Comprehensive Report on Peak Hour Traffic Analysis

1. Introduction

Mobility, fuel economy, and environmental sustainability are all severely hampered by urban traffic congestion. Effective traffic management and planning depend on knowing when traffic congestion is at its worst, why it happens, and how it changes over time.

Using combined traffic volume, weather, and event data, this report provides a thorough overview of traffic during peak hours. The main measure of traffic congestion is the number of vehicles per hour. Peak hours, temporal patterns, contributing factors, and practical insights for traffic optimization are the main objectives of the study.

2. Overview of Data

The combined dataset used for the analysis is made up of:

1) Traffic information: Hourly counts of cars at various intersections

2) Weather information: wind speed, temperature, humidity, and precipitation

3) Event data: A binary indicator that shows days with and without events

3. Congestion Metrics Definition

Since speed or delay data is unavailable, congestion is defined using traffic volume metrics, which effectively reflect traffic load.

The following metrics are used:

- **Average vehicle count per hour**—primary congestion indicator
- **Maximum vehicle count per hour** – captures extreme congestion
- **Traffic variability (standard deviation)**—measures consistency of congestion

Congestion Level = Hourly Vehicle Count

4. Peak Hour Identification

4.1 Hourly Congestion Analysis

Hourly traffic data across multiple days and weeks was analyzed to create an hourly congestion profile. The analysis reveals:

- Clear morning and evening traffic peaks
- Certain hours consistently show higher average traffic volumes
- These hours represent candidate peak hours

4.2 Statistical Confirmation of Peak Hours

To ensure peak hours are not random fluctuations:

- **Moving averages** were applied to smooth traffic variations and highlight persistent trends
- **Variability analysis** confirmed that peak hours show repeated congestion patterns across days

> Peak hours are defined as hours that consistently exhibit high congestion across multiple days and weeks.

5. Temporal Pattern Analysis

5.1 Day-of-Week Patterns

Traffic congestion was analyzed across weekdays and weekends:

- **Weekdays** show sharper and more pronounced peak hours
- **Weekends** display flatter congestion curves with peak hours often shifting later
- Individual weekdays show varying congestion intensity

This indicates that work-related travel dominates weekday peak congestion, while weekend traffic is more evenly distributed.

5.2 Monthly and Seasonal Patterns

Monthly traffic trends reveal:

- Congestion severity varies across months
- Certain months show consistently higher traffic volumes

- Seasonal factors and holiday periods influence congestion intensity

While peak hours remain largely consistent, their severity changes seasonally.

6. Impact of External Factors

6.1 Weather Influence on Congestion

Correlation and visualization analysis show that:

- **Precipitation (rainfall)** is associated with increased congestion during peak hours
- Adverse weather conditions intensify existing peak-hour congestion
- Weather variables contribute to traffic variability, though not as strongly as time-of-day effects

This indicates that weather acts as an amplifying factor, rather than the primary cause of congestion.

6.2 Event Impact on Congestion

Event-based analysis reveals:

- Traffic volume is significantly higher on event days
- Events increase congestion intensity during already busy hours
- In some cases, events shift peak congestion to non-typical hours

This confirms that events play a major role in disrupting normal traffic patterns.

7. Junction-Level Analysis

A junction-wise analysis identifies:

- Distinct peak hours for each junction
- Varying congestion intensity across locations
- Certain junctions experience consistently higher congestion
  This highlights the need for location-specific traffic management, rather than a uniform strategy

8. Actionable Insights and Recommendations

8.1 Traffic Signal Optimization

- Adjust signal timings during identified peak hours
- Introduce adaptive signal control at highly congested junctions

8.2 Event-Based Traffic Management

- Deploy additional traffic personnel during events
- Implement temporary diversions and parking controls
- Provide public advisories for alternate routes

8.3 Weather-Aware Congestion Planning

- Increase monitoring during adverse weather conditions
- Use weather forecasts to anticipate congestion surges
- Implement early warning systems for commuters

9. Conclusion

The peak hour traffic analysis demonstrates that congestion is primarily driven by time-of-day patterns, particularly during morning and evening commute hours. However, weather conditions and events significantly influence congestion severity and variability.

By combining traffic, weather, and event data, the study provides a holistic understanding of congestion dynamics. The findings support data-driven traffic management strategies that are time-aware, event-responsive, and weather-sensitive.