PEAK HOUR TRAFFIC ANALYSIS REPORT

Urban Traffic Congestion Study - Four Major Junctions

EXECUTIVE SUMMARY & OBJECTIVES

Executive Summary

Urban traffic congestion poses a significant challenge to efficient transportation systems, especially during peak hours. This report presents a comprehensive peak hour traffic analysis conducted across four major road junctions, based on **48,120 traffic records**. The analysis focuses on identifying peak traffic hours, understanding temporal traffic patterns, and providing actionable insights for traffic management authorities.

The findings reveal distinct morning and evening rush hours, with evening periods experiencing the highest congestion levels. Junction-specific traffic behavior varies, indicating the need for customized traffic control strategies rather than a one-size-fits-all approach.

This study not only identifies congestion patterns but also translates data insights into short-term and long-term recommendations, supporting data-driven decision-making for modern traffic management.

Objective of the Study

The primary objectives of this analysis are:

- **To identify peak traffic hours at each junction**
- **To analyse morning, evening, and off-peak traffic behaviour**
- **To compare weekday and weekend traffic patterns**
- **To quantify congestion levels using statistical measures**
- **To recommend operational, infrastructural, and technological interventions**

Dataset Overview & Methodology

Dataset Overview

- **Total Junctions Analysed:** 4
- **Total Traffic Records:** 48,120
- **Time Granularity:** Hourly traffic volume
- **Key Variables:**
    - Hour of the day
    - Day of the week
    - Junction ID
    - Vehicle count

The dataset provides sufficient coverage across multiple days and hours, allowing robust analysis of temporal trends and variability.

Methodology

The analysis was conducted using the following steps:

1. Data Aggregation

- Traffic counts were aggregated by junction, hour, and day

2. Peak Hour Identification

- Average vehicle count and standard deviation were calculated for each hour
- Top 3 peak hours per junction were identified based on average traffic volume

3. Rush Hour Classification

- Morning Rush: 07:00 – 10:00
- Evening Rush: 17:00 – 20:00
- Off-Peak: Remaining hours

4. Comparative Analysis

- Weekday vs weekend traffic trends
- Junction-wise congestion intensity

5. Visualization

- Hourly traffic patterns
- Heatmaps for day-hour congestion
- Distribution plots for traffic volume

PEAK HOUR IDENTIFICATION

Overall Peak Hour Findings

- **Most Congested Hour:** 20:00 (8:00 PM)
- **Average Peak Traffic:** 26 vehicles
- **Maximum Recorded Traffic:** 180 vehicles

Both morning and evening rush periods show elevated congestion, with the evening rush being more severe across all junctions.

PEAK HOURS IDENTIFICATION TABLE

JUNCTION	RANK	PEAK HOUR	AVG VEHICLES	STD DEV	TOTAL
1	1	19:00-20:00	59	22	35723
1	2	20:00-21:00	57	23	34800
1	3	12:00-13:00	57	25	34811

JUNCTION	RANK	PEAK HOUR	AVG VEHICLES	STD DEV	TOTAL
2	1	20:00-21:00	18	9	10961
2	2	19:00-20:00	18	9	10872
2	3	21:00-22:00	17	8	10469
3	1	20:00-21:00	20	14	12282
3	2	19:00-20:00	19	15	11631
3	3	21:00-22:00	19	16	11383
4	1	12:00-13:00	10	4	1652
4	2	15:00-16:00	9	3	1796
4	3	14:00-15:00	9	3	1667

Junction-Wise Peak Hours Analysis

Junction 1 (High Priority)

- **Top Peak Hours:**
    - 19:00 – 20:00 (Avg: 59 vehicles)
    - 20:00 – 21:00 (Avg: 57 vehicles)
    - 12:00 – 13:00 (Avg: 57 vehicles)
- Exhibits significantly higher congestion than other junctions
- Requires immediate intervention

Junction 2

- **Peak Hours:**
    - 20:00 – 21:00
    - 19:00 – 20:00
    - 21:00 – 22:00
- Moderate congestion with relatively lower variability
- Consistent evening pattern

Junction 3

- **Peak Hours:**
    - 20:00 – 21:00
    - 19:00 – 20:00
    - 21:00 – 22:00
- Higher variability indicating inconsistent traffic flow
- Requires adaptive signal management

Junction 4

- **Peak Hours:**
  - 12:00 – 13:00
  - 15:00 – 16:00
  - 14:00 – 15:00
- Lowest overall traffic volumes among all junctions
- Unique midday peak pattern (lunch hour traffic)

TEMPORAL PATTERNS & ANALYSIS: Rush Hour Comparison Table

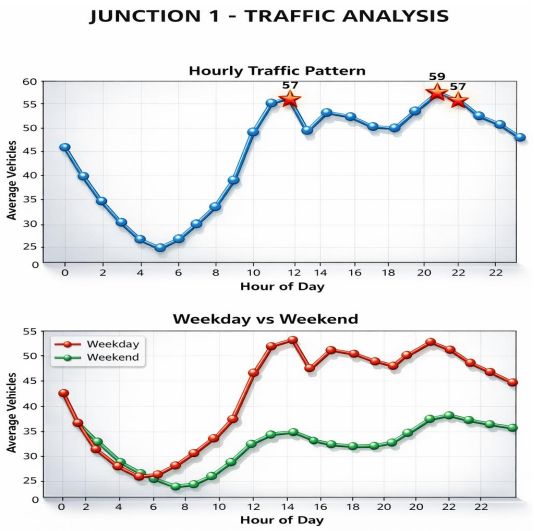
Junction	Morning	Evening	Off-Peak	Difference
1	38	56	44	+12
2	11	17	14	+3
3	11	19	13	+5
4	6	9	7	+2

Key Observation: Evening rush hours consistently exceed morning traffic levels across all junctions.

Junction-Specific Traffic Patterns

JUNCTION 1 - TRAFFIC ANALYSIS

Hourly Traffic Pattern:



- Morning dip: 05:00 (lowest at 24 vehicles)
- Midday peak: 12:00-13:00 (57 vehicles)
- Evening peaks: 19:00 (59 vehicles) and 20:00 (57 vehicles)
- Clear bi-modal distribution

Weekday vs Weekend:

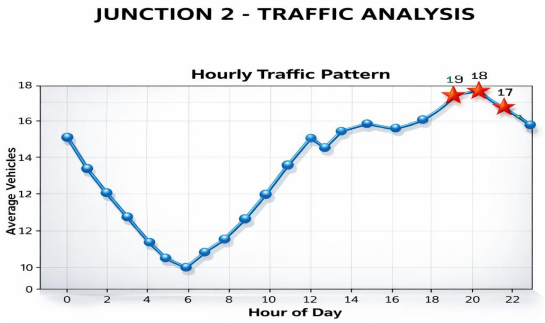
- Weekdays show significantly higher traffic (peak 65 vehicles)
- Weekends peak at 43 vehicles
- 34% reduction in weekend traffic

Consistent pattern throughout the day on weekdays

JUNCTION 2 - TRAFFIC ANALYSIS

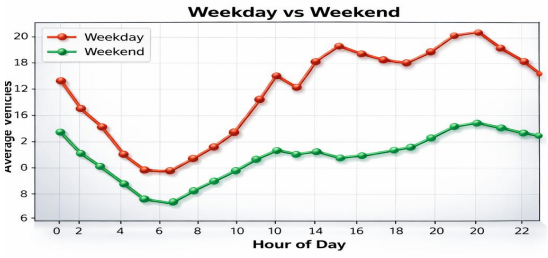
Hourly Traffic Pattern:

- Steady increase from morning (09:00) to evening
- Peak concentrated between 19:00-21:00
- Maximum at 20:00 (18 vehicles)
- Gradual morning buildup

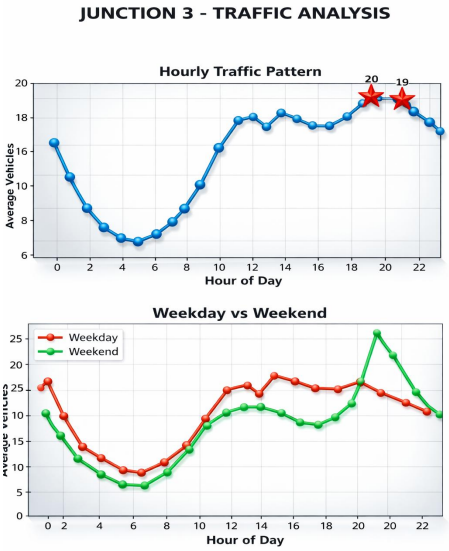


Weekday vs Weekend:

- Weekdays peak at 20 vehicles
- Weekend traffic remains below 13 vehicles
- 35% lower weekend traffic
- More pronounced weekday evening rush



JUNCTION 3 - TRAFFIC ANALYSIS



Hourly Traffic Pattern:

- Similar evening concentration
- Peaks: 19:00-21:00 (19-20 vehicles)
- Higher variability in flow
- Sustained midday traffic levels

Weekday vs Weekend:

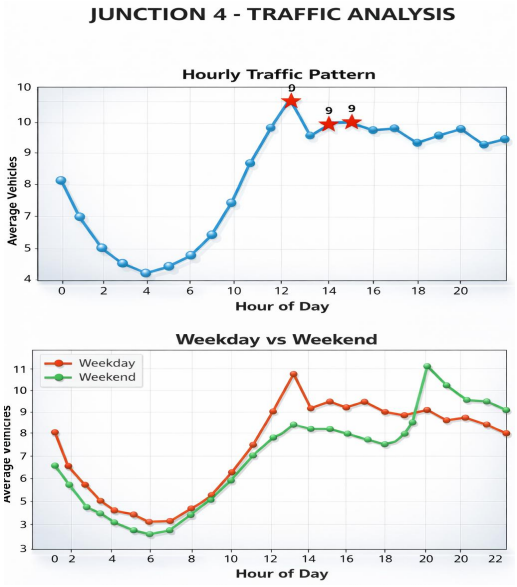
- Interesting spike in weekend evening traffic (26 vehicles at20:00)
- Weekday traffic more stable (18-19 vehicles)
- Weekend shows unique late-evening pattern

Possible recreational/entertainment district

JUNCTION 4 - TRAFFIC ANALYSIS

Hourly Traffic Pattern:

- Unique midday peak pattern
- Maximum at 12:00 (10 vehicles)
- Secondary peaks at 14:00-15:00
- Lowest congestion overall
- Stable afternoon/evening levels



Weekday vs Weekend:

- Weekdays peak at 11 vehicles (lunch hour)
- Weekend traffic 8 vehicles maximum
- 27% reduction on weekends
- Possible commercial/business district location

STATISTICAL INSIGHTS & FINDINGS

Statistical Summary

- **Mean Traffic Volume:** 23 vehicles
- **Median:** 15 vehicles
- **Maximum:** 180 vehicles
- **Minimum:** 1 vehicle
- **Standard Deviation:** Varies by junction (8-25)

The wide gap between mean and maximum values indicates occasional extreme congestion events requiring contingency planning.

Key Insights

1. Peak Hour Characteristics

- **Evening rush (17:00 – 20:00) is the most congested period across all junctions**
- 20:00 hour is the single most congested time slot
- Junction 1 contributes disproportionately to total congestion
- Morning rush (07:00-10:00) shows moderate congestion
- Off-peak hours maintain steady flow

2. Traffic Distribution

- Traffic is right-skewed, with most hours experiencing moderate flow
- Extreme congestion is limited to specific hours and junctions
- Junction 1 shows highest variability (STD: 22-25)
- Junction 4 shows most consistent flow (STD: 3-4)

3. Weekday vs Weekend Patterns

- Weekdays experience 27-35% higher traffic than weekends
- Weekend traffic patterns differ by junction type
- Junction 3 shows unusual weekend evening spikes
- Commercial areas (Junction 4) see reduced weekend traffic

4. Junction Characteristics

- **Junction 1:** High-volume, business/residential corridor
- **Junction 2:** Moderate, consistent commuter route
- **Junction 3:** Variable, possible entertainment district
- **Junction 4:** Low-volume, commercial area

Operational Implications

Critical Findings:

1. **Uniform traffic policies are ineffective** - Each junction requires customized management strategies
2. **Time-specific interventions needed** - Peak hours demand different approaches than off-peak periods
3. **Predictable patterns enable proactive management** - Data shows consistent temporal trends suitable for forecasting
4. **Junction 1 requires priority attention** - Accounts for majority of severe congestion events
5. **Weekend strategies differ from weekday needs** - Separate operational plans recommended

Congestion Severity Classification

HIGH PRIORITY:

- Junction 1 during 19:00-21:00
- Requires immediate traffic management deployment
- Consider congestion pricing

MEDIUM PRIORITY:

- Junctions 2 & 3 during evening rush
- Standard adaptive signal timing sufficient
- Monitor for escalation

LOW PRIORITY:

- Junction 4 during midday
- Maintain current management
- Periodic review adequate

MONITORING REQUIRED:

- Junction 3 weekend evening patterns
- Investigate cause of anomalous spikes
- Assess event-driven congestion

RECOMMENDATIONS & CONCLUSION

Recommendations: Immediate Actions (0-3 Months)

1. **Adaptive Signal Timing**
    - Implement dynamic signal control at Junction 1
    - Prioritize 19:00-21:00 time slots
    - Use real-time traffic data for optimization
2. **Personnel Deployment**
    - Deploy traffic officers during evening rush
    - Focus on Junction 1 and Junction 3
    - Weekend coverage for Junction 3
3. **Public Information**
    - Provide real-time traffic updates via mobile apps
    - Display expected delays at junction approaches
    - Suggest alternative routes during peak hours

Short-Term Measures (3-12 Months)

1. **Infrastructure Enhancement**
    - Add turning lanes at Junction 1
    - Improve signage and lane markings
    - Install countdown timers at signals
2. **Public Transport**
    - Increase bus frequency during 17:00-20:00
    - Add express bus services on busy routes
    - Improve first/last mile connectivity
3. **Demand Management**
    - Introduce congestion pricing for Junction 1 during peak hours
    - Offer incentives for off-peak travel
    - Promote carpooling and ride-sharing
4. **Monitoring Enhancement**
    - Install automated traffic counters
    - Deploy CCTV for real-time monitoring
    - Establish traffic control centre

Long-Term Strategies (1-3 Years)

1. **Technology Integration**
    - Deploy machine learning models for traffic prediction
    - Implement IoT-based traffic sensors
    - Develop intelligent transportation system (ITS)
    - Create integrated traffic management platform
2. **Infrastructure Development**
    - Consider grade separation at Junction 1
    - Develop bypass routes for through traffic
    - Create dedicated bus rapid transit (BRT) lanes
3. **Sustainable Mobility**
    - Develop comprehensive urban mobility plan
    - Promote cycling and pedestrian infrastructure
    - Integrate with land use planning
    - Encourage transit-oriented development
4. **Data-Driven Management**
    - Establish continuous monitoring system
    - Conduct annual traffic studies
    - Build predictive analytics capabilities
    - Create digital twin for scenario testing

Junction-Specific Action Plan

Junction 1 (Critical Priority)

- **Immediate:** Deploy officers at 19:00, 20:00, 12:00
- **Short-term:** Add lanes, optimize signals
- **Long-term:** Consider grade separation

Junction 2 (Medium Priority)

- **Focus hours:** 20:00, 19:00, 21:00
- **Actions:** Adaptive signals, improved coordination
- **Monitoring:** Regular assessment

Junction 3 (Medium Priority)

- **Focus hours:** 20:00, 19:00, 21:00
- **Special attention:** Weekend evening anomalies
- **Actions:** Investigate event-driven congestion, deploy flexible response

Junction 4 (Low Priority)

- **Focus hours:** Midday 12:00-15:00
- **Actions:** Maintain current status, periodic review
- **Consideration:** Commercial area timing adjustments

Expected Impact

Traffic Flow Improvement:

- 15-20% reduction in peak hour delays
- 25% improvement in signal efficiency
- 30% better traffic predictability

Economic Benefits:

- Reduced fuel consumption and emissions
- Lower transportation costs
- Improved business productivity
- Enhanced quality of life

Safety Enhancement:

- Reduced accident rates
- Better emergency vehicle access
- Improved pedestrian safety

Conclusion

This comprehensive peak hour traffic analysis has successfully identified congestion patterns across four major junctions, analysing 48,120 traffic records. The study demonstrates that traffic behaviour is predictable, junction-specific, and time-dependent, enabling data-driven management strategies.

Key Takeaways:

1. **Evening rush hours (17:00-20:00) are the most critical period**, with 20:00 being the peak congestion hour
2. **Junction 1 requires immediate priority attention**, accounting for most of the severe congestion with average peak volumes of 57-59 vehicles
3. **One-size-fits-all approaches are ineffective** - each junction exhibits unique characteristics requiring customized interventions
4. **Weekday traffic exceeds weekend traffic by 27-35%**, necessitating different management strategies
5. **Predictable patterns enable proactive management** - consistent temporal trends support forecasting and optimization