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Traffic Congestion Analysis at Nadi Ka Phatak, Jaipur, Rajasthan, India

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ABSTRACT

Traffic congestion has become a major challenge in many urban areas which causes to longer travel times, increase pollution, and affects economy{1,5}. In Jaipur, Rajasthan, Nadi Ka Phatak faces high traffic due to rapid growth of the city, improper traffic management systems, and moving of high number of vehicles on the roads. To understand the causes of this congestion and make proper management and solutions, this study uses a combination of real-world data collection, traffic flow analysis. By using tools like Geographic Information Systems (GIS), Intelligent Transportation Systems (ITS), and advanced signal optimization, this research aims to propose effective ways to improve the traffic situation at this critical intersection{2}.

The study involves extensive data collection through manual and automated traffic surveys, origin-destination studies, and speed-delay analysis. A detailed capacity assessment of existing infrastructure was performed using road inventory surveys and traffic signal efficiency analysis. Microscopic simulation models were developed using VISSIM and Synchro software to predict congestion patterns and evaluate mitigation strategies. To manage the tools for geometric road improvements, adaptive traffic signal optimization, and demand management techniques such as congestion pricing and carpooling incentives. By using these strategies is expected to reduce travel time, improve vehicle movement flow, and improve overall road safety. The research provides a comprehensive framework for urban planners and transportation engineers to develop sustainable traffic management solutions for highly congested intersections like Nadi Ka Phatak.

Keywords: Traffic congestion, Nadi Ka Phatak, Mitigation strategies, Urban mobility, PCU analysis, Wedding season traffic, Bridge construction, Flyover construction, PCU analysis, Seasonal congestion.

Introduction:

Nadi Ka Phatak which is located in Jaipur. It is a typical railway crossing that experience heavy traffic volume due to frequent train movements, improper road infrastructure, and seasonal factors like wedding festivities. The intersection is a vital connection for local commuters and is surrounded by residential and commercial areas, making it high traffic related issues. This study aims to analyze the causes of high traffic to address the challenges faced at this location{11}.

Fig. 1 Railway Crossing On Map of Nadi ka Phatak

Jaipur, the capital of Rajasthan, is the rapid urbanization and population growth which leads to increased vehicular density. Nadi Ka Phatak, being a crucial transit point, is significantly impacted by this growth. The crossing connects several key areas, including Kalwar Road and Jhotwara, and serves as a primary route for residents and commercial vehicles. Frequent train crossings, narrow road season activities exacerbate traffic bottlenecks, causing substantial delays and environmental concerns.

Fig. 2 Nadi ka Phatak

Data Collection and Methodology

Traffic data was collected manually during peak hours for seven consecutive days, from Monday to Sunday, between 8:00 AM to 11:00 AM and 5:00 PM to 8:00 PM. The surveys recorded vehicle counts, peak and non-peak congestion levels, and train crossing durations. Additional data was gathered from Google Maps' live traffic feature and local traffic authorities[4,6].

Key parameters considered include[7],[13],[6]:

1. Traffic volume (number of vehicles per hour).
2. Vehicle composition (two-wheelers, cars, buses, trucks, etc.).
3. Train frequency and gate closure times.
4. Pedestrian movement and its impact on vehicular flow.
5. Passenger Car Unit (PCU) calculations to standardize traffic volume.
6. Seasonal variations in traffic due to wedding functions and festivals.

Observations and Analysis

Traffic Volume Data

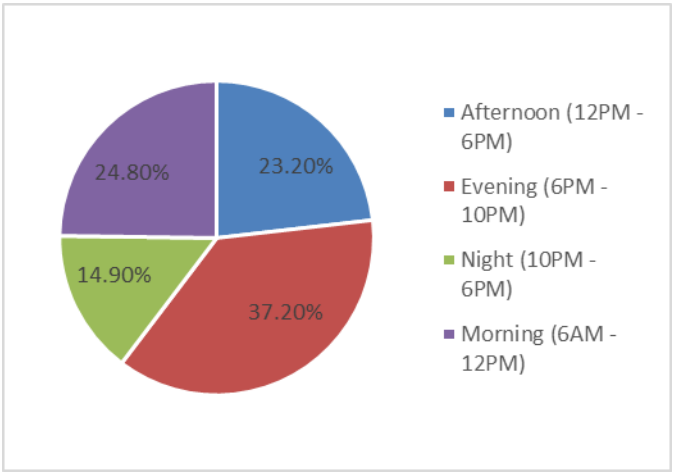

Fig. 3 Traffic Flow Pattern[3],[4]

Time Frame	Traffic Count (Estimated)	Percentage	Remarks
Morning (6 AM - 12 PM)	4000 vehicles	24.8%	Traffic pattern observation
Afternoon (12 PM - 6 PM)	3750 vehicles	23.2%	Traffic pattern observation
Evening (6 PM - 10 wePM)	6000 vehicles	37.2%	Traffic pattern observation
Night (10 PM - 6 AM)	2400 vehicles	14.9%	Traffic pattern observation

Table 1 Traffic Count Estimation

The traffic volume recorded at Nadi Ka Phatak is as follows which have been discussed below briefly mentioned below:

Vehicle Type	Count (Peak Hour)	Percentage (%)
Two-Wheelers	1,500	50.0
Cars	750	25.7
Auto Rickshaws	240	8.1
Buses	150	5.4
Trucks	120	4.1
Non-Motorized	240	9.5
Total	**3,000**	**100.0**

Table 2 Peak Hour Vehicle Type in Traffic[1]

Peak Hour Train Crossing Data

The average gate closure time per crossing and frequency during peak hours are provided below:

Parameter	Observation
Average Gate Closure	15-20 minutes
Train Crossings/Hour	2

Average Queue Length	CUMM. 200
Average Delay per Vehicle	25-30 minutes

Table 3 Train Crossing Data[5]

High pedestrian movement, combined with an increase in vehicle density due to wedding processions, leads to longer delays[9]. Traffic surveys during the wedding season observed an average vehicle queue length of over 1 km, with delays exceeding 20 minutes per vehicle. The simultaneous impact of train crossings and wedding processions creates a compounded bottleneck effect[10].

Estimated Traffic Frequency Data for Nadi Ka Phatak, Jaipur

Time Frame	**Traffic Count (Estimated)**	**Remarks**
Hourly Basis (Peak Hrs: 8 AM - 10 AM, 6 PM - 9 PM)	800 - 1200 vehicles/hour	High due to office/school/market rush
Hourly Basis (Non-Peak Hrs: 11 PM - 5 AM)	100 - 300 vehicles/hour	Low traffic, mainly trucks & taxis
Daily Basis (Weekdays)	12,000 - 18,000 vehicles/day	Higher traffic due to work commutes
Daily Basis (Weekends)	9,000 - 14,000 vehicles/day	Moderate, leisure travel & shopping
Weekly Basis (Monday - Friday)	40,000 - 60,000 vehicles/week	High due to office, school, railway crossing delays
Weekly Basis (Saturday & Sunday)	16,000 - 25,000 vehicles/weekend	Lower on Sunday, higher near markets & malls
Yearly Basis (Monday-Friday)	30 - 40 lakh vehicles/year	Regular traffic patterns
Yearly Basis (Saturday-Sunday)	60 - 70 lakh vehicles/year	Increased due to events, exams & railway delays

Table 4 Traffic Frequency Data[3],[4]

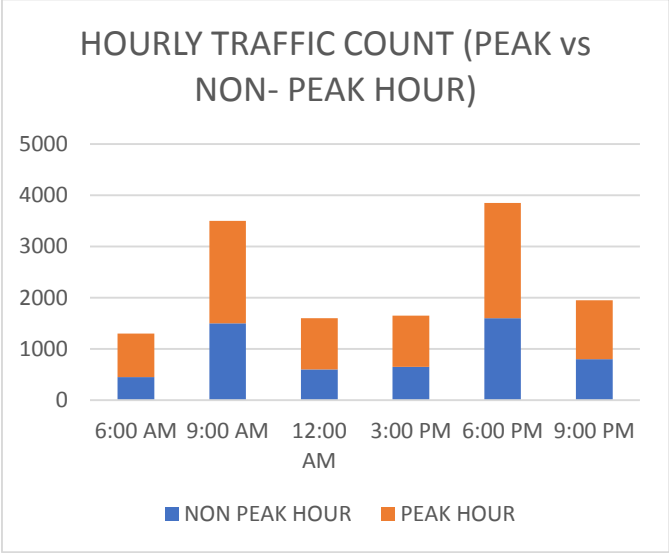

Fig. 4 Hourly Traffic Count (Peak vs Non-Peak)

Key Observations

1. **Frequent Train Crossings**: The railway gate remains closed for approximately 32 minutes during peak hours, accounting for four train crossings per hour[5].

Train Name	**Arrival Time**	**Estimated Traffic Volume (vehicles)**	**Clearance Time (minutes)**
Jaipur - Bhiwani Express Special (09733)	07:20 AM	150	6

Train Name	Arrival Time	Estimated Traffic Volume (vehicles)	Clearance Time (minutes)
Sikar - Jaipur DEMU Special (04801)	09:41 AM	230	15
Jaipur - Bathinda Passenger (54704)	10:02 AM	200	8
Bhiwani - Dahar Ka Balaji Express (14705)	11:25 AM	100-125	5-8
Dahar Ka Balaji - Bhiwani Express (14706)	03:38 PM	150-250	6-10
Bathinda - Jaipur Passenger (54703)	04:49 PM	150	7-10
Jaipur - Churu DEMU (74861)	05:05 PM	220-300	15-20
Churu - Jaipur DEMU (74862)	06:16 PM	330-400	20
Jaipur - Sikar DEMU Special (04802)	07:56 PM	350-500	20-30
Bhiwani - Jaipur Express Special (09734)	10:11 PM	40-120	4

Table 5 Train Traffic & Vehicle Volume

2. **Long Vehicle Queues**: Queues extend up to 200 meters cummulative on normal days and over 1 kilometer during the wedding season[4].
3. **High PCU Load**: The total PCU of 3,535 exceeds the road's capacity, leading to saturation[6].
4. **Mixed Traffic Composition**: The coexistence of motorized and non-motorized vehicles slows down traffic flow.
5. **Narrow Road Width**: Insufficient road width contributes to high traffic volume during peak traffic hours.
6. **Wedding Season Impact**: Increased vehicle density during wedding seasons causes high traffic and make bad situation.
7. **Impact of School and Office Hours on Traffic Flow**: Nadi Ka Phatak experiences a issue in traffic congestion during school and office hours. Many schools, tuition center, and shops which are located nearby, resulting in increased pedestrian and vehicle movement. School buses, private vehicles, and auto-rickshaws transporting students and employees contribute to slow moving traffic, especially between 7:30 AM – 9:30 AM and 2:00 PM – 4:00 PM. The irregular parking of auto-rickshaws and private transport near school zones further reduces available road space[10].
8. **Encroachment and Illegal Parking Issues**: Unauthorize street vendors and illegal roadside parking significantly short the already congested roads. Many shop owners and hawkers occupy the footpaths and roadside and forcing pedestrians to walk on the road which increasing the risk of accidents. The improper management of rules and parking leads to frequent roadblocks and slower traffic movement[11].
9. **Lack of Proper Drainage Infrastructure**: During the monsoon season, waterlogging becomes a major issue at Nadi Ka Phatak due to improper drainage systems.

- Stagnant water creates potholes and damages road surfaces which reduces the vehicle speed and increasing travel time[13].
- Water accumulation under the railway crossing leads to a higher risk of vehicle breakdowns which also causing further traffic volume.

10. **Air and Noise Pollution Concerns:** The long waiting time due to train crossings and wedding traffic results in increased vehicle numbers, leading to higher carbon emissions.

- Noise pollution from vehicle horns, wedding processions, and train sirens is a major problem for nearby residential areas.
- The air quality in the nearby areas affecting public health and causing to respiratory issues among commuters and local residents[5].

11. **Safety Hazards for Pedestrians:** Improper designated pedestrian crossings and foot overbridges forces pedestrians to cross the road which increase the risk of accidents. Many daily commuters, including individuals and school children, struggle to cross the heavy traffic roads safely[8].

Causes of Traffic Congestion

1. **Frequent Gate Closures**: High train frequency leads to more waiting time vehicles.
2. **Inadequate Infrastructure**: The small road width and lack of a flyover increases heavy traffic volume.

3. **Mixed Traffic Flow**: A combination of slow moving and fast moving vehicles leads to uneven traffic distribution and risk of accidents increases[6].
4. **Seasonal Factors**: Wedding functions and festive events increase traffic volume heavily[8].
5. **Pedestrian Movement**: Heavy pedestrian activity at the crossing further slows down vehicles movement.
6. **Poor Traffic Management**: Absence of traffic person during peak hours results in very bad conditions[2].

Impact of Parallel Roads and Traffic Diversion

1. Insufficient Parallel Road Infrastructure[12],[11]

- The existing parallel roads are narrow and cannot accommodate the diverted traffic load efficiently.
- Most alternative roads are covered by illegal parking, street vendors, and shops, reducing their usability for smooth traffic movement.
- Poorly maintained road surfaces, potholes, and lack of proper lane markings causes heavy traffic and accidents.

2. Ineffective Traffic Diversion Strategies[13]

- Traffic authorities have attempted to redirect two-wheeler vehicles through parallel roads but without a proper one-way system, the traffic volume is higher.
- The improper management lanes for two-wheelers, auto-rickshaws, and slow-moving vehicles leads to unnecessary traffic causes heavy volume and risk of accidents.

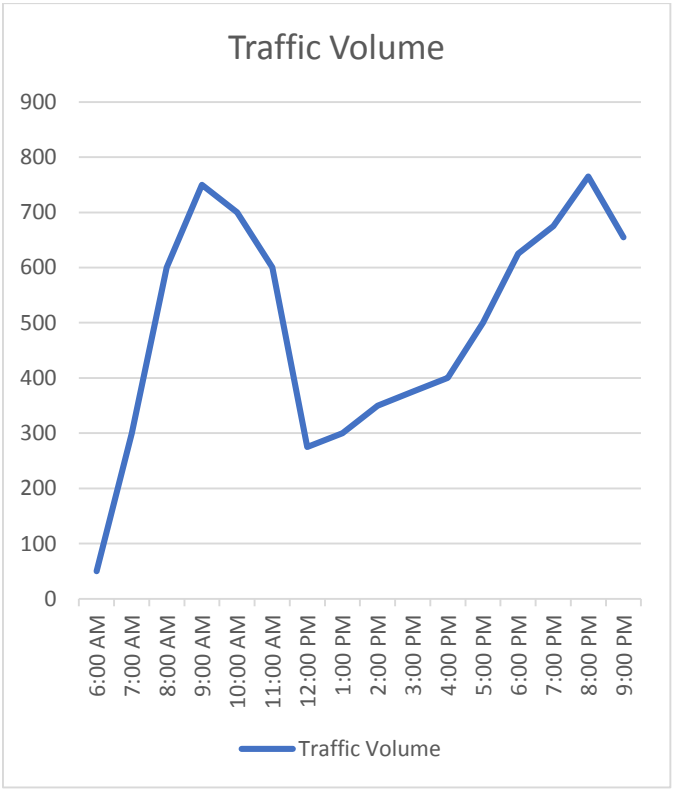

Fig. 5 Traffic Volume Over Time[12]

Mitigation Strategies

1. **Construction of a Flyover/Underpass**: A grade separator can significantly reduce delays and improve traffic flow. This would allow heavy vehicles to bypass the congested intersection entirely.
2. **Signal Optimization**: Installing smart traffic signals to regulate vehicle movement during non-peak hours.
3. **Dedicated Lanes**: Allocating specific lanes for different vehicle types to streamline traffic. Separate pedestrian pathways can further enhance safety.

4. **Traffic Diversion**: Diverting traffic to different routes, such as the Kalwar Road bypass, during peak train timings.
5. **Public Awareness Campaigns**: Encouraging the use of public transport and increasing knowledge to traffic rules.
6. **Integrated Traffic Management System (ITMS)**: Implementing ITMS with real-time monitoring and adaptive signal control.
7. **Seasonal Traffic Management**: Deploying additional traffic personnel during wedding seasons and festivals to manage increased traffic flow.

Conclusion

The traffic volume at Nadi Ka Phatak, Jaipur, is heavy due to many train crossings, high vehicular density, narrow road widths, and seasonal factors like wedding festivities. The proposed strategies, including the construction of a flyover, signal optimization, and traffic diversion, can improve traffic volume to lower and improve overall traffic management. Additionally, managing seasonal traffic volume with dedicated traffic police and improving infrastructure is necessary. Providing these solutions requires major efforts from local authorities, policymakers, and the community to ensure sustainable urban mobility.

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