customers and management.

Background :

Delivery time is a multifaceted issue influenced by a range of operational and external factors. Previous research highlights that variables such as weather, road traffic, and delivery personnel performance play critical roles in shaping delivery outcomes. In the modern food delivery landscape, customer satisfaction depends heavily on efficient and timely deliveries. This dataset allows for a comprehensive analysis of these factors using data visualization techniques in R, providing deeper insights into how these elements interact and impact Zomato's delivery time and overall service quality.

Problem Statement :

The primary objective is to analyze and identify factors that impact delivery time in Zomato's delivery operations. The target is to explore relationships between variables like weather conditions, road traffic, delivery person ratings, and delivery time. This helps to uncover patterns and possible bottlenecks in the delivery process.

Results

- **Road Traffic Density vs. Delivery Time**: Barplots can reveal how different traffic density levels (low, medium, high) impact delivery times, helping identify the extent to which road conditions influence delivery efficiency.
- **Delivery Person Ratings**: Scatter plots can illustrate the relationship between delivery person ratings and delivery time, showing whether higher-rated delivery personnel tend to deliver faster.
- **Vehicle Condition vs. Delivery Time**: Boxplots could highlight the impact of vehicle condition on delivery time, indicating whether well-maintained vehicles contribute to faster deliveries.
- **Festival Deliveries**: A pie chart visualizes the proportion of deliveries made during festivals versus non-festive periods, helping assess how holidays affect delivery volume and time.
- **Delivery Time Distribution**: Histograms display the distribution of delivery times, showing whether most deliveries are within a specific time range or if there are significant delays that need addressing.

- **Average Delivery Time Over Time**: Line plots can track the changes in average delivery time over days, revealing patterns in how delivery times fluctuate based on external factors such as demand surges or weather conditions.

Discussion

- **Road Traffic Density**: Road traffic density plays a crucial role in determining delivery time. Visualizing delivery time across different traffic conditions helps assess the severity of delays caused by heavy traffic. This could provide actionable insights for optimizing delivery routes and times during peak traffic hours.
- **Delivery Person Ratings**: Delivery person ratings, which reflect their performance and experience, significantly influence delivery time. A scatter plot between ratings and delivery time may show a negative correlation, suggesting that better-rated delivery personnel tend to make faster deliveries. This could underscore the importance of training and incentivizing delivery staff.
- **Vehicle Condition**: Vehicle condition is a key operational factor in delivery efficiency. Boxplots comparing delivery times by vehicle condition can highlight whether poorly maintained vehicles contribute to longer delivery times. Identifying outliers may further highlight operational inefficiencies.
- **Festival Deliveries**: The proportion of deliveries made during festival periods can reveal the operational stress that arises during peak demand. Analyzing this data through a pie chart provides insights into whether delivery operations need reinforcement during holidays, to ensure timely deliveries.
- **Delivery Time Distribution**: The overall spread of delivery times provides a foundational understanding of the service's operational performance. A histogram that displays the distribution of delivery times can highlight whether deliveries are consistently efficient or if certain orders experience significant delays, pointing to potential bottlenecks.
- **Average Delivery Time Over Time**: Line plots showing average delivery time across days help identify trends and anomalies in the delivery process. Peaks in delivery times may suggest operational challenges during certain periods, such as high demand days or adverse weather conditions, providing opportunities for targeted improvements in service planning.

RSTUDIO PLOTS :

Dataset Overview

The dataset contains 45,584 entries and 20 columns. Important variables include:

Delivery_person_Age, Delivery_person_Ratings: Details about the delivery person.

Weather_conditions, Road_traffic_density: External factors affecting delivery time.

Vehicle_condition, multiple_deliveries, Time_taken (min): Key indicators of delivery operations.

Order_Date: Date of the order.

City, Type_of_vehicle, Festival: Additional categorical variables.

Plot 1 :

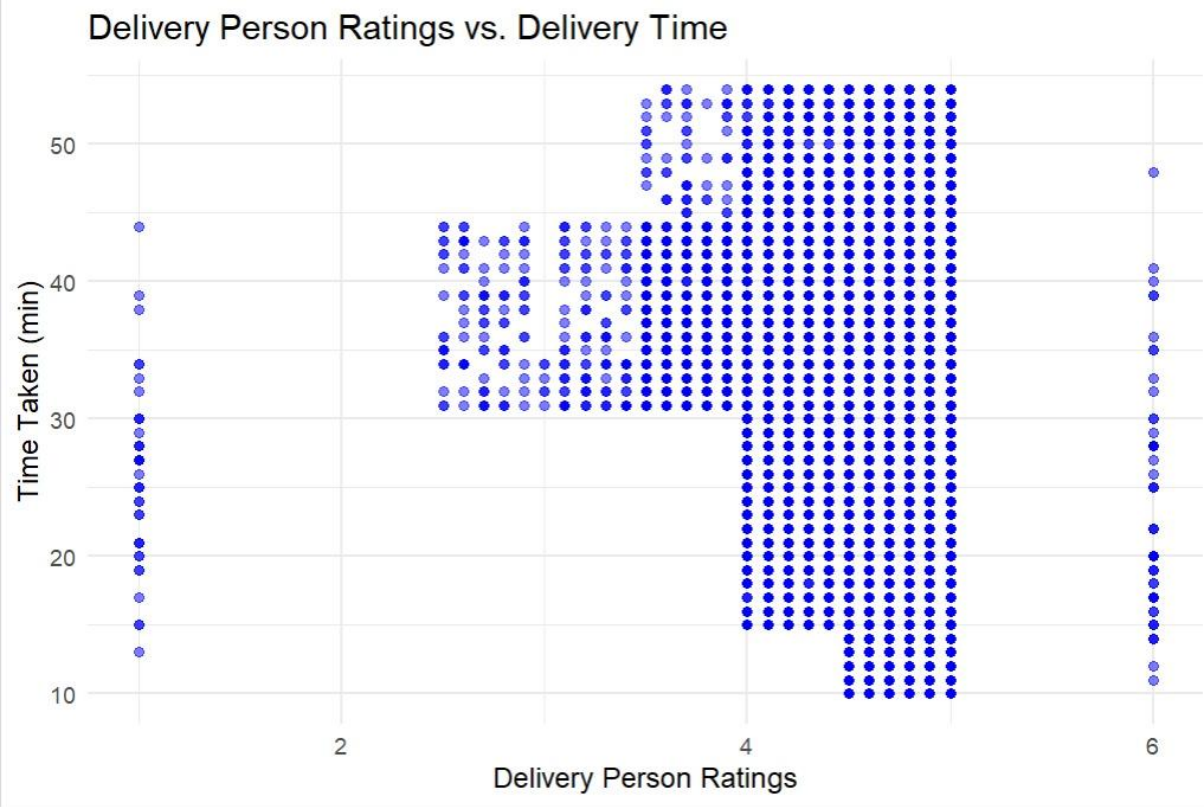
```
# Load necessary libraries
library(ggplot2)

# Load the dataset
View(Zomato.Dataset)


# Barplot for Road Traffic Density vs. Delivery Time
ggplot(Zomato.Dataset, aes(x=Road_traffic_density, fill=as.factor(Time_taken..min.))) +
  geom_bar() +
  labs(title="Delivery Time Distribution Across Traffic Density", x="Road Traffic Density", fill="Delivery Time (min)") +
  theme_minimal()
```

Summary :

Bar Plot (Road Traffic Density vs. Delivery Time): The bar plot shows how delivery time is distributed across different levels of road traffic density. Higher traffic densities tend to have more deliveries with longer times, suggesting that heavier traffic may contribute to delayed deliveries.

PLOT 2 :

```
# Scatter plot for Delivery Person Ratings vs. Delivery Time
ggplot(Zomato.Dataset, aes(x=Delivery_person_Ratings, y=Time_taken..min.)) +
  geom_point(alpha=0.5, color="blue") +
  labs(title="Delivery Person Ratings vs. Delivery Time", x="Delivery Person Ratings", y="Time Taken (min)") +
  theme_minimal()
```

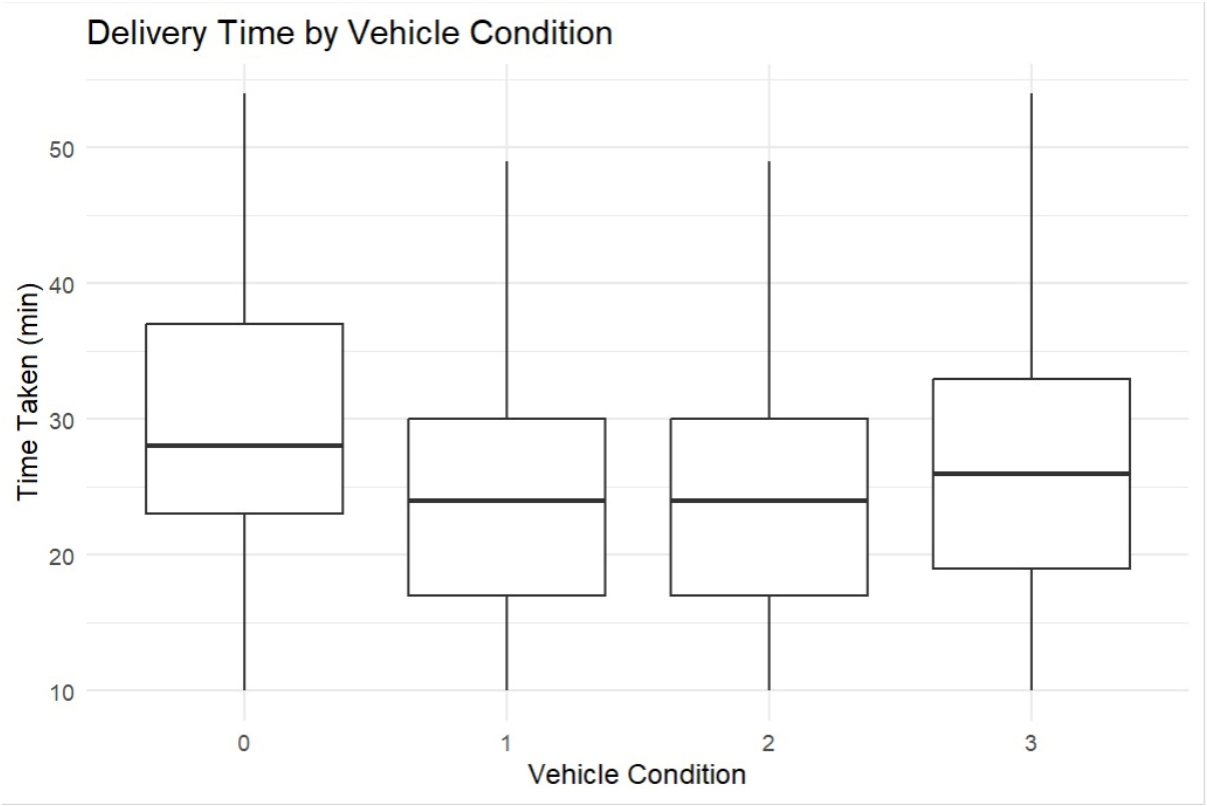


Summary :

Scatter Plot (Delivery Person Ratings vs. Delivery Time): The scatter plot shows that delivery times are spread across various rating levels, but higher ratings (5-6) seem associated with faster delivery, indicating a slight trend where better-rated personnel complete deliveries quicker.

PLOT 3 :

```
# Boxplot for Vehicle Condition vs. Delivery Time
ggplot(Zomato.Dataset, aes(x=as.factor(Vehicle_condition), y=Time_taken..min.)) +
  geom_boxplot() +
  labs(title="Delivery Time by Vehicle Condition", x="Vehicle Condition", y="Time Taken (min)") +
  theme_minimal()

# Pie Chart for Festival Deliveries
```

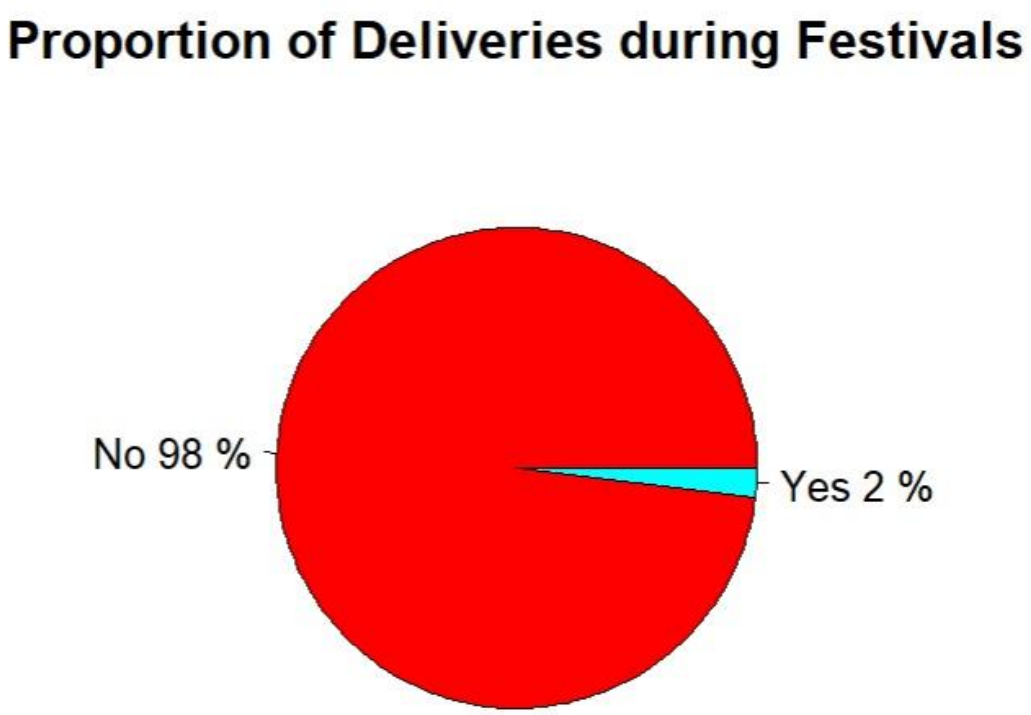


Summary :

Box Plot (Delivery Time by Vehicle Condition): The box plot suggests that vehicle condition does not drastically affect delivery time. The median delivery times remain fairly consistent across different conditions, though there is some variability within each condition group.

PLOT 4 :

```
# Pie Chart for Festival Deliveries
festival_data <- table(Zomato.Dataset$Festival)
pie(festival_data, labels = paste(names(festival_data), round(100 * prop.table(festival_data), 1), "%"),
    main = "Proportion of Deliveries during Festivals", col = rainbow(length(festival_data)))
```

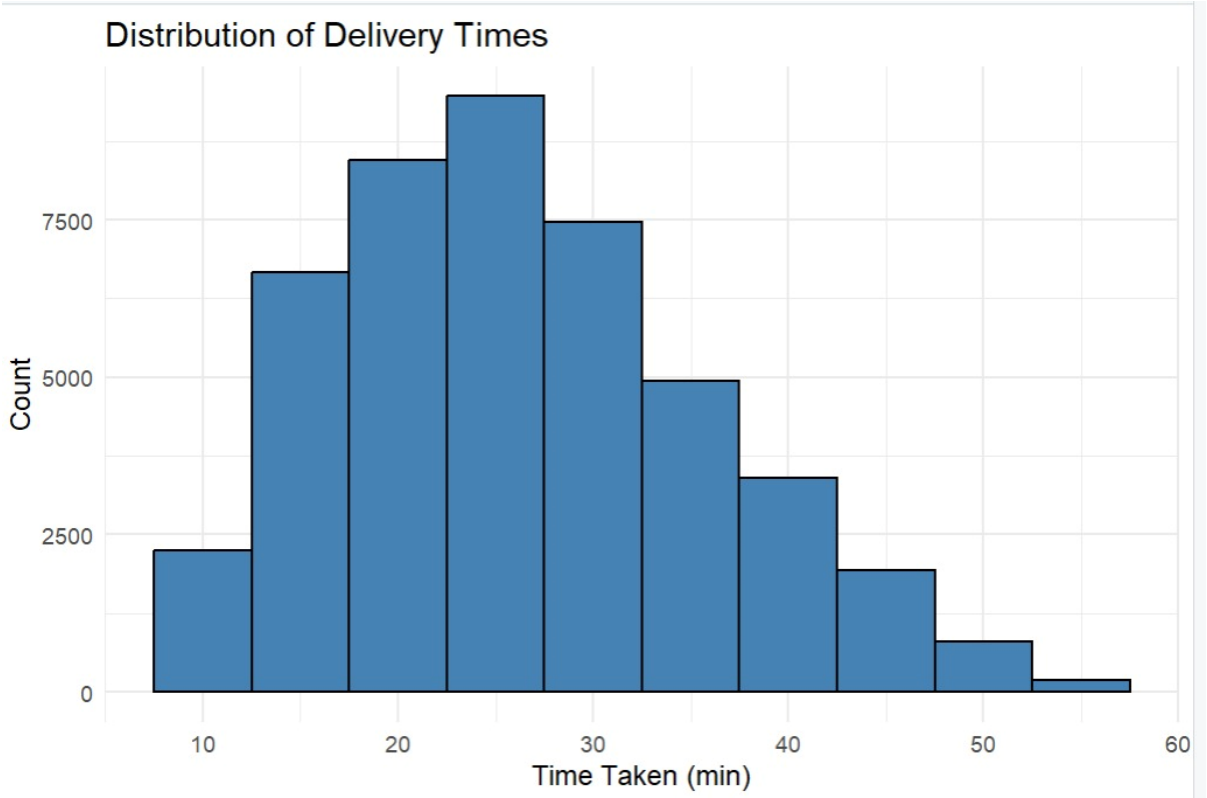


Summary :

Pie Chart (Festival Deliveries): The pie chart illustrates the proportion of deliveries during festivals versus non-festival days. It highlights the distribution, showing whether a significant portion of orders occur during festivals, with each segment labeled by its percentage share.

PLOT 5 :

```
# Histogram for Delivery Time
ggplot(Zomato.Dataset, aes(x=Time_taken..min.)) +
  geom_histogram(binwidth=5, fill="steelblue", color="black") +
  labs(title="Distribution of Delivery Times", x="Time Taken (min)", y="Count") +
  theme_minimal()
```



Summary :

Histogram (Delivery Time): The histogram displays the distribution of delivery times, with most deliveries falling within specific time ranges. The bars, grouped in 5-minute intervals, indicate the frequency of deliveries, highlighting common delivery durations and potential outliers.

PLOT 6 :

```
# Converting Order Date to Date format
Zomato.Dataset$Order_Date <- as.Date(Zomato.Dataset$Order_Date, format="%d-%m-%Y")

# Line plot for average delivery time over days
avg_time_per_day <- aggregate(Time_taken..min. ~ Order_Date, data=Zomato.Dataset, mean)

ggplot(avg_time_per_day, aes(x=Order_Date, y=Time_taken..min.)) +
  geom_line(color="darkgreen") +
  labs(title="Average Delivery Time Over Time", x="Order Date", y="Average Time Taken (min)") +
  theme_minimal()
```

Summary :

Line Plot (Average Delivery Time Over Time): The line plot shows the trend of average delivery time across different order dates. It highlights fluctuations in delivery performance over time, revealing potential patterns such as peak days with longer delivery times or improvements in efficiency on certain dates.

Conclusion:

This analysis provides valuable insights into the key factors influencing delivery performance. Critical aspects such as road traffic density, vehicle condition, and delivery personnel ratings were examined to understand their impact on delivery times. The findings suggest that improving traffic management and incentivizing better-rated delivery personnel could enhance efficiency. Visualizing these patterns offers actionable insights for logistics managers and stakeholders to optimize operations and improve customer satisfaction.

Team Members :

1 Rudra Pratap Singh 2308591
2 Shubham Shelar 2303889
3 Ramkuvar Prajapati 2309817
4 Saurav Bansode 2307222