International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 07 | July - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

Traffic Volume Study and Analysis at Major Road Network in an Urban Area

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Abstract

Traffic volume is a significant method to study the time and movement of vehicles on the road. The study was carried out at six different sampling sites in Greater Noida. The current study effectively analyzed the peak hours of several roadways using traffic flow per hour. To perform this study, the traffic flow per hour in the research region was calculated using both manual and video camera (photographic) approaches. Additionally, PCU (Passenger Car Unit) data was utilized to examine how urban roadways were used. According to PCU data, there are a lot of two-wheelers in Greater Noida, with 206 PCUs in total. This indicates that a lot of two-wheelers use the city's roadways. The results of the PCUs show that the 2-wheelers are the major contributor to urban air pollution. As 2-wheelers use petrol as their fuel, the composition of their exhaust emissions is like that of gasoline-operated vehicle emissions.

Keywords: - *Traffic Volume, Vehicular Emission, Roadways, Passenger Car Unit,*

1. Introduction

Air pollution is a worldwide problem and is reported to cause the greatest damage to the health of living thing especially in the Asian countries [1]. Most of the metropolis cities like Delhi, Mumbai, Kolkata, and Chennai of India are being suffered from the tremendously high concentration of air contaminants [2]. Air pollution is fast becoming an issue of regional as well as global concern. The situation seems far worse in developing countries, which constitute some of the world's fastest growing urban regions. In these regions, pollutant concentrations and exposures are consistently higher than WHO permissible limits because of burgeoning industrial activities, an overreliance on dirty fuels (like wood, coal, and residual furnace oil) for power generation and other industrial activities, a lack of essential awareness regarding healthcare, inadequate air quality standards, and outdated technologies [3].

Transport is essential in the lives of communities and individuals: how people interact, work, play, organize, produce, develop towns, and have access to services, utilities, and goods is inextricably linked to the growth of mobility and the choices they make about it [4]. It make a major contribution to pollution through discharge (exhaust pipe) and non-exhaust pollutants [5]Vehicles exhaust fumes emissions and road dust resuspension have been recognized as the two main sources of particulate matter (PM) in the urban atmosphere (60–80%) [7][8]). Policy and decision-makers have been employed together in recent years to lessen the influence of the transport sector on air contamination by enacting production standards and advising the adoption of contamination control skills; however, vehicular releases have not been drastically decreased due to an increase in motor

population and its consequent contribution to road dust releases [9][10]. In recent years, the massive expansion of heavyweight transportation convoys city infrastructures has resulted in amplified traffic flow cramming and discharges.

One of the major reasons for urban atmospheric contamination is traffic-related air contamination [11-14]Among the main causes of this situation is an intensification in the number of obsolete automobiles [15] a development plan that does not keep up with the fast resident's growth, and a rustic evacuation. Transportation needs have increased in tandem with expansion, industrial development, and various marketable actions to see the demands of these exponentially growing residents [16].

The use of two-wheelers (motorcycles and scooters), which are easier and less costly than four-wheelers, has increased, especially in developing nations [17]. There are now more than 500 million autos in the world, up from an estimated 53 million in 1950; an additional 19 million cars are added annually [18]. Higher emissions are a result of several factors, including car ageing, poor performance, and poor maintenance. Congestion is made worse by narrow roads, frequent gridlock, bad geometry, and traffic, which is bad for the climate and human health. Emissions from two- and three-wheelers are roughly double that of all other sources. According to researchers, urban air pollutants cause 800,000 deaths each year.

Traffic capacity is well-defined as the numeral of automobiles crossing a piece of highway per unit of period at any given time [19]. Today, one of the major global concerns is environmental pollution, with traffic volume cited as one of the reasons of air contamination in most parts of the world. Several factors contribute to environmental degradation, one of which is the release of greenhouse gases by industries and other man-made activities such as vehicle emissions. Rapid automobile development in India and other developing countries contribute to high levels of urban air pollution [20]. Aside from the key concern of increasing residents, our country's exponential rise in vehicular numbers as a result of the population explosion is commendable.

This can have a significant influence on human health, particularly in a city like Greater Noida, where mobbing near highways and poor traffic management can exacerbate the problem. Road surface scrape, road dust resuspension, vehicle constituent wear and tear, and tire clutch and brake wear are all non-exhaust discharge causes of particulate matter.

1.1 Urban Transportation

According to data from the last three decades, the number of vehicles doubles every decade, particularly in Asiatic nations, with 2% to 5% yearly evolution in other emerging and developed states. Emergent countries similar to ours may use more vehicles in the approaching years. It is believed that the advancement of the vehicular sector has contributed to major issues in developing countries such as financial disparity, health and welfare, ecological subjects, and so on.

The automobile industry has grown to be the largest user of petrochemical products. As per the report of World Energy Outlook, it is expected that the automobile industry in evolving countries will generate the majority of the income for economic development, as a request for petroleum products has increased from 8.7 crore barrels per day (mb/d) in 2010 to 99 (mb/d) in 2035. From the remaining inefficient, high-carbon energy scheme and carbon dioxide discharges, all countries may accept a new system. We must concentrate on air-noxious wastes because of the dramatic increase in the use of automobiles and fuel consumption, particularly in evolving nations.

It is required for governing air contamination in the atmosphere that air influence emissions from the stream of traffic to be measured on a consistent basis. Since the intensification of individual income and the enlargement of many cities, vehicular

mobbing has skyrocketed in developing countries [21] Air pollutants such as Nitrogen Oxides (NOx), Carbon Monoxide (CO), and Volatile Organic Compounds (VOC) are produced in streams of traffic, particularly in urban zones.

An effective measure to evade air impurities is to conduct a study on the rate of recurrence of emission of polluted noxious wastes in traffic flow corridors in cooperation with the local and national stages. Obtaining information on the proportion of toxic air waste emitted by vehicles only data on city expenses will not benefit to lessen the amount of air impurities; severe rules must be implemented. Polluted air is hazardous to humans because they breathe unclean air, which causes a variety of enduring diseases. Polluted air source has developed a threat to both developed and developing countries. "Key pollutants that contribute to air impairment include CO, NO_X, HC, and SO_2. Polluted fuels, particularly those cast off in transportation, have contributed to increased emissions, particularly in new engines.

1.3 Vehicular Population

In recent years, Asiatic republics have seen a surge in the manufacture of light and heavy vehicles, primarily in urban areas. Automobile exhaust emissions, such as passenger travel or moving goods, have become the primary cause of contaminated oxygen supply. The automobile industry contributes to air pollution, particularly in large cities. As usual, all vehicle types and the total automobile population appear to be growing at an exponential rate. Most cities are reported to have higher levels of pollutant emissions. The majority of automobiles are concentrated in urban areas. Rapid population movement and a rise in the number of automobiles in Greater Noida result in polluted air and urban mobilization.

1.4 Traffic volume and congestion

Motor vehicle emissions in congested areas have risen dramatically in recent years. Motor vehicles are always on the road and emit more CO_2. As a result, vehicle-induced turbulence is created by the speeding up of motorized vehicles. Automobile accumulation increases vehicle speed, which may cause an increase in vehicle acceleration; various discontinuing and starting release air impurities that depend on the engines used in the vehicles. Because of heavy traffic, metropolitan cities suffer from high levels of toxic waste, which also increases travel time. According to the data, carbon dioxide emissions occur primarily during peak morning and evening travel times.

2. Materials and Methods

2.1 Study Region

Greater Noida is a planned metropolis in the Gautam Buddha Nagar district of Uttar Pradesh (2011 Census of City Population) the city was established as an extension of the Noida area by the UP Industrial Region Development Act of 1976. (U.P. Act No. 6 of 1976). The Noida-Greater Noida Expressway connects two cities 30 kilometers south of Delhi and takes about half an hour to travel between them.

Heavy traffic is the main source of air contamination in Greater Noida. Greater Noida is an emerging city in Uttar Pradesh, and it is nearly connected to highways, which causes heavy vehicle movement on occasion, contributing to increased air pollution. Greater Noida is currently a developing and rapidly urbanizing city, so there is a lot of construction going on, which raises the level of air pollution.

According to Gautam Buddha Nagar Transport Department, there were over 0.1 million new vehicles registered in the year 2022, up from 77,825 the previous year, a 39.14% increase. According to a report by ARTO (Assistant Regional Transport Officer) of

Gautam Buddha Nagar, stated that the transportation department saw an increase in vehicle registrations in 2022, which were divided into two categories: non-transport (cars and bikes) and transport (trucks, buses, and goods carriers). In 2022, ARTO Gautam Buddha Nagar counted 97,382 non-transport vehicles and 10,911 transport vehicles. In the year 2021, 72,893 non-transport vehicles and 4,932 transport vehicles were registered.

Two-wheelers account for roughly 31% of total traffic in Greater Noida, while cars, jeeps, and vans account for 43.3 percent, buses account for 3.1 percent, three-wheelers account for 8.1 percent, cycles, and cycle rickshaws account for 2.2 percent, and cargo vehicles account for 12.3 percent.

2.2 Site Selection

For real-time monitoring six sampling locations were selected on the route of traffic density per day. Sampling was done with the frequency of thrice a week. The table below lists the monitoring locations as well as their coordinates.

Table 1 Sampling Sites Location

S. No.	Site Name	Type	Location
1	Sharda University	Arbitrary Road	28.4753° N, 77.4823° E
2	Rampur Jangir	Commercial Road	31.1790° N, 75.2603° E
3	Delta 1	Arbitrary Road	28.4784° N, 77.5256° E
4	Jagat Farm	Commercial Road	28.48083°N 77.49917°E
5	Surajpur-Kasna Road	Major Road	28.4467751°N 77.5294359°E
6	Beta 2	Residential Road	28.4848659 °N , 77.5134595°E

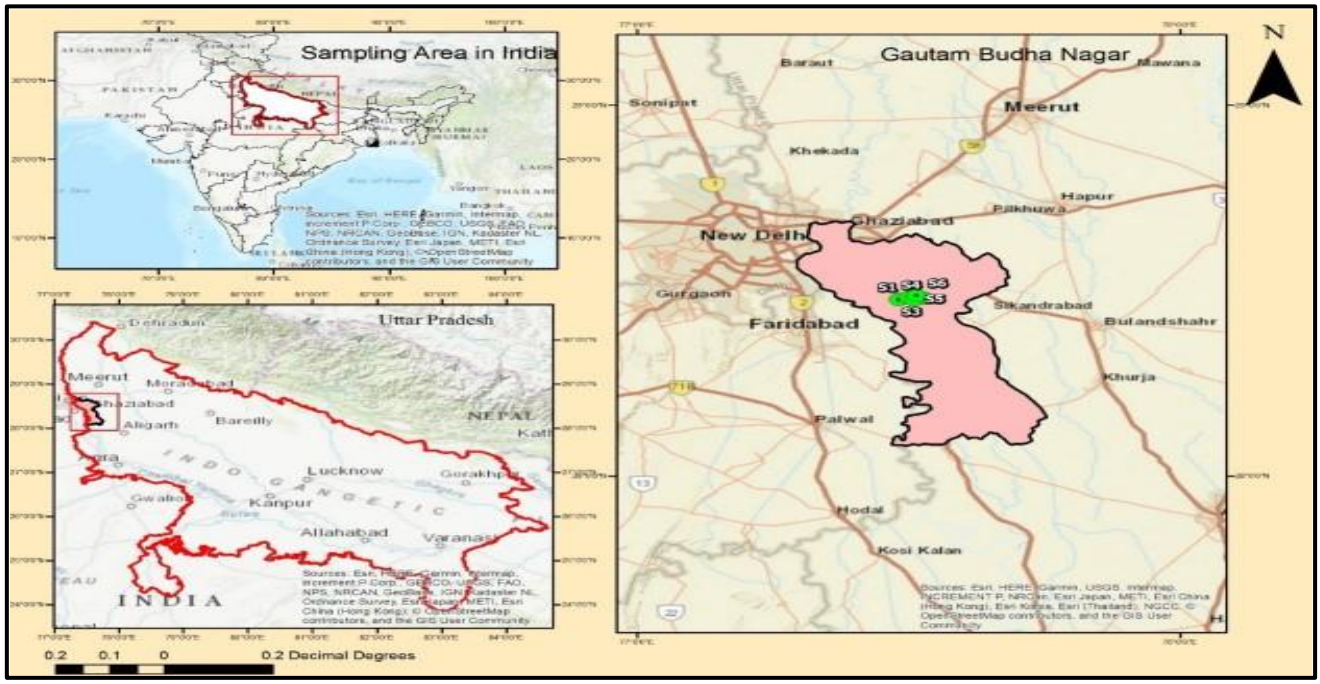


Figure 1 Location Map of Sampling Sites

3. Methodology Adopted

3.1 Traffic Volume Analysis

Traffic volume in the study area was calculated by using both manual and video camera (photographic) methods. A smartphone camera was used to make a traffic map in a specific location. Different datasheets are then created to account for hourly traffic variations. MS Excel was also used to create data sheets for PCU equivalents. According to IRC: 106-1990, corresponding Passenger Car Units (PCUs) for diverse vehicle groups are not continual in all circumstances. It is determined by the bodily extent and operating speed of each automobile class. In city areas, the speed difference between different vehicle classes is usually small, so the PCU factor is mainly determined by the physical dimensions of different vehicles. However, increasing the share of a particular vehicle type in total traffic affects the associated PCU. Considering all these factors, it is recommended to use the conversion factors given in Table 2.

Table 2 PCU Factors for Different Vehicles on Urban Roads

Vehicle Type	Equivalent PCU Factors
Fast Vehicles	
Two Wheelers Motor	0.5
Passenger Car	1.0
Auto-Rickshaw	1.2
Light Commercial Vehicle	1.4
Truck or Bus	2.2
Agricultural Tractor Trailer	4.0
Slow Vehicles	
Cycle	0.4
Cycle Rickshaw	1.5
Tonga	1.5
Hand Cart	2.0

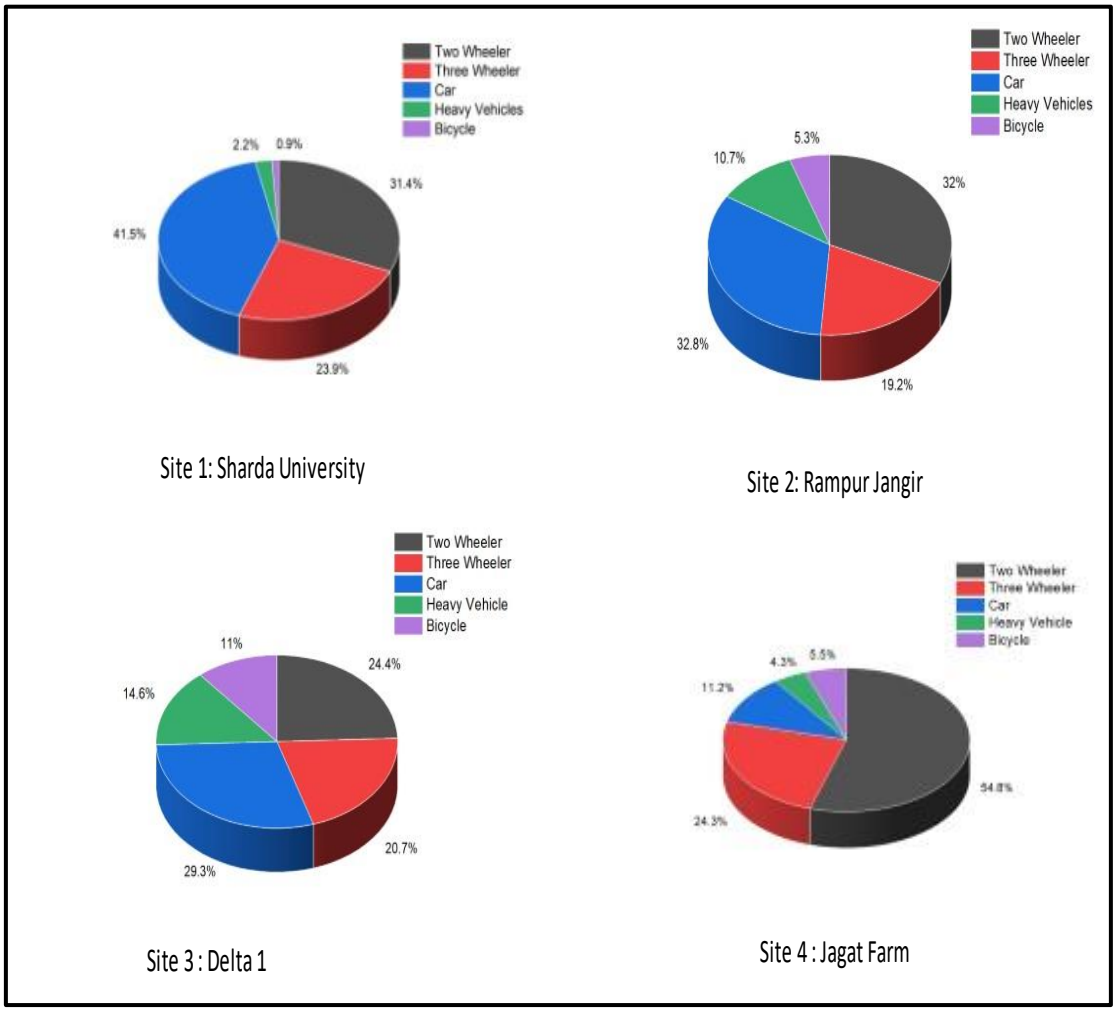
4. Result and Discussion

4.1 Vehicular Composition

The tally method was used to analyze video graphic data. A pie chart was created to show the composition of vehicles at various study locations during the study period. It was discovered that 2 wheelers are the most common mode of transport in Greater Noida. Surajpur Kasna Road has the highest vehicular flow per hour (834) with 417 two-wheelers accounting for approximately half of the total vehicular flow because it connects two major areas of Greater Noida. Sharda University has the lowest vehicular flow (318 vehicles per hour), with 41.3% being passenger cars, 31.4% being two-wheelers, 23.9% being three-wheelers, and the remainder being heavy vehicles and bicycles. The table below (Table 3) depicts the vehicular composition of various road corridors within Greater Noida, and the figure 2 depicts their graphical representation. The consequences show that 2-wheelers and 4-wheelers (Passenger Cars) contribute more to the adverse air quality in the nearby area.

Table 3 Vehicular Composition across different sampling sites of study area

Site No.	Site	Vehicular Composition					
		Two-Wheeler	Three-Wheeler	Passenger Car	Heavy Vehicles	Bicycles	Vehicular Flow/Hour
1	Sharda University	100	76	132	7	3	318
2	Rampur Jangir	150	90	154	50	25	469
3	Delta 1	100	85	120	60	45	410
4	Jagat Farm	230	102	47	18	23	420
5	Surajpur-Kasna Road	417	109	160	110	38	834
6	Beta 2	200	75	120	25	30	450



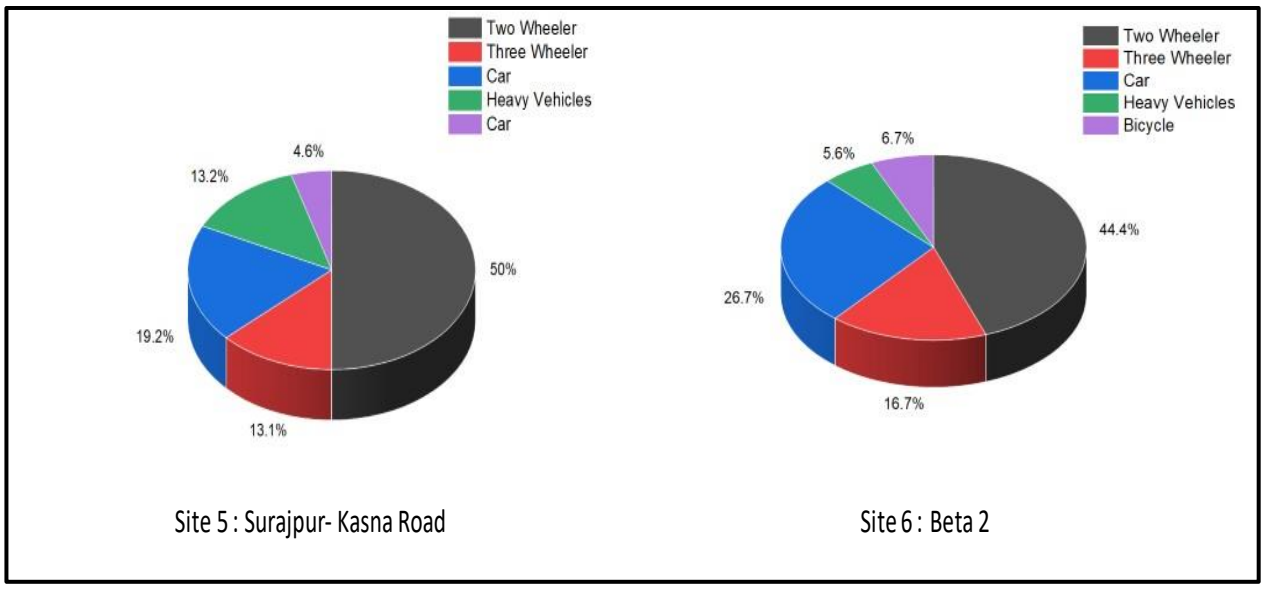


Figure 2 Vehicular Composition of different sampling sites in Greater Noida

4.2 Daily Traffic Volume

It's far better to trade the unit of visitors extent from automobile to passenger automobile unit (PCU) by making use of passenger automobile equivalencies when comparing different visitors volumes with one-of-a-kind traffic compositions at specific sampling web sites. The present study observations (Table 3 and Figure 3), underneath both comparable and combined site visitors conditions, the size of resistance to traffic float, measured in terms of PCU numbers, will increase at lower extent tiers. The increasing trend keeps until a certain volume level is reached, and then the PCU price begins to say no. furthermore, it's miles discovered that the array of variations of PCU cost for any precise challenge automobile is wide whilst the configuration of that car is low, and this decreases because the composition increases. the basis cause of the trend of version of PCU cost over extent (V/C ratio) and composition is the relative adjustments within the speeds of the reference automobile (automobile) and the subject car (for which PCU value is anticipated) at various visitors extent tiers as a result of the overall site visitors environment. in addition, in the contemporary study, the values of PCUs for heavy cars show growing developments on the decrease-stage volume at the diverse Greater Noida websites, as shown inside the determine underneath.

Table 3 PCU Equivalencies of different Vehicular Composition in Greater Noida

S.No	Sampling Site	PCU Equivalencies				
		Two Wheeler	Three Wheeler	Passenger Car	Heavy Vehicles	Bicycles
1	Sharda University	50	91.2	132	15.4	1.2
2	Rampur Jangir	75	108	154	110	10
3	Delta 1	50	102	120	132	18
4	Jagat Farm	115	122.4	47	39.6	18
5	Surajpur- Ksana Road	208.5	130.8	160	242	15.2
6	Beta 2	100	90	120	55	12

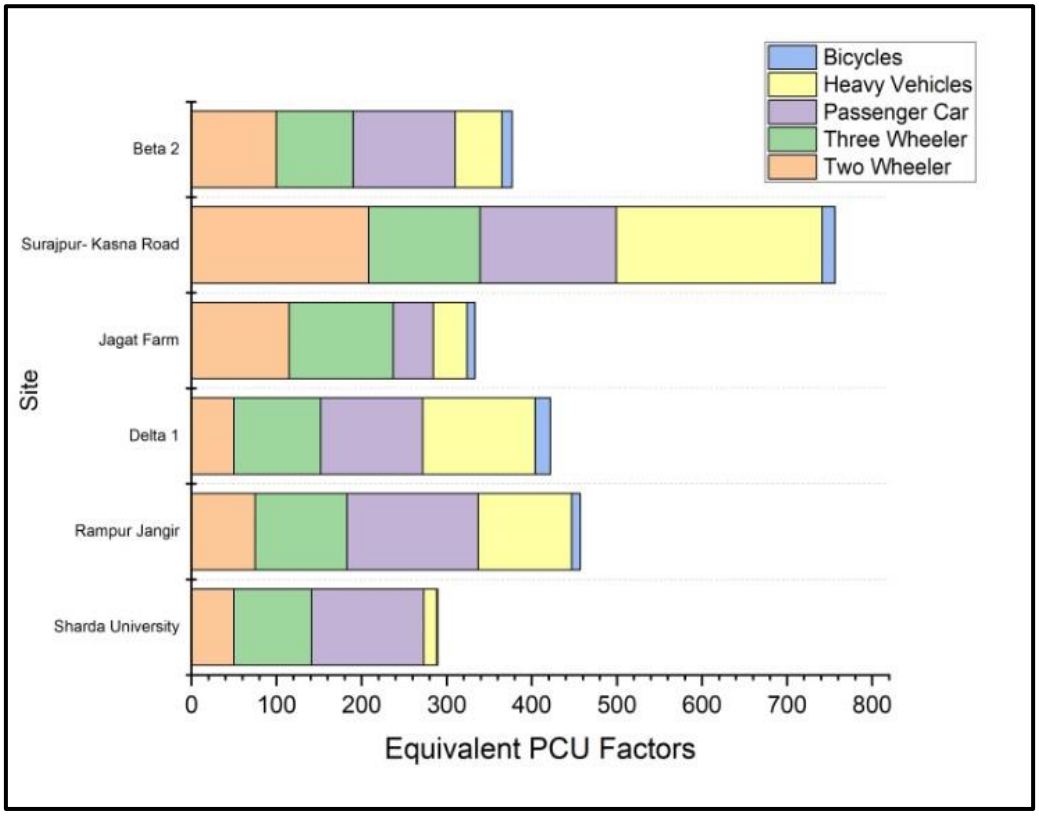


Figure 3 PCU Equivalencies at different Sampling Sites in Greater Noida

5. Conclusion

In this paper, the traffic data was converted into PCU equivalence to determine whether the traffic is heterogeneous or homogeneous. The results of the traffic volume analysis in terms of PCUs in the current study show that motorcycles and passenger cars are the most frequent users of the roads in Greater Noida.

Vehicular exhaust has a number of opposing effects on human health and the surrounding environment. As a result, it is critical to examine traffic volume samples effectively so that the government can frame new and stringent policies to control vehicle emissions in India. Modifying engine designs to avoid the emission of particulate and gaseous pollutants can help to reduce vehicle emissions. Crankcase vent pipes inserted into the engine are used to control these pollutants. Exhaust gas recirculation (EGR) and two-stage combustion are used to reduce nitrogen oxide emissions and thus reduce photochemical smog and acidic rain. The research will also assist policymakers in implementing policies that will aid in the reduction of air pollution in India.

Author contribution

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by [Naresh Kumar], [Suman]. The first draft of the manuscript was written by [Naresh Kumar] and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Data availability All data generated or analyzed during this study are included in this article.

Declarations

Funding The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

Financial Interest The authors have no relevant financial or non-financial interests to disclose.

Ethics approval Not applicable.

Consent to participate Not applicable.

Consent to publish Not applicable.

Conflict of interest The authors declare no competing interests.

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