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Study of Traffic Flow and Management in Urban Areas

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ABSTRACT

Rapid urbanization and increasing vehicle ownership in mid-sized Indian cities have intensified traffic congestion, adversely affecting mobility, safety, and environmental quality (Treiber & Kesting, 2013). This study presents a comprehensive traffic flow analysis along a critical arterial corridor in Durg, Chhattisgarh, combining multi-source data collection with GIS spatial analysis and user surveys (Chen et al., 2019; Kumar & Reddy, 2017). Key findings reveal oversaturated intersections, inefficient signal timings, and conflicts between public transport and other road users (Zhao et al., 2020; Singh & Sharma, 2018). Adaptive traffic signal systems, bus-only lanes, and improved non-motorized transportation infrastructure are among the suggestions. This paper underscores the need for data-driven, inclusive traffic management strategies to improve urban mobility in emerging cities[1].

Keywords: Urban Traffic Flow, Congestion Analysis, Traffic Signal Optimization, Public Transport, GIS Spatial Analysis, Durg

1. Introduction

In expanding Indian cities, where infrastructure frequently falls behind growing vehicle demand, urban traffic management is becoming a more difficult problem(Treiber & Kesting, 2013). Durg, a fast-developing city in Chhattisgarh, faces persistent congestion and traffic inefficiencies due to mixed land use, heterogeneous vehicle types, and limited transport planning (Singh & Sharma, 2018). This paper aims to analyze traffic conditions on a major corridor—Station Road to Pulgaon Chowk—identify key congestion hotspots, and propose evidence-based interventions for improving traffic flow and safety (Chen et al., 2019)[5].

2. Literature Review

Traffic flow modeling has evolved from macroscopic fluid analogies to microscopic simulations capturing individual vehicle dynamics (Treiber & Kesting, 2013). Studies demonstrate the efficacy of adaptive signal control and dedicated bus lanes in reducing congestion in Indian urban contexts (Zhao et al., 2020; Singh & Sharma, 2018). GIS-based spatial analyses effectively visualize traffic hotspots and support targeted infrastructure upgrades[4]. Public perception surveys complement quantitative data, providing insights into user behavior and preferences (Kumar & Reddy, 2017) [2].

3. Data Sources and Collection Methods

3.1 Primary Data

- Traffic Volume Surveys: Manual and automated vehicle counts at major intersections, categorized by vehicle type (Singh & Sharma, 2018).
- On-Site Observations: Field visits assessing traffic flow, road conditions, and driver behavior (Chen et al., 2019) [3].
- Questionnaires and Interviews: Structured surveys of commuters, public transport operators, and traffic police (Kumar & Reddy, 2017).
- GPS Tracking: Real-time vehicle speed and congestion data from ride-sharing and commercial fleets (Zhao et al., 2020).

3.2 Secondary Data

- Municipal records (vehicle registration, road development plans) (Chen et al., 2019).
- Traffic police logs (accident reports, violation records) (Singh & Sharma, 2018).

- Satellite imagery and GIS data for spatial mapping (Chen et al., 2019).
- Academic research and government reports (Treiber & Kesting, 2013).

3.3 Summary of Traffic Data Collection Methods

Data Type	**Collection Method**	**Purpose**	**Location/Period**
Vehicle Counts	Manual & Automated Surveys	Volume and Vehicle Classification	Four major intersections, Jan-Mar 2025 (Singh & Sharma, 2018)
Speed & Congestion	GPS Tracking (Ride-sharing fleets)	Real-time speed & congestion	Key arterial routes (Zhao et al., 2020)
Traffic Observation	CCTV footage & On-site visits	Traffic flow & pedestrian behavior	Station Road corridor (Chen et al., 2019)
User Feedback	Structured Surveys & Interviews	Commuter behavior and opinions	150 road users surveyed (Kumar & Reddy, 2017)
Spatial Mapping	Satellite & GIS Data	Identification of congestion hotspots	Entire corridor (Chen et al., 2019)

4. Traffic Modelling Techniques

The study employed a combination of:

- Microscopic Models (e.g., Car-Following Models) for detailed intersection analysis (Treiber & Kesting, 2013),
- Mesoscopic Models to simulate corridor-level traffic flows (Zhao et al., 2020),
- Macroscopic Models for aggregate traffic density and flow estimation (Treiber & Kesting, 2013),
- Analytical Models for queue length and signal delay estimation (Singh & Sharma, 2018),
- Simulation-Based Models to test traffic control scenarios (Zhao et al., 2020).

Software tools included VISSIM for micro-simulation and VISUM for network-level planning (Chen et al., 2019).

5. Case Study: Urban Traffic Flow Analysis

5.1 Study Area

The 4.5 km corridor from station road to Pulgaon Chowk encompasses commercial zones, educational institutions, and transport hubs[1]. It contains multiple signalized intersections and mixed traffic involving private vehicles, buses, auto-rickshaws, and pedestrians (Singh & Sharma, 2018).

Fig. 5(a) Location of pulgaon chowk

5.2 Data Collection and Analysis

- Fixed sensors recorded vehicle counts and speeds at four junctions (Zhao et al., 2020).
- CCTV footage provided real-time traffic observations (Chen et al., 2019).
- GPS data offered floating vehicle speeds and congestion levels (Zhao et al., 2020) [2].
- Manual peak hour surveys validated automated counts and assessed pedestrian activity (Kumar & Reddy, 2017).

5.3 Key Findings

- Volume-to-Capacity Ratios exceeded 1.0 at Shastri Chowk and Pulgaon Chowk (Singh & Sharma, 2018).
- Peak hour speeds dropped below 15 km/h near marketplaces and schools (Zhao et al., 2020).
- Queues extended beyond 150 meters due to short signal cycles (Singh & Sharma, 2018).
- GIS mapping highlighted hotspots around Junction Mall, Government Hospital, and bus stops (Chen et al., 2019)[3].

6. Results and Discussion

6.1 Traffic Volume and Peak Conditions

Peak congestion occurs 7:00–9:00 AM and 4:30–6:30 PM, with vehicle volumes exceeding 1800 per hour per lane on key roads (Singh & Sharma, 2018).

6.2 Intersection Efficiency

Poor signal synchronization and insufficient pedestrian infrastructure cause delays and queue spillovers at key junctions (Zhao et al., 2020).

6.3 Public Transport Conflicts

Lack of dedicated bus lanes forces public transport vehicles to stop within traffic lanes, disrupting flow and safety (Singh & Sharma, 2018).

6.4 Spatial Congestion Patterns

GIS analysis confirms congestion hotspots at commercial and mixed-use nodes with high pedestrian interactions (Chen et al., 2019).

6.5 User Survey Insights

Most commuters cite congestion as a key concern, with significant willingness to shift to walking and cycling if infrastructure is improved (Kumar & Reddy, 2017).

7. Recommendations

- Adaptive Traffic Signal Systems: AI-driven signal control responsive to real-time traffic (Zhao et al., 2020).
- Intersection Redesign: Channelized turn lanes and signal coordination (Singh & Sharma, 2018).
- Dedicated Bus Lanes: Enforce curbside regulations for uninterrupted public transport (Singh & Sharma, 2018).
- Non-Motorized Infrastructure: Continuous footpaths and cycling tracks to promote modal shift (Kumar & Reddy, 2017).

8. Conclusion

This study highlights the multifaceted traffic challenges in Durg, driven by infrastructure constraints, growing vehicle demand, and inadequate traffic control (Treiber & Kesting, 2013). Data-driven interventions combining technology and infrastructure upgrades can alleviate congestion, enhance safety, and promote sustainable urban mobility (Zhao et al., 2020; Chen et al., 2019). Future research should focus on long-term monitoring, simulation-based scenario planning, and smart city integration (Singh & Sharma, 2018).

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