URBAN TRANSPORTATION AND TRAFFIC REGULATION - FOR SUSTAINABLE TRANSPORT ADVANCEMENT IN GURUGRAM CITY

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ABSTRACT

The study is currently significant due to the poor condition of traffic management in Gurugram. Despite significant technological advancements across various domains in the previous decade, traffic management solutions remain rudimentary. A definitive structure for traffic operations is essential to address traffic delays, congestion, and parking management functions. Unplanned urban expansion has resulted in traffic issues in the urban region of Gurugram. The technology revolution, particularly in transportation, has transformed lifestyles in metropolitan areas. The absence of established goals and objectives, particularly in traffic management, may prove counterproductive. This document has outlined traffic management concerning time delays, congestion, parking, and operational frameworks, establishing clear vision and mission statements for the future. The framework aims to identify traffic management concerning accessibility and mobility, safety and security, economy, and environment. The planners have a more demanding job in the current context, where social planning and the integration of new technology in traffic and transport are of paramount importance.

KEYWORDS: Inadequacy, congestion, traffic delay, parking management, traffic management.

INTRODUCTION

Gurugram, a fast-urbanizing city in India's National Capital Region (NCR), has evolved from a little village on the outskirts into a significant economic center marked by rapid expansion in the corporate services, information technology, automotive, and related industries Srivastava, S. (2021). Its advantageous location next to Delhi, the country's capital, has sparked changes in land usage, population growth, and spatial expansion, making it an important hub in patterns of regional development. Recent estimates place Gurugram's urban population at over 4.3 million in 2025 (estimated), with both residential and commercial areas continuing to grow. A sharp increase in motorization rates and increased travel demand have coincided with such rapid urban growth.

The increase in personal car ownership in Gurugram has been mostly attributed to the growth of economic activity and rising household incomes. This has put strain on the city's transportation system, making traffic jams, travel delays, and worries about road safety worse. Bhardwaj et al. (2022). These patterns are reflected in the increase in motor vehicle registrations according to recent monthly data, there were 10,369 registered vehicles in Gurugram as of November 2025 (RTO, 2025), with sporadic variations in new registrations throughout the year. The growing number of cars has made urban mobility extremely difficult, exposing traffic flow inefficiencies and the capacity constraints of current road networks.

Patterns of land use and poor integration between urban planning and transportation systems exacerbate issues with traffic congestion and inefficient mobility. Jinollo, Habtemariam and Belete (2025). Urban travel issues have been exacerbated by uneven growth, growing urban expansion, high demand for private transportation, and comparatively few public transportation options. Lu and Chen (2009). These problems are made worse by poor planning and inadequate infrastructure upkeep, which raises the possibility of accidents and lengthens travel times, particularly during rush hours. Dulin et al. (2025).

For example, Balamohan (2000) highlighted the importance of trip generation, travel patterns, and land-use connections in urban mobility studies. In a similar Keith R. Johnson (2003), put forth thorough models for road maintenance and upgrading that are pertinent to enhancing roadway performance in metropolitan environments with rapid growth. While Shih-Lung (1984) developed GIS-based methods for analyzing household trip data, Lakshman Rao (2000) emphasized the effects of traffic, pollution, and hazardous travel conditions.

To promote evidence-based design in urban transport networks, Reginald Souleyrette (2003) made contributions to methods for vehicle categorization and traffic monitoring. This corpus of work offers a theoretical and methodological framework for analyzing the transport dynamics in Gurugram. Considering this, the current study examines how Gurugram's urban traffic performance, travel demand, and growing motorization interact to guide sustainable transportation design in developing Indian cities.

PROBLEM STATEMENT

The status of traffic management in India makes the study extremely important. Even though technology has advanced in practically every area over the past few decades, traffic management solutions are still in their infancy. Future transportation infrastructure, of which road traffic is a crucial component, must be developed state-of-the-art for the nation's overall development. Because of this, the study is highly valid given the current circumstances in Gurugram.

OBJECTIVES

- To research Gurugram's public transportation issue.
- To determine the research area's traffic, travel time, and delays.
- To recommend, control, and manage traffic congestion in the future.

METHODOLOGY AND SOURCE OF DATA

The investigation was conducted methodically by gathering a variety of data from numerous organizations and sources. The traffic police stations, various regional transport offices, the Municipal Corporation of Gurugram (MCG), and the Gurugram Development Authority (GMDA) have all provided secondary statistics on the number of traffic accidents. The Gurugram Municipal Development Authority's proposed maps from 2041, the comprehensive development plan, and the topo sheets from the Survey of India, Bangalore, were used to create the maps using Geographic Information System software. The spatial distribution and location of accident sites, traffic movement, etc. have all been analyzed using these data sets. This data has been added to GIS generating thematic maps using a set of software.

Residents' purchasing power has increased due to the quick expansion of economic activity, rising disposable incomes, and shifting lifestyle goals, which have accelerated motorization levels even more Duan et al. (2024). Gurugram's growth as a business, IT, and industrial center has strengthened consumer-focused travel habits, which has led to a rise in the use of private vehicles. As a result, the city's car population has increased at a startling rate. Around 1 lakh automobiles were registered in recent years, according to data from the Regional Transport Office (RTO), Gurugram. This represents a significant increase over previous decades. The number of motorized vehicles in Gurugram has been growing yearly, which has resulted in serious problems like traffic jams, poor service on main thoroughfares, longer travel times, problems with road safety, and pollution. The vehicle registration data, which is shown in Table 1 and illustrates the rise in motorized vehicles in Gurugram over time, reflects the trend of rapid motorization.

Table 1: Registration of Vehicles, Source: Parivahan

Type of Vehicles	2005	2010	2015	2020	2025
Two-Wheeler	22980	28606	35929	32212	56514
Light Motor Vehicle	12191	20759	23716	25384	40206
Medium Motor Vehicle	0	1	5	123	143
Heavy Motor Vehicle	0	2	1	30	78
Others	6	9	24	117	251
TOTAL	35177	49377	59675	57866	97192

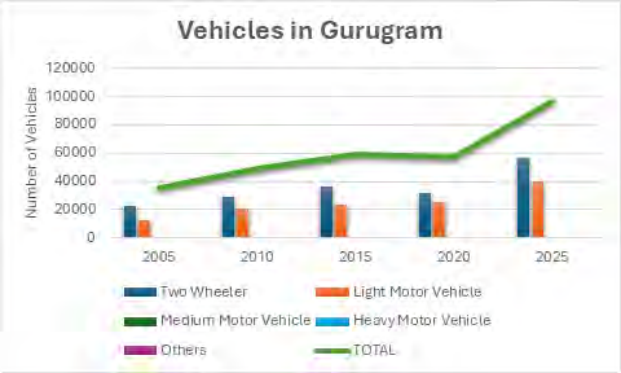

Figure 1: Registration of vehicles in Gurugram over the Decade

The data on registered vehicles in Gurugram over the last few decades indicate that two-wheelers constitute the largest share of registrations in the city. Two-wheeler registrations increased from 22,980 in 2005 to 28,606 in 2010, reflecting an average annual growth rate of 24.4%, which coincided with rapid economic expansion and growth in the real estate sector. Between 2010 and 2015, registrations rose further from 28,606 to 35,929, representing an average annual increase of 25.5%, again consistent with a booming local economy. In contrast, the period from 2015 to 2020 shows a decline from 35,929 to 32,212, corresponding to an average annual change of −10.3%, which may be associated with the economic disruption caused by the COVID-19 pandemic. Subsequently, registrations increased sharply from 32,212 in 2020 to 56,514 in 2025, approximately a 75.4% rise suggesting a strong recovery potentially supported by renewed economic activity and infrastructure development in the city. The LMV in the city showed annual growth after 2005 from 12191 to 20759 to 2010 by an increase of 70% percent annually. data for 2020 shows that there will be marginal decrease to 7% annually and the number is 40206 in 2025 which shows the tremendous growth in 4 wheelers 58.4% which will occupy more on roads and lead to congestion in traffic. The consistent rise in the number of medium motor vehicles, especially the sharp jump between 2015 and 2020 from 5 to 123 in numbers highlights a transformation in transportation needs and business operations. The curve little flattens post-2020, possibly due to market saturation, stabilization in demand, or a shift toward alternative transport methods, such as electric or shared freight systems. The registration of Heavy Motor Vehicles in Gurugram saw a massive spike after 2015, driven by industrial expansion, infrastructure projects, and its key position in the Northern India logistics network. From just 1 vehicle in 2015 to 78 in 2025, the growth indicates a booming demand for large-capacity transport in a rapidly urbanizing and economically active region. The trend reflects Gurugram’s evolution from a corporate hub to a major logistics and construction powerhouse. As of now 97,192 registered vehicles are on the road of Gurugram with an increase of nearly 30,000 vehicles yearly which causes serving problems on the roads.

STUDY AREA

One of the fastest-growing cities in the Indian state of Haryana, Gurugram is a part of the National Capital Region (NCR). According to the 2011 India census, the city's population was 10.08 lakh. An estimated 16.82 lakh people live in the GMUC research region as of 2019. According to the Gurugram-Manesar Urban Complex (GMUC) Final Development Plan 2031, it is anticipated to increase to 42.5 lakh by that year. With defensive land excluded, the study area is 338 km2. The GMUC area's proposed total gross population density is 126 PPHa.

As of right now, Gurugram has the third-highest per capita income in all of India. Gurugram, sometimes referred to as Millennium City Shown in Fig 2, is home to over 250 Fortune 500 enterprises. The first business to establish a car manufacturing facility in the city in the 1970s was Maruti Suzuki Limited. In the 1980s, large tracts of land in the city were purchased by DLF Limited and other real estate firms. By offering outsourcing solutions in software, IT, service, and sales through delivery facilities and call centers, Gurugram has become one of the world's most significant offshoring hubs. With about 260 big and medium-sized industrial facilities and 8,000 small-scale facilities in the region, Gurugram's industrial sector has grown thanks to the government's comprehensive strategy to build industrial infrastructure.

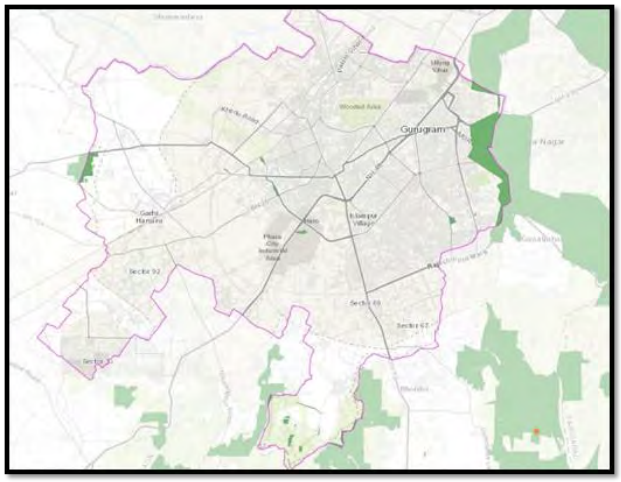

Figure 2: Study Area Map

TRANSPORT PLANNING AND MANAGEMENT

Due to the limited amount of land available for expansion, there is also evidence that the city's physical growth needs to be controlled. Therefore, the efficient operation of the city requires the provision of an efficient transportation system. The inadequacy of the public municipal bus services is demonstrated by the fact that private vehicles significantly outnumber government public carriers like buses. To avoid delays and reach where they want to go, people have obviously started driving their own cars. An inventory of approximately 953 km of roads, including collectors, arterial, sub-arterial, and expressway streets. Nearly 75% of all intercity (external) traffic movement is headed from external areas to internal areas, and 25% is headed from external-to-external locations (through), according to traffic pattern analysis. To reduce the burden of traffic on the city network, alternative regional road connectivity must be developed. 16.82 lakh people are expected to live in the study region in 2019. According to estimates, the average household size in the research area is 3.8 individuals. Transportation costs account for around 10% of the average household's monthly income of Rs 24,652. While 23% of families own cars, almost 65% own two private wheelers. In the research area, an estimated 21.88 lakh motorized intra-city journeys are made per day. When walking is included, the per capita trip rate (PCTR) is 1.90; when walking is not, it is 1.30. Walking accounts for 33% of all journeys, whereas public transportation accounts for 9%. Work-related travel accounts for about 57% of travel, with education-related travel coming in second at 29%. 14% of journeys, excluding walks, are made by public transportation, compared to 41% and 20% for two-wheelers and autos, respectively. The average trip duration is 6.8 kilometers. The average travel length varies depending on the method of transportation: 7 km for buses, 5.5 km for two-wheelers, and 9.1 km for cars. While cars are occasionally utilized for intercity transportation, two-wheelers are primarily employed for intra-city transit. Due to inadequate intra-city bus services, there is a significant reliance on customized forms of transportation, which causes traffic jams and low environmental quality. The average walkability score for the study area is assessed to be 0.68, indicating a generally poor state, even though 33% of walks occur in Gurugram. Appropriate targeted measures are urgently needed to improve the overall walkability index. Major traffic problems and issues in the city are as mentioned below:

- There is a lack of hierarchy of road network within the study area.
- A significant number of people travel daily between Gurugram and Delhi & beyond, but there are only two direct road linkages between them to carry the traffic.
- In the absence of alternative networks, the major roads in the city are congested because of funnel effect.
- A significant volume of inter-city traffic is through. In nature however, there is owing to the absence of bypasses the entire traffic passes through the middle of the city.
- The road intersections are inadequately designed, and traffic management is poor.

The CMP suggests a strategic change to increase last-mile connectivity and greater integration with the current metro rail services to strengthen public transportation systems, especially the city bus network, to address these problems. By promoting safer and ongoing infrastructure for bicyclists and pedestrians, the plan also highlights the importance of non-motorized transportation (NMT). Additionally, traffic management strategies are recognized as essential instruments for enhancing operational efficiency. These strategies include junction enhancements, corridor optimization, parking regulation, and the application of intelligent transportation systems. Although the CMP outlines long-term mobility goals in detail, its recommendations are still mostly strategic. There is little information on institutional coordination,

performance monitoring systems, and phased deployment. Consequently, it is still difficult to translate policy intent into consistent results on the ground. The fact that Gurugram residents are subjected to air and noise pollution that exceeds allowable levels is much more crucial to consider. The increasing number of automobiles, especially two-wheelers, and poorly maintained public transportation vehicles are blamed for pollution. According to the CPCB Central Pollution Control Board report, levels of coarse particulate matter (PM10) (212 ug/m3 against acceptable 100 ug/m3) and fine particulate matter (PM2.5) (106 micrograms per cubic meter against permissible 60 micrograms per cubic meter) The State's cultural center has noise levels between 75 and 80 db. The levels are obviously much higher than what is allowed. The government organizations in charge of health and medical treatment are quite concerned about the clear health effects of air and noise pollution. Growing more trees, controlling traffic, and maintaining cars properly are all recommended ways to reduce the sharply rising pollution levels. The two areas of transport planning and management are included in the study and recommendations. Road upkeep, underpass design, subway parking lots, flyovers, and quick and effective public transportation are all still on paper, demonstrating the enormous aspirations of the people of Gurugram.

RESOLVING TRANSPORT PROBLEMS

Gurugram city is beset with problems of transport, as has been clearly demonstrated by the analysis of traffic flow and patterns during peak and non-peak hours in all seasons. The key issues that have emerged from the study are:

- Public transport, or rather the delays and inefficiencies in reaching destinations.
- Traffic congestion, frequent traffic violations, and the challenges associated with their control.

RESOLVING PUBLIC TRANSPORT DELAYS AND TRAFFIC CONGESTION

The individuals commuting and visiting from outside the city need to reach their intended locations punctually. Achieving this requires alleviating the traffic congestion on the routes leading into the city. Ring roads have demonstrated effectiveness in easing traffic flow by accommodating freight vehicles; however, there exists a threshold beyond which they cease to alleviate congestion on urban roads. Considering the anticipated rise in the number of private automobiles, including motorbikes and cars particularly the late over the forthcoming years, it is essential to initiate the construction of freeways surrounding the city. These freeways should facilitate the influx of traffic through multiple access points into the urban area.

This approach might extend the duration of the journey more than necessary; however, individuals will ultimately arrive at their desired locations on time. Public transportation serves as a viable substitute for the expensive option of private transport, if it is reliable for timely travel and reaching destinations promptly. If this reliability is achieved, there may be a slowdown in the rise of private vehicle ownership, as many middle-class individuals would prefer the more economical, efficient, and trustworthy public transit system. The core issue seems to stem from the fact that both public and private bus terminals are positioned centrally within the city, resulting in a substantial volume of buses operating toward these locations throughout the day and night. A practical solution to this dilemma would be to relocate the bus terminals, both public and private, to the outskirts of the city, creating access points from which individuals can utilize town buses or private vehicles to reach the city center. This strategy has proven effective in other regions of the country to alleviate urban congestion. It would be feasible to establish multiple central bus stations on the outskirts, halting bus traffic at the city's entries, such as one along the Delhi-Jaipur expressway, another along the Pataudi road, and a third along the Faruknagar road, as examples. The adoption of the Bus Rapid Transit System (BRTS) in the Central Business District (CBD) and suburban areas decreases the significant number of two-wheelers, particularly during peak congestion times, which leads to traffic jams causing substantial delays, accidents, and various forms of pollution. Additionally, the pollution generated by these vehicles poses serious concerns for both the community and local authorities. It is imperative that state or local governments offer citizens alternative, economical, and superior transportation options. The Bus Rapid Transit System (BRTS) represents one such initiative aimed at diminishing the prevalence of private vehicles in urban areas. Consequently, it is essential to enhance effective bus transit services in Gurugram city during peak hours. Ultimately, this paper presents a range of viable strategies aimed at establishing a sustainable public transportation environment, ensuring ongoing transportation development in Gurugram city.

CONCLUSION, SUGGESTION AND SCOPE FOR FUTURE WORK ON URBAN TRANSPORT IN GURUGRAM CITY

There are nearly 97,192 vehicles choking the city lung spaces. The vehicles have been increasing in multiple ratios, but the land is stagnant. The transportation land use has not shown changes on par with the vehicles. The prospect is that the Gurugram city roads would change for worse, if the boom city becomes accepted as the next most attractive hub to Bangalore. It appears that the 953 km road network of the city has hardly seen any efforts to manage and maintain its strength and quality (Nagaraj, 2007). But the city has been managing the transport problems even if inefficiently so far and there is scope and hope for the future, for two reasons: the City Government cannot any longer ignore transport planning and development and must gear up sooner or later for developing a plan for transport and its management and newer thinking is emerging with the public becoming aware of the situation and participating in decision making. The local government in the Gurugram city

Corporation and the City bus service (GMCBL) has to think of planning and would emerge as the most significant planning and management exercise in the future by taking into consideration of the following studies such as Encourage carpooling, Implementation of BRTS, Incremental technologies for traffic signal hardware, Parking control standardization, Automated toll collection for buses, Bus lane implementation, Better signs, route maps and signals, passenger information systems in the form of variable message signs, Efficient licensing systems, Trials for applicability of 'Area traffic control systems', segregation of traffic towards various arterials, installation of LED based signals, synchronization of traffic signals, construction of flyover, installation of cameras and sensors on ring road and maintain a control room, Variable signs to be installed at vital positions for incident messages, real time traffic speeds, traffic situation in the area to be reported on radios, television. Enforce strict lane discipline for buses in areas of Gurugram city. This may bring about a synergetic transformation in the commuter, through these technologies. It may lead to benefits, including the reduction of commuter waiting time, fuel consumption, emissions, traffic congestion, operational costs etc. It will increase the accessibility of the system, safety of users, and improve traffic efficiency, environmental quality, energy efficiency, and economic productivity.

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