TRANSITIONAL IMPACT OF INFLUENCING FACTORS LEADING TO TRAFFIC CONGESTIONS

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ABSTRACT

There has been a dramatic increase in traffic congestion across Hyderabad's road network as a consequence of the city's fast urbanization and motorization. With an emphasis on arterial and sub-arterial roads' functions in urban mobility, this research examines the long-term effects of the variables that cause traffic congestion. Despite their central role in the city's transportation network, these roads are under growing strain from factors such as increased vehicle density, changes in land use, and existing infrastructural constraints. The study maps traffic patterns, congestion hotspots, and the changing road network layout using QGIS (Quantum Geographic Information System) methodologies. The research offers visual and data-driven insights on the concentration of congestion along important corridors and junctions across time by merging geographical data with traffic volume and urban development indicators.

The results show that insufficient integration of land use and transportation planning, restricted accessibility of public transit, and imbalanced growth are the main factors that cause congestion. Targeted interventions and policy planning may be guided by the high-stress zones identified by the QGIS-based spatial analysis on arterial and sub-arterial roadways.

This study highlights the significance of spatial analytic methods in urban transport studies and helps to establish informed strategies for improving infrastructure design, reducing traffic congestion, and promoting sustainable mobility.

I. INTRODUCTION

Urban road networks in emerging nations are increasingly plagued by traffic congestion. Getting a better grasp on how the spatial patterns of urban land use impact congestion could be one way to lessen its impact. Regrettably, this impact is seldom given much thought. A decline in urban quality of life, longer travel times, and higher levels of air pollution are all consequences of traffic congestion, which is itself caused by a number of interconnected issues.

Unplanned urban expansion, limited or encroached highways, insufficient and underused public transit networks, ineffective traffic management, and a dramatic increase in private automobile ownership are all factors that contribute to this problem. The problem is made worse by inadequate parking places, poor land use planning, and a lack of coordinated transportation strategies. If we want to build sustainable solutions to traffic congestion and mobility issues, we need

to understand these aspects. Here we break down the project into its component parts and look at how each one affects the traffic situation in Hyderabad.

1.1 The Effects of Contributing Factors on Traffic Congestion During Transition Many environmental, social, and economic elements interact to form urban traffic congestion. Because of fast urbanization, changing transportation demands, and changing travel habits, these influencing variables have a disproportionately large transitory influence on places like Hyderabad.

Traffic patterns and congestion levels are affected by transitional impacts, which are changes that occur over time. These changes include things like an increasing population, urban expansion, more car ownership, and technology developments. The consequences on traffic, road capacity, and commuter experience are complicated and dynamic, caused by the interaction of these shifts. For example, traffic congestion has worsened due to people's growing dependence on personal automobiles rather than on conventional public transportation. Similarly, isolated delays have been caused by unexpected commercial projects that lack accompanying infrastructure, which has affected traffic distribution. For efficient traffic planning and long-term urban mobility, knowledge of these changing elements and the implications of transition is essential. The purpose of this research is to catalog the variables that have had an effect on Hyderabad's traffic congestion and to determine how that effect has evolved over time to produce the city's present transportation problems.

II. LITERATURE REVIEW

A thorough examination of the dynamic interplay between socioeconomic, infrastructural, and behavioral variables impacting traffic congestion in Hyderabad is presented in this chapter. This chapter takes a shift in perspective by looking at traffic concerns through a transitional lens, specifically at how these elements evolve over time and impact congestion patterns in a dynamic way.

In their study on road traffic accidents and the deterioration of road safety in Sylhet zones, Banik B.K. et al. [1] aimed to identify the most dangerous roads and locations, the vehicles and parts that cause them, the health of drivers and pedestrians, the demographics of accident victims, the societal impacts of these accidents, the priorities for safety in the city, and the options that are currently available. Because they weren't paying attention, pedestrians end up being the ones hit by cars the most. They completely disregard other drivers' rights to use the road and the potential hazards that may arise as a result of their reckless driving. When faced with huge trucks that are both laden and moving at a fast speed, lightweight three-wheelers powered by four-stroke engines have a fighting chance. Analysis of trustworthy traffic accident data is crucial to the effectiveness of highway development and traffic safety initiatives, according to Anitha Selvasofia S.D. and Prince Arulraj.G. [2]. Their study focused on three roads in the Coimbatore district: NH 67 Gandipuram to Mettupalayam, NH-209

Gandhipuram to Annur, and NH 47 Gandhipuram to Avinashi. They also spoke about how to use ArcGIS to find areas with a high accident risk.

III. METHODOLOGY

This section describes the research strategy used to examine the long-term effects of the variables that cause traffic jams on a subset of Hyderabad's arterial and arterial routes. The research looks at three types of roads: arterial (NH-65, PV Narasimha Rao Expressway, IRR & ORR), and sub-arterial (Road No. 36, Jubilee Hills, Tolichowki-Gachibowli Link Road, and the Nampally-Koti corridor). The study uses a mixed-methods research strategy, which combines quantitative and qualitative techniques, to guarantee a thorough comprehension of the dynamics of traffic congestion. Two separate urban traffic situations in Hyderabad are highlighted by two sub-arterial corridors: Tolichowki-Gachibowli and Nampally-Koti.

Interstate Highways

The National Highway 65 carries a mix of residential and business traffic as it links Miyapur and LB Nagar. High-speed routes with grade-separated crossings include the PV Narasimha Rao Expressway, which links Mehdipatnam to Shamshabad Airport and was developed for speedy inter-city traffic. The Inner Ring Road and the Outer Ring Road (ORR) are also part of this network.

Figure: Arterial Roads

Sub-Arterial Roads

Jubilee Hills Road No. 36: mixed-use road with residential and business areas; heavy local traffic.

Tech parks, educational institutions, and a large number of daily commuters are served by the Tolichowki-Gachibowli Link Road.

• The Nampally-Koti Corridor: a high-density pedestrian area and a major transportation node.

Figure: Sub-Arterial Roads

Data Collection

Primary Data Sources

• Peak-hour traffic volume counts, both manual and automated, taken at certain junctions and mid-block spots.

Classification information for vehicles, including 2-wheelers, automobiles, buses, LCVs, and more.

• Estimates of the Passenger Car Unit (PCU):

IRC standards are used to convert vehicle counts to PCUs so that they may be compared to one another.

• Keeping track of driving habits, road conditions, encroachments, and kinds of junction controls by on-site observations.

Identifying the Elements That Have an Impact

1. Information on the Roadway's Width at Various Points
2. Overlooking Obligations
3. The condition of the pavement's surface extends

Using Google Earth for the purpose of digitizing the research area

In the field of urban transportation research, Google Earth is an incredibly useful and user-friendly tool for digitizing road networks. The chosen research region in Hyderabad's arterial and sub-arterial roadways were digitized using Google Earth for this project, allowing for precise mapping and geographical analysis.

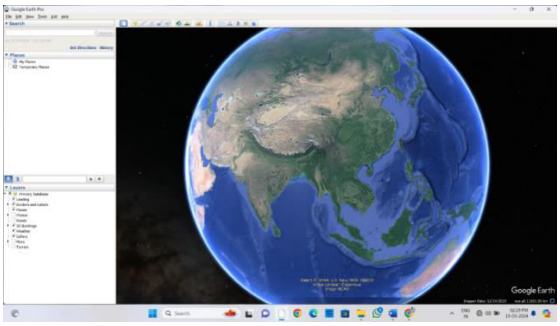

Figure: GUI of Google Earth Application

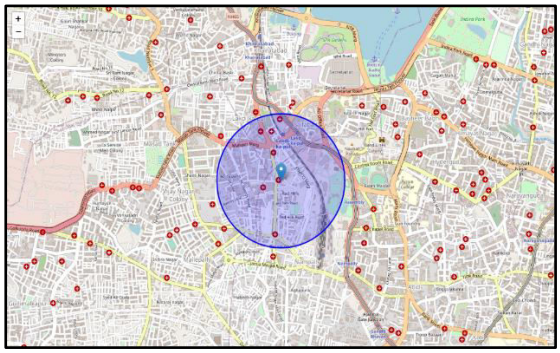

Figure: Earmarking of the extents of study area (NH-65 connecting Miyapur to LB Nagar) using tools menu in Google Earth

IV. RESULTS AND DISCUSSIONS

The results of the geographical study of traffic congestion on arterial and sub-arterial roads in Hyderabad, conducted using QGIS, are presented in this chapter. It explains the consequences for urban traffic management, identifies key congested zones, and emphasizes the transitional effects of several elements.

Figure: Loop Detectors for Vehicle Detection

4.1 Arterial Roads Traffic Volume Data

Urban mobility is largely supported by arterial highways in Hyderabad, which connect important residential, commercial, and institutional zones and handle large amounts of mixed-vehicle traffic. To gain crucial insight into current congestion patterns, traffic load distribution, and modal split, traffic volume analysis on important arterial corridors is conducted. These corridors include NH-65 (Miyapur to LB Nagar), PV Narasimha Rao Expressway (Mehdipatnam to Shamshabad Airport), the Inner Ring Road, and the Outer Ring Road (ORR). Presented below are the findings from traffic volume studies that were carried out at key

points along these routes. The numbers show how much traffic there was and how it changed over time and across various kinds of roads. The research finds high-stress traffic zones by combining this data with QGIS geospatial mapping, which helps with the development of targeted interventions to improve arterial road performance and decrease congestion in the metropolitan network.

Section 4.1.1 Information on Highway 65's Traffic Volume from Miyapur to LB Nagar

From its western terminus at LB Nagar to its eastern suburb of Miyapur, NH-65 is an important arterial corridor in Hyderabad. It goes through densely populated neighborhoods, metro stations, and important business districts. Peak load times, vehicle type distribution, and congestion severity are highlighted in this section, which provides the traffic volume data gathered across various critical places along this route.

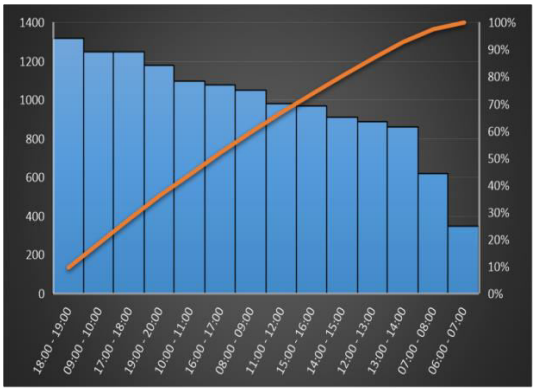

Figure: Traffic Volume Data on NH-65 (Miyapur to LB Nagar)

There are clear peak hours and patterns in traffic density when looking at the 24-hour traffic volume distribution along NH-65 (Miyapur to LB Nagar). Hourly vehicle counts are shown in the blue bar graph, while the cumulative proportion of total daily traffic is shown by the orange line. In order to aid with traffic management and the design of road infrastructure, this study helps to identify times of heavy congestion.

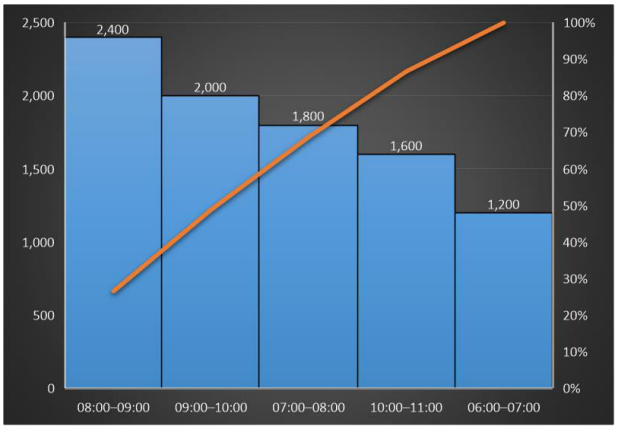

Figure: Traffic Volume Data on PV Narasimha Rao Expressway

From 6:00 to 11:00, the figure shows the PV Narasimha Rao Expressway's hourly traffic volume statistics in vehicle counts, covering the key morning peak time. The orange line shows the overall percentage of traffic observed during this time, while the blue bars show the hourly traffic volume. There is a larger concentration of passenger cars between 5:00 and 7:00 PM and 8:00 and 10:00 AM, according to studies on metropolitan expressways, which are also the times of peak traffic. Although the expressway is designed to handle this traffic effectively, there may be times when it becomes congested, particularly at entrance/exit locations or where the expressway meets adjacent routes.

The best places to get accurate and current traffic information for the PV Narasimha Rao Expressway are the local traffic police agency or the Hyderabad Metropolitan Development Authority (HMDA).

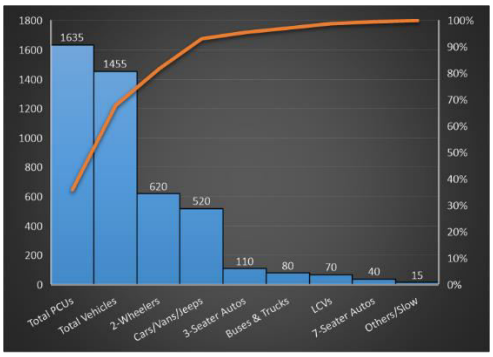

Figure: Route data for both the inner and outer rings

• The orange line represents the overall proportion of vehicles, which is used to identify the most significant traffic sources. The majority of traffic consists of 2-wheelers and cars, vans, and jeeps, as seen by the flattening of the curve following the cars, vans, and jeeps category. These two types of vehicles make up more than 78% of all vehicles on the road.

An indicator of a weighted metric for road space utilized, total PCUs (Passenger Car Units) are higher than the actual car count.

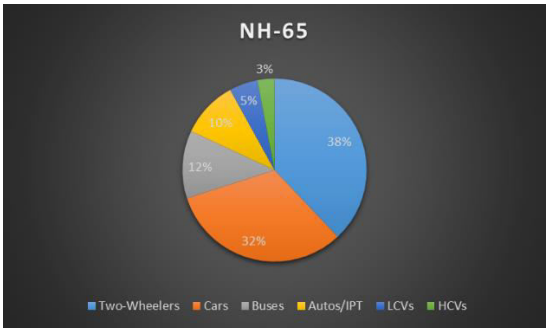

Figure: Traffic Volume Distribution by Vehicle Type

Discussion

• Mixed-use development and inadequate traffic management cause the worst congestion on NH-65. • The access-controlled PV Narasimha Rao Expressway performs better overall, although it is especially bad at entrance and departure locations. Upgrades to the infrastructure and traffic calming measures are necessary to achieve a balance between flow and safety on the Inner Ring Road.

• Despite its vital role in freight transit, ORR is underused in portions; optimizing its function further may be achieved by enhancing logistical facilities.

4.2.1 Side Roads

The urban transportation system in Hyderabad relies heavily on sub-arterial roadways. Connecting main arterial roads to smaller streets, these roadways ease traffic flow inside the city and make them easier to reach. Because of the heavy traffic and quick urbanization of Hyderabad, sub-arterial roads play an essential role in directing traffic from main thoroughfares like the Inner and Outer Ring Roads (IRR & ORR) to residential, business, and institutional zones. Transferring traffic from major thoroughfares to smaller streets is the job of sub-arterial roadways. Route 36 (Jubilee Hills), the Tolichowki-

Gachibowli Link Road, and the Nampally to Koti corridor are all good examples. Due to significant foot traffic, limited width, and poorly managed intersections, these roadways often encounter congestion.

CONCLUSION

1. Roads in Hyderabad are classified and distributed spatially in a way that emphasizes the importance of arterial and sub-arterial roads for urban movement. Congestion, encroachments, mixed traffic, and restricted access control are common problems on arterial routes like NH-65, PV Narasimha Rao Expressway, and the Ring routes, which link important residential and business centers. Because of its feeder role and the heavy foot traffic they experience, sub-arterial roads like as Road No. 36 and the Tolichowki-Gachibowli Link Road are notoriously tiny and congested. Finding high-stress congestion zones and highlighting the influence of variables including land use patterns, junction density, and traffic mix, a QGIS-based spatial study of these roadways highlights these elements' transitional effects. To improve road network efficiency and reduce urban traffic congestion, this geographic information may help with targeted interventions and long-term policy planning.

Long-Term Goals:

1. Real-Time Traffic Data Integration: QGIS platform users may improve congestion mapping accuracy and enable dynamic traffic management by integrating real traffic inputs from GPS, CCTV, and IoT sensors.
2. Using GIS and Multi-Criteria Decision Analysis (MCDA), interventions may be prioritized according to environmental considerations, socio-economic effect, and feasibility.
3. Extending to Peripheral Zones: In order to better understand the new patterns of congestion caused by fast urban development, future research may broaden the scope of spatial study to include peri-urban and rural links.

Integration with traffic simulation tools (e.g., VISSIM) allows for the prediction of future congestion situations and the virtual testing of mitigation techniques prior to their actual deployment.

Some suggestions:

First, expand roads at recognized bottlenecks and eliminate encroachments; this is particularly important in sub-arterial parts like Tolichowki-Gachibowli.

2. Redesigning Intersections: To cut down on wait times and enhance traffic flow, upgrade intersections with roundabouts or grade separators where possible.

Encourage modal shift by setting aside specific lanes for non-motorized traffic, such as walkers, bicycles, and public transportation.

4. Implementing Intelligent Traffic Management Systems: In densely populated regions, optimize vehicle flow in real-time by using adaptive traffic signals and control systems

based on artificial intelligence. Fifth, enact parking limitations, congestion pricing, and incentives for carpooling in the worst-hit regions. This will help decrease the number of vehicles on the road.

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