Traffic Infrastructure in Kanpur

A comparative study of year 2015&2018

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By
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CERTIFICATE

This is to certify that the research work presented in the Ph.D Thesis entitled **"Traffic Infrastructure , in Kanpur a comparative study b/w 2015& 2018"** has been carried out by **Mr. Saurabh kumar** under my supervision and guidance.

He has fulfilled all the requirements for the degree of Masters in Arts in Geography, PPN P.G. College, CSJM University regarding nature and prescribed period of work. The work included in the thesis is all original and done by him.

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PREFACE

India is one of the fastest growing countries in the world after China and needs to maintain its growth momentum in a sustainable manner to improve its overall standard of living and reduce poverty.

Investment climate surveys like doing business in India repeatedly show that the limited and poor quality of **Transport infrastructure** facilities act as a major impediment to business growth in India. In this context, the present study analyses the current status and issues related to India's transport infrastructure, mainly roads.

The study finds that the major issues in **Transport infrastructure** in study area. Problem of Encroachment, Traffic load, traffic congestion, Movement of vehicles (24 hr. continuous Video recording),PCU value, mode of transportation, Composition of Vehicles,Road capacity,Preferred means of transport.

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Introduction

An efficient transport system is a pre-requisite for sustained economic development. It is a key infrastructural input for the growth process. The road transport plays an important role in promoting the development of the backward regions and integrating them with the mainstream economy by opening them to trade and investment. Roads are a crucial mode of transportation which connects long distances and also remote villages in country like India. Moreover, the road connection is also essential for other modes of transport

Transportation in India

Ancient texts and epics mention various modes of transport that were used in the Indian civilization. With the decent road system, people used different modes to cover long distances. The rich & influential in India often used horses for speedy movement. Palanquins, also known as palkis was one of the luxurious methods used by the rich and noblemen for travelling. This was primarily used in the past to carry a deity or idol of a God. Later it was used by noblemen and ladies from the upper classes of society. Modern use of palanquins is limited to wedding ceremonies and pilgrimage by the old. Hand-pulled rickshaw is still available in the city of Kolkata wherein a person pulls the rickshaw by hand. Bullock carts have been traditionally used for transport, especially in rural India. The arrival of the Europeans saw drastic improvements in the horse carriages which were used for transport since early days. Today, they are used in smaller towns and are referred as Tonga or buggies. Cycle and Cycle rickshaws were introduced in India in the 1940s. The latter are bigger than a tricycle where two people sit on an elevated seat

at the back and a person pedals from the front. Since 1947, they are providing the cheapest mode of transport. Public transport is the predominant mode of motorized local travel in cities. Buses take up over 90% of public transport in Indian cities and serve as a cheap and convenient mode of transport for all classes of society. Services are mostly run by state government owned transport corporations.

PALANQUINS

Early accounts of travel in India make frequent reference to the use of Palanquins/Palkis, The chair Palkis are similar to the European sedan. Indian Palanquins have a single thick pole usually of Bamboo from which the litter is suspended on two such poles each some four feet long, secured to the front and back of the palanquin by iron rods. The poles may be straight or curved and the ends are often capped in metal animal heads. The palanquin and dolie carried by men were also used in religious ceremonies. The Long Palanquin brought to India by the Europeans was used in towns, where they had settled, such as Kolkata, Chennai, Mumbai etc. It was of sturdy design & construction and had lanterns with four bearers. The Meeana Palanquin derived from the Hindustan-Persian word Miyana meaning middle–sized was developed for the Indian and Europeans. The Boutcha Palanquin was invention by the Indians. It resembles a sedan chair and is ornamented in copper. Its use is described in most of the religious institutions. The Chowpaul Palanquin is an open palanquin and its single bamboo pole is carried by four bearers, with an addition covering a bed of six or seven feet long and three feet wide with a small rail all around.

BULLOCK CARTS & HORSE CARRIAGE

Excavations at various ancient sites have led to the discovery of toy models of carts drawn by oxen. The bullock cart is pulled by one or several oxen used for carrying goods. The Arthasashtra, ancient treatise on administration, mentions palanquin and carts drawn by horses, camels and bullocks. In Mauryan times there was a superintendent of chariots and factories for the manufacture and maintenance of chariots and other types of carriage.

Rath Bullock Cart is attached to a bullock team by a special chain attached to yokes, but a rope may also be used for one or two animals. The driver and any other passengers sit on the front of the cart, while load is placed in the back. The cargo was usually agrarian goods and lumber in rural India. Tonga is a light carriage or curricle drawn by a single horse used for transportation in rural and urban India. They have a canopy over the carriage with a single pair of large wheels, which helps it to move fast. The passengers reach the seats from the rear while the driver sits in front of the carriage. This was a faster means of transport in rural India from early times. Horse Carriage was developed in the early 20th century by the Europeans who were fond of luxury travels in the cities.

A pulled rickshaw or a hand rickshaw is a mode of human-powered transport by which a runner draws a two-wheeled cart which seats one or two people. A modified version on the chassis of the cycle rickshaw is the new prototype utility vehicle used to carry goods. This also supplemented in some rural areas as a school rickshaw.

in 1905 by Herbert Austin. The Austin 20 was introduced after the end of the First World War in April 1919 & continued in production until 1930. The first model was referred to as the Austin 20/4. Before 1919 Austins were also expensive.

VINTAGE CAR

Sutomobiles arrived in India very early by the turn of the 19th century; various types and models were imported into the country. These cars were used by the royalty in India for rituals, ceremonies and weddings. In the early 20's and 30's India had no automobile industry and these expensive cars were brought in the country in a knocked down condition from Europe by sea and transported to various towns in the hinterland via rail. These kits were assembled in workshops to cater to the small market of the ruling elite and Indians. The presence of such vehicles led to the birth of an indigenous spare parts industry mostly concentrated

in the south of the country. Rolls-Royce Motor Cars Limited engineers, manufactures and distributes luxury automobiles and automobile parts worldwide. The Rolls-Royce Silver Ghost was the origin of Rolls-Royce's claim of making the "Best car in the world". The Austin Motor Company Limited was a British manufacturer founded in 1905 by Herbert Austin. The Austin 20 was introduced after the end of the First World War in April 1919 & continued in production until 1930. The first model was referred to as the Austin 20/4. Before 1919 Austins were also expensive

prestige cars, Chevrolet an American automobile manufacturer was founded by Louis Chevrolet & William C. Durant in 1911. The Chevrolet Series BA Confederate was launched in 1932. The company retained its lead in the American car sales table even during the Great Depression. The Series BA had the sloping windshield and either side of the hood had open vents, finished in distinctive chrome on DeLuxe models. The Ford Motor Company is an American automaker founded by Henry Ford and incorporated in 1903. The Ford line of cars was updated in 1937 with one major change i.e. introduction of an entry-level V8 in addition to the popular flathead V8.

PUBLIC TRANSPORT

Buses take up over 90% of public transport in Indian cities, and serve as a cheap and convenient mode of transport for all classes of society. Public transport remains the primary mode of transport for majority surface travel made by India's public in urban and rural India. City Tram transport in India was established by the British in the 19th century. Horse-drawn trams were first introduced in India in the early 19th century. The first electric tram service was started in Madras (Chennai) in 1895. Electric trams were subsequently introduced in Kolkata (1900), Mumbai (1907), Kanpur (1907) and Delhi (1908). In 1873, the Bombay Tramway Company Limited was given the license to operate trams in the city. The company started its service in 1874, with horse-drawn tram. The Calcutta Tramway Co. Ltd was formed in 1880. This is the oldest operating electric tram in Asia, running since 1902, and currently the only tramway in India. It provides an emission-free means of transport in Kolkata.

The first modern urban mass rapid transit system (metro) started operations as the Kolkata Metro in 1984. The Delhi Metro is India's second conventional metro which began operations in 2002, with a total length of 213 km connecting 120 stations (2016). This also connects the Rapid MetroRail of Gurgaon. The Namma Metro in Bangalore began operations in 2011, followed by Chennai in 2015. Metro systems are also planned for Jaipur, Lucknow, Kochi and Nagpur.

In 1926, the B.E.S.& T. Company (Bombay Electric Supply & Tramways Company Limited) introduced trolley buses or motor buses to supplement the tramway service in the city on experimental basis. In 1937 double-decker buses were introduced to cope with the growing traffic. The single-deck vehicle carried 36 passengers; the double- decker could take as many as 58.

1-Vehicular growth and availability of transport infrastructure in metropolitan cities

During the year 2009, 115 million vehicles were playing on Indian roads (Table 1). According to the statistics provided by the Ministry of Road Transport & Highways, Government of India, the annual rate of growth of motor vehicle population in India has been around 10% during last decade. The basic problem is not the number of vehicles in the country but their concentration in a few selected cities, particularly in metropolitan cities. From 1999 to 2009, number of vehicles per 1000 people in metropolitan cities has increased more than two-fold from 132 to 286 (Figure 1). Vehicle ownership rate, number of vehicles per 1000 people, in many big cities including Delhi has already crossed the mark of 400. There are at least 5 metropolitan cities having vehicle ownership rate in excess of 500. It is interesting to note that nearly 35% of the total vehicles in the country are plying in metropolitan cities alone, which constitute just around 11% of the total population. During the year 2009, nearly 15 million vehicles were plying in four big cities (Delhi, Bengaluru, Chennai, and Hyderabad) alone, which constitute 16.6% of all motor vehicles in the country (Table 2). Delhi, the capital of India, which contains around 1.4% of Indian population, accounts for nearly 7% of all motor vehicles in the country.Traffic composition in Indian cities is of a mixed nature.

There is a wide variety of about a dozen types of both slow and fast-moving vehicles. Two-wheelers[i] and cars account for over 85% of the vehicle population in most of the metropolitan cities. They account for at least 90% of total vehicles in Ahmedabad, Bhopal, Coimbatore, Delhi, Kanpur, Lucknow, Nagpur, Vadodara, Varanasi, and Vishakhapatnam. Two-wheelers alone account for more than 80% of the total vehicles in number of metropolitan cities. For example, during the year 2009, in Nagpur (84%), Varanasi (84%), Surat (83%),Coimbatore (83%), Madurai (82%), Bhopal (81%), Kanpur (81%), Vadodara (81%), Vishakhapatnam (81%), and Lucknow (80%), two-wheelers accounted for at least 80% of the total vehicles. Analysis of data presented in Table 3 reveals that, during the year 2009, the share of buses is negligible in most Indian cities as compared to personalized vehicles. For example, two-wheelers and cars together constitute at least 90% of the total vehicles in Ahmedabad (91%), Delhi (90%), Lucknow (93%), and Nagpur (91%)whereas in these cities buses constitute only 1%, 0.7%, 0.3%, and 0.4% respectively.

Table 1: Total number of registered motor vehicles in India: 1951-2009 (in thousands)

Year (as on 31st March)	All vehicles	Two-wheelers	Cars	Buses	Goods vehicles	Others
1951	306	27	159	34	82	4
1961	665	88	310	57	168	42
1971	1865	576	682	94	343	170
1981	5391	2618	1160	162	554	897
1991	21374	14200	2954	331	1356	2533
2001	54991	38556	7058	634	2948	5795
2002	58924	41581	7613	635	2974	6121
2003	67007	47519	8599	721	3492	6676
2004	72718	51922	9451	768	3749	6828
2005	81501	58799	10320	892	4031	**7457**
2006	89618	64743	11526	992	4436	7921
2007	96707	69129	12649	1350	5119	8460
2008	105353	75336	13950	1427	5601	9039
2009	114951	82402	15313	1486	6041	9710

Source: Transport Research Wing, Ministry of Road Transport & Highways, Government of India, New Delhi.
Road Transport Year Book (2007-09).

Table 2: Total number of registered motor vehicles in selected metropolitan cities in India: 1999-2009 (year as on 31st March and no. of vehicles in thousands)

Metropolitan cities	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	CAGR (%) 1999-2009
Ahmedabad	739	799	846	899	978	1075	1632	1780	1451	1586	1691	8.6
Bengaluru	1332	1550	1593	1680	1771	1891	2232	2617	2179	2640	3016	8.5
Chennai	1056	1150	1257	1356	1895	2015	2167	2338	2518	2701	2919	10.7
Delhi	3277	3423	3635	36S99	3971	4237	4186	4487	5492	5899	6302	6.8
Hyderabad	951	N.A.	N.A.	1241	1319	1356	1433	1522	2181	2444	2682	10.9
Jaipur	542	598	644	693	753	824	923	1051	1177	1289	1387	9.9
Kolkata	N.A.	N.A.	N.A.	801	842	875	911	948	987	573	581	9.5
Lucknow	N.A.	N.A.	465	556	615	N.A.	N.A.	N.A.	801	962	1025	9.0
Mumbai	911	970	1030	1069	1124	1199	1295	1394	1503	1605	1674	6.3
Nagpur	298	331	416	459	503	543	770	824	884	946	1009	13.0
Pune	568	593	620	658	697	755	827	874	930	1141	1153	7.3

Source: Transport Research Wing, Ministry of Road Transport & Highways, Government of India, New Delhi. Various Issues. *Motor Transport Statistics of India* and *Road Transport Year Book*.
Note: (1) N.A. indicates unavailability of data. (2) CAGR indicates compound annual growth rate. (3) From 2007 to 2008, there is a sudden drop in no. of vehicles registered in Kolkata because the Calcutta High Court in July 2008 ordered a ban on commercial vehicles registered before January 1, 1993 from Kolkata and its outskirts.

Table 3A: Private transport vehicles in selected metropolitan cities in India (as on 31st March 2000 and 2009)

Metropolitan cities	Two-wheelers (2000)	Two-wheelers (2009)	Two-wheelers CAGR (%)	Cars (2000)	Cars (2009)	Cars CAGR (%)
Ahmedabad	616738	1312601	8.75	104179	233320	9.37
Bengaluru	1164204	1946767	5.88	238374	586639	10.52
Chennai	848118	2017816	10.11	207860	511457	10.52
Delhi	2184581	3846721	6.49	869820	1881135	8.95
Hyderabad	757684	1836549	10.34	99314	426733	17.58
Jaipur	444889	1035999	9.85	76133	204871	11.63
Kolkata	298959	173891	-5.84	238560	313900	3.10
Lucknow	344268	825088	10.20	53069	142861	11.63
Mumbai	407306	909993	9.34	325473	509246	5.10
Nagpur	272734	850276	13.47	27573	94823	14.71
Pune	443266	831029	7.23	62885	147108	9.90

Source: Transport Research Wing, Ministry of Road Transport & Highways, Government of India, New Delhi. Various Issues. *Motor Transport Statistics of India* and *Road Transport Year Book*.
Note: (1) CAGR indicates compound annual growth rate. (2) Cars include jeeps

Table 3B: Public transport vehicles in selected metropolitan cities in India (as on 31st

March 2000 and 2009)

Metropolitan cities	Taxis (2000)	Taxis (2009)	Taxis CAGR (%) (2000-2009)	Buses (2000)	Buses (2009)	Buses CAGR (%) (2000-2009)
Ahmedabad	43865	94264	8.87	14993	17407	1.67
Bengaluru	77375	235525	13.17	6380	18176	12.34
Chennai	45016	136635	13.13	4409	34491	25.68
Delhi	104747	229991	9.13	37733	41142	0.97
Hyderabad	48898	110772	9.51	2539	22725	27.57
Jaipur	12513	33344	11.51	14362	18873	3.08
Kolkata	41946	49571	1.87	8586	6938	-2.34
Lucknow	15454	16010	0.39	2816	2794	-0.09
Mumbai	156261	161674	0.38	15414	13061	-1.82
Nagpur	10666	17436	5.61	2788	4160	4.55
Pune	44590	17533	-9.85	7827	12800	5.62

Source: Transport Research Wing, Ministry of Road Transport & Highways, Government of India, New Delhi. Various Issues. *Motor Transport Statistics of India* and *Road Transport Year Book*.
Note: (1) CAGR indicates compound annual growth rate. (2) Taxis include auto-rickshaws.

Road network is traditionally the backbone of Indian transport infrastructure. About 65 percent of all goods and 86 percent of total passenger traffic use road network in the country. The poor maintenance and congestion on roads contribute to substantial reduction of vehicular speeds, cause avoidable delays and inefficiencies in economy and trade. In road accidents, many of which are fatal, India unfortunately is at the top of the World. There is an urgent need to upgrade and modernize our road network, improve geometrics and maintenance, build world class expressways, highways, bridges, flyovers, footbridges and underpasses. A country-wide efficient road network is also essential for trade flows and achieving the vision of a Single National Market in India, so essential for the country's trade and economic integration.

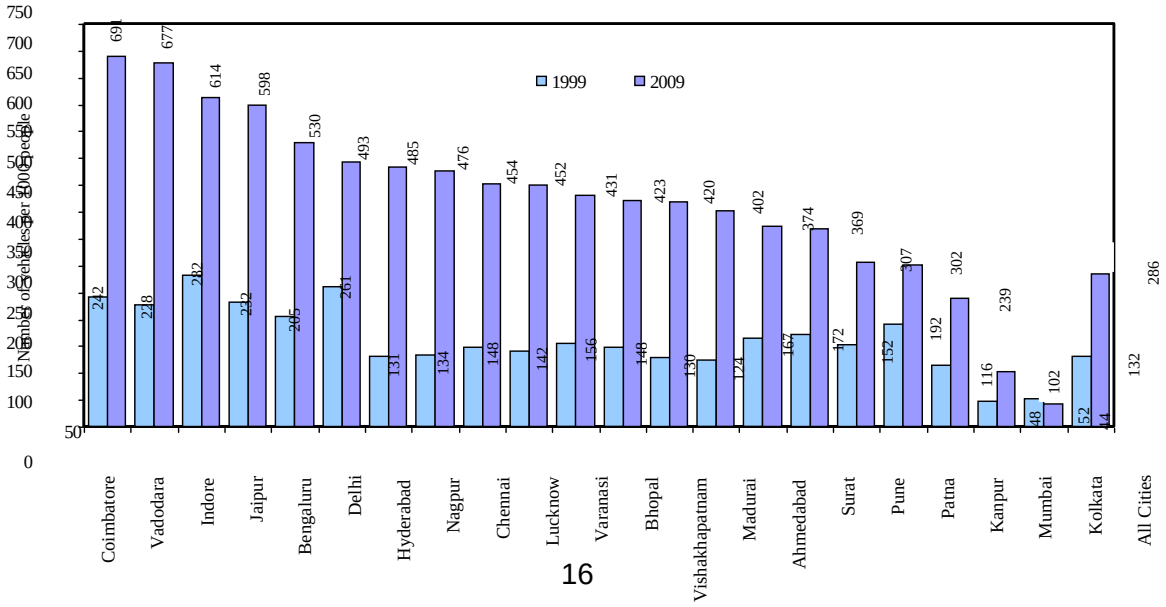


Figure 1: *Vehicle ownership rate in selected metropolitan cities in India: 1999-2009 Source: Transport Research Wing, Ministry of Road Transport & Highways, Government of India, New Delhi. Various Issues. Motor Transport Statistics of India and Road Transport Year Book.*

Table 3 reveals that, from 2000 to 2009, the growth in two-wheelers and cars is significantly higher than the growth in buses across metropolitan cities. For example, in Delhi, from 2000 to 2009, number of cars increased at the rate of 9% per year whereas number of buses grew only at the rate of 1% per year.

Moreover, availability of transport infrastructure is not only inadequate but also used suboptimally in Indian cities. The area occupied by roads and streets in Class – I cities (population more than 100,000) in India is only 16.1% of the total developed area while the corresponding figure for the United States of America is 28.19% (Singh, 2005). In general, the road space in Indian cities is grossly insufficient. To make the situation worse, most of the major roads and junctions are heavily encroached by parked vehicles, roadside hawkers, and pavement dwellers. As a consequence of these factors, already deficient space for movement of vehicles is further reduced.

The present urban rail services in India are extremely limited. Only four cities - Mumbai, Delhi, Kolkata and Chennai are served by suburban rail systems. The rail services in these four main cities together carry more than 7 million trips per day. Interestingly, the Mumbai Suburban Rail System alone carries about 5.5 million trips per day. A few other cities also have limited suburban rail systems but they hardly meet the large transport demand existing in these cities.

Although, few years back, bus transport services were available mainly in the cities located in southern and western regions of India, but they are now available in most of the metropolitan cities, thanks to the Government of India's Jawaharlal Nehru National Urban Renewal Mission (JNNURM). Services are mostly run by publicly owned State Transport Undertakings (STUs) or Municipal Transport Undertakings (MTUs). Most of the passenger buses use the standard truck engine and chassis and hence are not economical for city use. There are very few buses in India specifically designed for urban conditions. Qualitatively, the available

urban mass transport services are overcrowded, unreliable, and involve long waiting periods. Over-crowding in the public transport system is more pronounced in large cities where buses, which are designed to carry 40-50 passengers generally, carry double the capacity during peak hours. As a result, there is a massive shift towards personalized transport, specially two-wheelers and proliferation of various types of intermediate public transport modes such as auto- rickshaws, tempos, and taxis.

1-Urban Transport

India's urban population concentration in larger Class 1 (100,000+) and million plus cities has been steadily increasing, leading to greater challenges in urban transport. According to the 2011 census, a total of 468 Class i urban agglomerations/ cities are believed to constitute more than 70 per cent of the urban population. Given that the issues of urban transport and private vehicle use are essentially con- centrated in larger cities, this is an important base trend for projecting urban transport requirements.

Cities have witnessed increasing usage of private vehicles because they are yet to develop adequate public transport systems to meet increased travel requirements. Since 1991, the total number of regis- tered motor vehicles has gone up from 21 million to 142 million, a more than sixfold increase. Two wheel- er private transport has gone up from 14 million to 102 million, a rise of more than 13 times

Analysis of data on vehicles registered in india reveals that the share of buses has declined to 1.1 per cent of all registered vehicles in 2011 from 11.1 per cent in 1951. The decline has been particularly rapid in the last decade from 2000 to 2011, when the growth in two-wheelers and cars was significantly higher across metropolitan cities.

2-Transport Infrastructure in India: A comparative Picture

In this section, a comparative view of India's transport infrastructure vis-à-vis other countries has been presented to do an international benchmarking. Transport

Infrastructure in India has a share of 6.4 per cent in GDP and its demand has been accelerating over the years.

Roads

An important component of transport infrastructure is road transport. The Table-8 presents a comparative picture on road Infrastructure in India *vis-à-vis* other countries. The road length per square kilometer of land area is known as density of roads. It is evident from the table that road density has been increasing over the years in India. For instance road density in India stood at 714 per sq km of land area in 1991, increased to 1008 per sq km during 1991 and stood at 1171 per sq. km in 2007. Infact, among the BRIC economies, road density in India is quite high. In Asia, only two countries namely Singapore and Japan have a better road density than India. However, most highways in India are narrow and congested with poor surface quality, and 40 percent of India‘s villages do not have access to all- weathe roads

Another important element of roads is the paved roads as a percentage of total roads. Paved roads are those surfaced with crushed stone (macadam) and hydrocarbon binder or bituminized agents, with concrete, or with cobblestones, as a percentage of all the country's roads, measured in length. Table-8 also shows that paved roads as a percentage of total roads in India have remained almostthe

same at an average of about 47 per cent. However, in several other countries like Russia, Korea, Malaysia and Japan paved, roads as a percentage of the total roads are quite high as compared to India. In Singapore, paved roads as a percentage of total roads are 100 per cent followed by Malaysia and Russia where the percentage is more than 80 per cent. Further, goods transported by road are the volume of goods transported by road vehicles, measured in millions of metric tons times kilometers traveled. Goods transported are the maximum in China followed by India. But over the years, goods transported using road network is growing much faster in India along with China

*This fast increase in freight traffic in India creates much pressure on the existing roads and thereby there is a demand for new roads. Another important parameter highlighting the importance of road infrastructure is the energy consumption of roadways. Road sector energy consumption is the total energy used in the road sector including petroleum products, natural gas, electricity, and combustible renewable and waste. This percentage is high for countries like Malaysia, Korea and Japan and low for countries like China and India (4.8 per cent and 6.2 per cent) respectively (See Table-*4).

Table-4: Roads Transport in India: A Comparative Picture

	Road density (km of road per sq. km road of land area)			**Paved Road (% total)**			**Goods Transported (million ton-km)**			**Energy Consumption (% total energy consumption*)**		
	1991	2001	2007	1991	2001	2007	1991	2001	2008	1991	2001	**2008**
India	714	1008	1171	47.3	47.7	48.3	267000	615789	978234	7	6.1	**6.2**
China	123	151	360	34.2	40.2	49.6	321456	620050	1256788	2	4.4	**4.8**
Brazil	196	203	282	8.6	5.5	5.6	-	-	975420	21.5	22.9	**22.7**
Russia	54	32.80	35.3	75.8	NA	80.9	-	23300	199000	6.1	5.9	**6.1**
Malaysia	274	218	278	71.3	77.9	81.3	-	-	-	19.5	21.7	**18.5**
Korea	599	607	1020	76.4	76.7	77.6	341	565	12545	12.2	12.2	**12.6**
Singapore	4136	4453	4710	97.1	100	100	-	-	-	12.6	10	**9**
Japan	**3060**	**3214**	**3166**	**70.1**	**77.1**	**79.3**	**283776**	**313072**	**346420**	**15.1**	**15.5**	**14.2**

Source: WDI, Various Years

Notes :* % total energy used in the road sector to total energy consumption in the country.

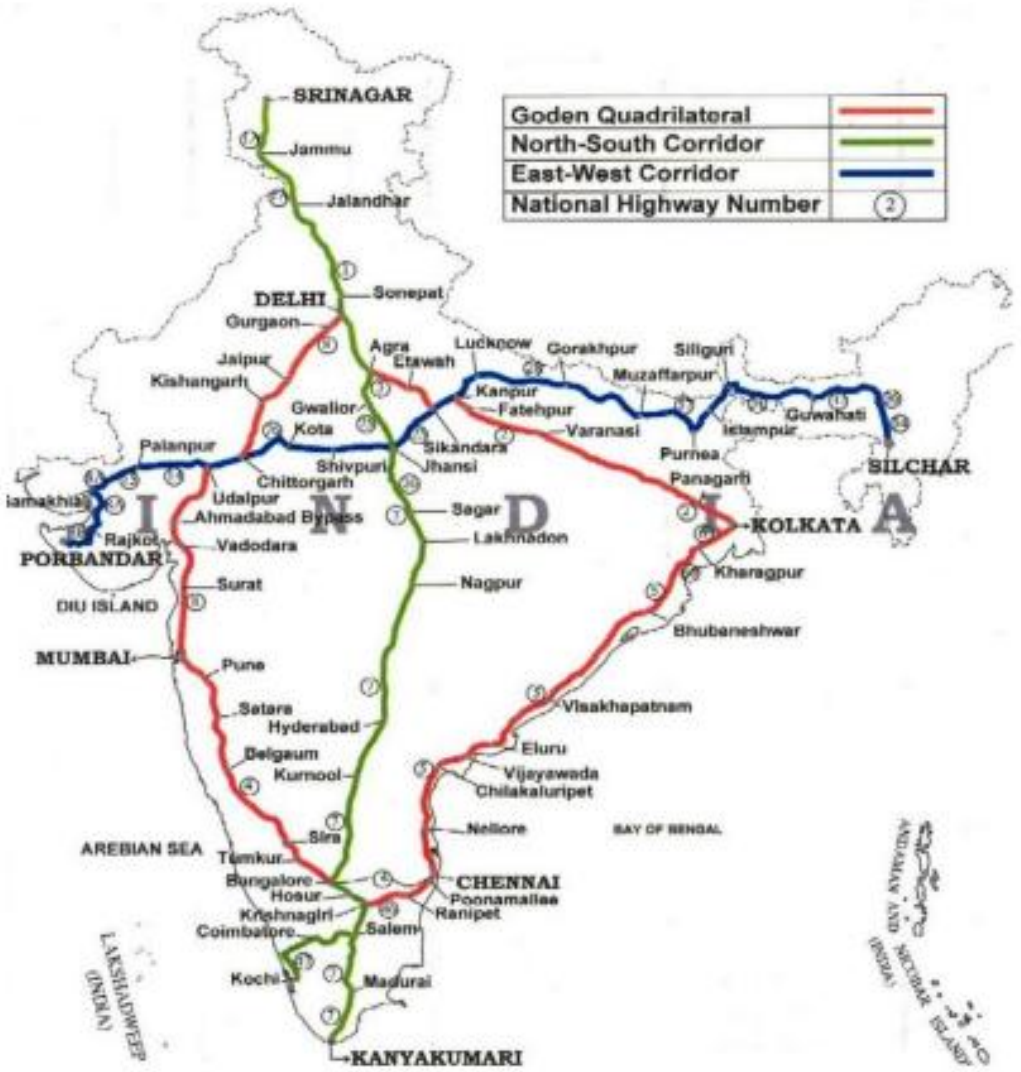


Figure:2 -Quadrilateral and North –south corridor

There are several other indicators which are used to analyse the importance and development of road infrastructure in the country. These include road length, passengers carried i.e. million passenger kilometers, vehicle per km of road, passenger cars per 1000 people etc. The total road length in India (in 000 kms) is comparable and almost on par with China and infact, better than countries like Japan and Singapore. Though the road length of India is one of the highest in the world, as mentioned before, the quality of roads is really poor compared with other developing and developed countries.

Table-5:Roads Transport in India: A Comparative Picture

	Total Road Length (_000'km)			Passenger Carried (million passenger-km)			Vehicle (per km of road)		Passenger Car (per 1000 people)		Per Capita Consumption (kt of Oil equivalent)		
	1991	2000	2007	1991	2001	2008	2002	2007	2002	2007	1991	2001	2008
India	2350	3316	3317	767700	2075700	725100	3	6.8	7.0	15	0	0	0
China	1230	1402	3583	-	720710	1150677	9	11.9	8	22.5	0	0	0
Brazil	1661	1724	-	-	-	78000	18	22	128	158.1	0.2	0.2	0.3
Russia	892	532	-	-	-	-	28.88	104	156	206	0.3	0.3	0.3
Malaysia	56	66	-	-		-	70	73.8	211	-	0.3	0.5	0.5
Korea	58	86	102	-	-	97854	145	160.6	205	248	0.2	0.5	0.6
Singapore	2	3	3.2	-	-	-	178	207	97	113	0.5	0.5	0.5
Japan	1115	1166	1196	869123	954294	905910	63	63.5	428	325	0.5	0.6	0.6

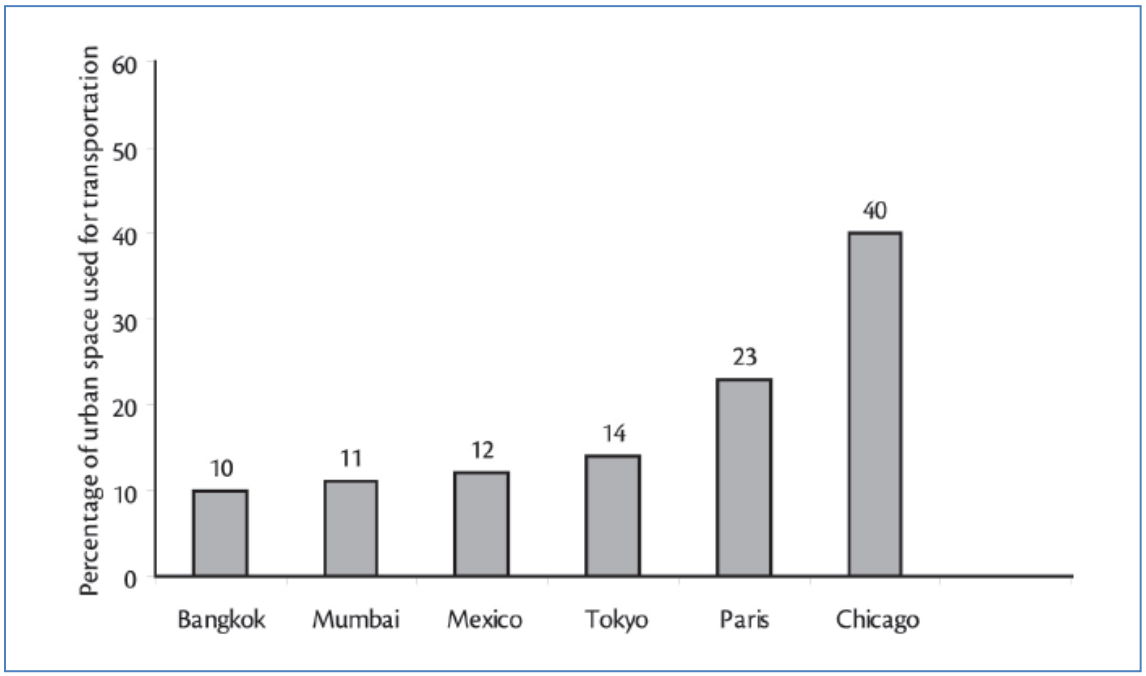
Source: WDI, Various Years

passengers per kilometer, the figure is quite high. Poor quality of road network and high passenger traffic along with high freight traffic shows the conditions of the Indian roads and the need for growing demand for more quality and quantity of road infrastructure. Given the present conditions, the fast growing vehicles (per K.M.) is going to create more congestion in coming years. See Table-9 for details. Overall, in almost all the other indicators, India has a long way to go as compared to China and other East and South East Asian

Transport Infrastructure in Indian Cities

The area occupied by roads and streets in Class I cities (population more than 100,000) in India is only 16.1 percent of the total developed area, while the corresponding figure for the United States is 28.19 percent. Interestingly, even in Mumbai, the commercial capital of India, the percentage of space used for transportation is far less when viewed in comparison to its counterparts in the developed world (Figu

Figure 3: Allocation of urban space for Transportation in City centres.



Source: Amsler 1996

In general, the road space in Indian cities is grossly insufficient. To make the situation worse, most of the major roads and junctions in Indian cities are heavily encroached by parked vehicles, roadside hawkers, and pavement dwellers. As a consequence of these factors, the already deficient space for movement of vehicles is further reduced. The present urban rail services in India are extremely limited. Only four cities (Mumbai, Delhi, Kolkata, and Chennai) are served by suburban rail systems. Rail services in these four main cities together carry more than 7 million trips per day. The Mumbai Suburban

Rail System alone carries about 5.5 million trips per day. A few other cities also have limited suburban rail systems but they hardly meet the large transport demand existing in these cities.

Jawaharlal Nehru National Urban Renewal Mission (JNNURM)

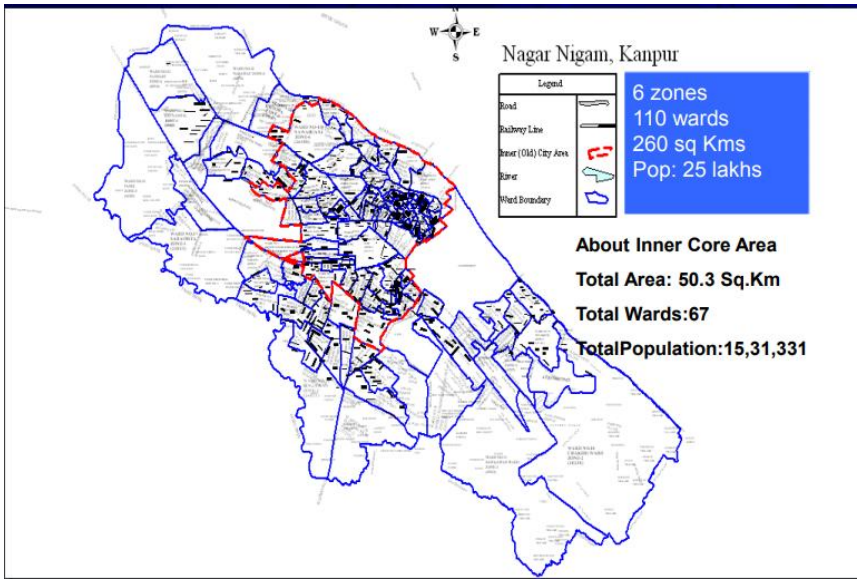
JNNURM was set up by the Government of India, and 63 cities were identified for urban renewal and reforms in phase I. JNNURM requires that all cities prepare a city development plan and all projects that are proposed are in tune with the city development plan. Moreover, JNNURM also requires that all proposed transport projects are compliant with NUTP. However, it is not clear that these conditions are being met and projects that are being funded promote public and non-motorized transport.

Introduction of Kanpur City

Kanpur is a metropolitan city, sprawling over an area of 260 sq km. According to the census 2001, Kanpur has a population of 25.51 lakhs. It is administratively divided into 6 zones and 110 wards with an average ward population range of 19000 to 26000. It is situated on the southern bank of Ganga River and has been an important place in the history of modern India. Kanpur is the biggest city of the State of Uttar Pradesh and is main centre of commercial and industrial activities. The City formerly known as Manchester of the country is now also called the commercial capital of the state. It is known for its cotton and woolen textile and leather industries. Kanpur is one of the biggest producers of Textile and Leather products. Apart from leather and textile industry, the fertilizer, chemicals, two wheelers, soaps, Pan Masala, hosiery and engineering industries are also operating prominently in the city. Kanpur is situated on the most important national highways no. 2 & 25 and on the main Delhi-Howrah railway trunk line. Kanpur is divided into two districts namely Kanpur-Nagar and Kanpur-Dehat. Kanpur comprises of 3 tehsil, 2 Municipal Board, 2 Nagar Panchayats

and 10 statutory Towns. Kanpur is also divisional headquarters of Kanpur commissionary consisting of Kanpur- Nagar, Kanpur-Dehat, Etawah, Auraiya, Farrukhabad and Kannauj districts. The town's population is nearly 2.5 million with an average annual growth rate of 2.6 per cent.

Figure 4: Kanpur Nagar (inner core city)



Linkage and Connectivity

Kanpur City is situated between the parallels of 25o26' and 26o58' north latitude and 79o31' and 80o34'east longitude. It is situated on the most important national highways no. 2 and 25 and state highway. It is also situated on the main Delhi-Howrah railway trunk line. It is situated on bank of holy river Ganga and is about 126 meters above the sea level. Within the city only one Civil Aerodrome is located at Kanpur Cantonment. Though presently there is no civilian air-service available for the city but a 9,000 feet air strip is available at civilian air terminal Chakeri (Ahirwan) which is approximately 11 km. away and one at I.I.T (Kalyanpur) which is 23 Km away. The nearest civilian air

port Amausi (Lucknow) is 65Km. away from Kanpur. Kanpur is connected by road with all the major cities of the country. It is situated on National Highway No. 2 on the Delhi-Agra-Allahabad-Calcutta route and on National Highway No. 25 on the Lucknow-Jhansi-Shivpuri route.It is located at the distance of 79 km from Lucknow, 193 km from Allahabad, 329 km from Varanasi, 398 km. Khajuraho, 269 km Agra and 222 kms from Jhansi.

Climate and Geology

Kanpur's climate is characterized by hot summer and dryness except in the south west monsoon season. The climate in Kanpur can be divided broadly into four seasons. The period from March to the mid of June is the summer season which is followed by the south-west monsoon, which lasts till the end of September, October and first half of November from the post -monsoon or transition period. The cold season spreads from about the middle of November to February. The climate is of a tropical nature and shade temperature varies from 20C to 480 C. Rainy season extends from June to September, with the period of maximum rainfall normally occurring during the months of July and August. About 89 percent of the annual rainfall is received during the monsoon months (June to September). The total rainfall in the district varies from between 450 mm to 750 mm. The annual rainfall in Kanpur Nagar was recorded 441 mm in actual in 2004 and 783 mm in general (Statistics Diary 2005). On an average there are 40 rainy days i.e. days with rainfall of 2.5 mm or more in a year in the district. This number varies from 35 mm at Narwal to 45 mm at Kanpur. The relative humidity varies from 15% to 85%. The relative humidity in Kanpur ranges from less than 30 percent in the summer season to 70 percent in monsoon season. The district lies in the Ganga basin which is formed of alluvium of the early quaternary period. In the district, no hard or consolidated rock exposures are encountered. The main constituents (sand, silt and clay) of alluvium occur in variable proportions in different sections. The mineral products of the district of saline earth from which salt petre and salt are derived and limestone conglomerates (U.P. District Gazetteers Kanpur).

Demography

Kanpur is the most important metropolis and biggest city of Uttar Pradesh. According to the 2011 census, the city had a population of 2,765,348 which made it the fifth most highly -populated city in India. Among the big towns of Uttar Pradesh, the growth of Kanpur has been phenomenal. It ranked third after Lucknow and Varanasi in 1901, but by 1961 it assumed a position on top of the list. It has registered an increase of over five times from 1,97,170 in 1901 to 8,83,815 in 1961 in the course of six decades. This is mainly due to its most central location in the state. Kanpur has benefited from its fertile agricultural hinterland of the Upper Ganga Valley and Bundelkhand plateau, the available developed links of transportation and the stimulant of World War-2 with its industrial demand. In spite of a low percentage of irrigated area, the density is quite high which is mainly due to industrial concentration

Population Growth Trends

As per census of 2011, Kanpur total population is 2,765,348 as compared to the 1,874,409 people registered in 1991. It may be observed that the average annual growth in population has increased to 3.5 percent during the period 1991-2011 from the average annual growth rate of 2.6 percent in the previous decade (1981-91) (Table 3.1). One of the factors for this kind of growth can be higher number of in-migration to Kanpur City from other areas. This growth rate is expected to continue in future. Out of total population, male population is 1,489,062 which is 53.8 percent and female population is 1,276,286 i.e. 46.15 percent. The household size is 6.71 persons per household which is very high (Census of India 2011).

Table6: Population Change in Kanpur.

YEAR	TOTAL POPULATION	DECADAL CHANGE	DECADAL GROWTH RATE
1951	638,734		
1961	883,815	245,081	38.36
1971	1,158,321	274,506	31.05
1981	1,481,789	323,468	27.92
1991	1,874,409	392,620	26.49
2001	2,551,337	657,728	35.08
2011	2,765,348	214,011	-

Source: Census of India 2011.

In the discussions, we have considered the area under the jurisdiction of Kanpur Nagar Nigam only. However, Kanpur Cantonment Board has been dealt separately in chapter 14. The Kanpur Urban Agglomeration as defined by the census of 2011, population is 2,765,348 and area is comprised of Kanpur Municipal area and outgrowth, Kanpur cantonment board, Armapur estate, northern railway colony and Chakeri.

Metropolitan Region Area

The metropolitan region defined under JNNURM by Kanpur Nagar Nigam, includes the Kanpur Nagar Nigam area, 8 kilometer around KNN boundary and newly included 47 villages of Unnao district on the north-eastern side, it spreads till murtaza nagar, in the west its limit is upto Akbarpur nagar panchayat limit, in the easte rn side the limit has been expanded on the road leading to Fatehpur and in extended upto. The metropolitan region area includes the area of shukla ganj nagar palika, Unnao nagar palika, Akbarpur nagar panchayat, Bithur nagar panchayat area.

Literature Review

Mr. Dhanendra kumar (2017) studied about Development of infrastructure in india. Basically he focused on transport infrastructure and how to eveluate new infrastructure .

Sultan Zhankaz (2016) studied aboutCurrent trends of road –traffic infrastructure Development.

Satish Chandra and Upendra Kumar (2002) Reported data were collected at ten sections of two-lane roads in different parts of India. All vehicles were divided into nine different categories and their PCU's were estimated at each road section. These data were analyzed and adjustment factors for lane width were calculated. V.Thamizh Arasan and Shriniwas S. Arkatkar (2010)reported traffic volume as number of vehicles passing a given section of road or traffic lane per unit time several types of vehicles with widely varying static and dynamic characteristics are comprised in the traffic.. This study is concerned with the estimation of PCU values of vehicles in such traffic conditions, using microscopic simulation. The PCU

values obtained for different types of vehicles, , show that the PCU value of vehicle significantly changes with change in traffic volume and width of roadway. Nguyen Y. Cao and Kazushi Sano (2012) Reported the accurate methodology of motorcycle equivalent units (MEUs) in mixed traffic flow. The values of capacity, maximum motorcycle flow, critical mean stream speed, and critical density of traffic flow were computed The capacity increse, increases with the number of lanes of urban roads. S. Anand and V.C. Sekhar (1999) reported Passenger Car Unit (PCU) value of each class of vehicle is very important for any mixed traffic flow studies at highways.. the PCU values is used for different classes of vehicles has been proposed for Malaysian roads Parvathy R, Sreelatha T, Reebu Z Koshy (2013) reported determine the PCU values for various types of vehicles, And therefore a comparison of results with PCU factors recommended by IRC code. It is found that the estimated PCU values are different from those being used in India, and they are indirectly related to the length of passenger car. Studies reveal that PCU values have a great impact on signal design, in this study can be used as a guideline in the design and analysis of signalized intersections.

Taragin and Eckhardt (1953) studied the effect of shoulder on speed and lateral placement of motor vehicles and found that when two lane pavements on main

highways are 6 m in width or less, shoulders should be constructed with at least 1.2 m of stabilized material, adjacent to pavement plus additional width of grass and gravel. Leong (1978) measured speeds and capacity at 31 sites on rural highways in New South Wales. The sites had varying lane and shoulder width and all sites had gravel shoulders. The data were analyzed using multiple regression and it was suggested that speed increased with increasing shoulder width. Prakash (1970) also observed that the highway capacity is considerably influenced by the type and width of shoulder. Farouki and Nixon (1976) studied the effect of carriageway width on speed of cars in the special case of free-flow conditions in sub-urban roads at Belfast. It was found that the mean free speed of cars in suburban area increases linearly with the carriageway width over a certain range of width (5.2 to 11.3 m). Turner et al. (1982) found that the conversion of a shoulder to an additional travel lane could be expected to increase average-speed of a two-lane highway by about 5 per cent for volumes exceeding 150 veh/h. Yagar and Aerde (1983)26 found that speed changes exponentially with change in lane width. Chandra and Kumar (1996) studied the effect of shoulder condition on speed of different types of vehicles and their placement on road during passing and overtaking maneuvers on single and two-lane highways. William and Reilly (1992) provided a summary of operational techniques that can be used to improve level of service and capacity on two-lane highways. Ramanayya (1988) observed that the capacity standards adopted in western countries do not take into account the mixed traffic characteristics prevalent in India. Sarna et al. (1989) emphasized on the need of developing highway capacity norms for Indian highways. Kadiyali et al. (1991) observed that vehicle speeds on Indian roads have increased during the past ten years. Speed-flow relationships have also undergone changes. Pursula and Enberg (1991) reported from Finland that the highest flow rate measured on two-lane two-way road was 2500 veh/h with a directional split of 50/50. Fi (1994) reported that traffic characteristics were similar to HCM and expected traffic volume on two-lane highway was near 1500 pcu/h/l. Bang et al. (1995) developed speed-flow relationship and simulation model for twolane road in Indonesia and found that free flow speed for two-lane roads under ideal conditions is considerably

lower in Indonesia than in developed countries. Sahoo et al. (1996) found that increase in traffic volume decreases the speed of vehicles. Parker (1996) observed that knowledge of traffic composition plays an important role in determining capacity. Kumar and Rao (1998) observed that speed density data could be reasonably represented by a linear relationship. Hossain and Iqbal (1999) studied vehicular free speed characteristics on two-lane national highway of Bangladesh. Karan et al. (1978) developed relationship between average speed and pavement conditions for two-lane highways. Schofield (1986) studied effect of light and weather conditions on the speed and capacity of two-lane roads. Brilon and Ponzlet (1997) studied influences of environmental factors on the speed-flow relationships on German autobahn

Chapter 2
METHODOLOGY

Aims and objectives

1. To study the Present transport infrastructure of Study area.
2. To find out the present traffic load in study area.
3. To study the trend of traffic growth in city.
4. To predict future transport infrastructure need.
5. To study traffic in terms of available transport infrastructure.
6. Comprative study of traffic infrastruture B/W 2015 , 2018

Research Questions

1. What is the available transport infrastructure for traffic in study area?
2. Do we need to expand transport infrastructure to cater traffic needs?
3. Whether improved public transport system can diminish need for transport infrastructure expansion?

Hypothesis

1. Current transport infrastructure in sufficient to handle transport needs but mismanagement and poor planning is largely contributing to traffic congestion and low accessibility.
2. Lack of public transport facilities are contributing in traffic congestion problem.
3. Because of crowed and violence people don't prefer to use public transport.

Problem Identification

It has been observed in the study area that available transport infrastructure has not been completely utilize due to inchrochment and poor traffic management. Thus the research attempt to quantify transport infrastructure capacity.

Methodology

The methodology has been divided into following three part-

1. Pre-field work
2. Field work
3. Post-field work

1. **Pre- field work**

1.1 Collection of littreture- For study, the liiterretures has been collected to related issue from libraries, internet , news paper and magazines.

1.2 Collection of map- different type of map, as district map, zonal map, road map has been collected from magazines and internet for the study.

1.3 Selection of study area- It has been observed that the problem of traffic jam is every part of the city. Bada Chauraha has been selected for the study due to overcrowed and problem of traffic jam. My study Area was Bada Chauraha (kanpur)

1.4 Identification of data needed to be collect- it has been identified that the data needed for the study. Primary and secondary both type of data required for study.

1.5 Preparion of survey sheet/questionnaire- questionnaire and survey sheets has been prepared for the data requirement in field work.

1.6 Identification of location- for daily traffic movement data collection, location has been identified, Bada chauraha .

1.7 Identification of concern deprtment- it has been identified concern department for the permission, primary and secondary data.

1.8 Identification of equipment- video camera has been used for the traffic movement data at bada chauraha and and computer for the prepration of map and data.

1.9 Permission- acquired written permission from traffic department and city administration for collection of data.

2. **Field work**

In field work, primary and secondary data has been collected-

2.1 Primary data

24 hour traffic movement has been recorded in study area at bada chauraha for the traffic data. Transport infrastructure data has been collected by measuring road length and width by inch tape and GIS sytem. Inchrochment also has been

measured in study area.

2.2 secondary data

Varius traffic and infrastructure data has been collected from Regional Transport Ofice, Kanpur, Central Pollution Control Board, Kanpur Development Authority, Kanpur Nagar Nigam, and varius report, research paper, news paper has also been used.

3. **Post- field work**
4. All data collected during field work has been analyzed. For this purpose various statistical technique has been used for analysis and visualisation. Computer has been used for the analysis and visualization of data. GIS software has been used for production of map and related data.

Chapter 3

A COMPRATIVE STUDY OF TRAFFIC INFRASTRUCTURE B/W 2015 & 2018

India has one of the largest road networks in the world. The entire network is classified into five distinct categories perhaps from the viewpoint of management and administration. The five categories are National Highways (NH), State highways (SH), Major district roads (MDR), other district roads (ODR) and Village roads (VR), among the different categories of roads, National highways constitute around 2 per cent, state highways 4 per cent, while 94 per cent of the entire network comprises of ODR, MDR and VR. Out of these Public Works Department (PWD) roads are 21 per cent, urban roads 7 per cent and the rest of the road length in India is accounted for by the rural roads. While the development and maintenance of National Highways is under the purview of the Central government , all other categories of roads come under the purview of the respective States/UT governments. The ministry of road transport and highways (MoRTH) is mainly responsible for development of roads and highways. While road wing of MoRTH deals with development and maintenance of national highways, the transport wing is in charge of administrative duties such as motor vehicles act, taxation, road safety etc. The development and maintenance of national highways main depend on state governments and union territories, National Highway Authority of India (NHAI) and Border Road Organization .

The National highways have a length of about 67,000 kms in 2006-07 and run across the length and breadth of India facilitating medium and long distance inter-city passenger and freight traffic. The government has made efforts to increase the total road length in the country with emphasis on all types of highways and other roads. See Table-14 for details. For example state highways and other roads constitute the secondary system of road infrastructure of India. The state highways provide linkages with national highways, district headquarters, important towns etc. The length of the state highways

which was 43,000 kms in 1950-51 increased to 127,000 kms in 1990-91 and stood at 137,000 kms in 2006-07. Similarly, the length of the other roads also increased sharply from 338,000 kms in 1950-51 to nearly 7921000 kms in 200-07. Further, another notable feature of the road transport sector has the manifold increase in the total number of motorized vehicles (Table-14). But the expansion in the road network has not been commensurate with this increase. The total number of vehicles has increased from 306,000 vehicles in 1950-51 to a whopping 48,857 thousand in 2000-01 and 89,618 in 2006-07. Of this, the largest increase has been in the case of goods vehicles, cars, jeeps and taxies and two wheelers. Infact, India has the largest number of two wheelers in the world. The number of two wheelers which was just 27,000 in 1950-51 increased to 64743,000 in 2006-07

Vehicles in Study Area

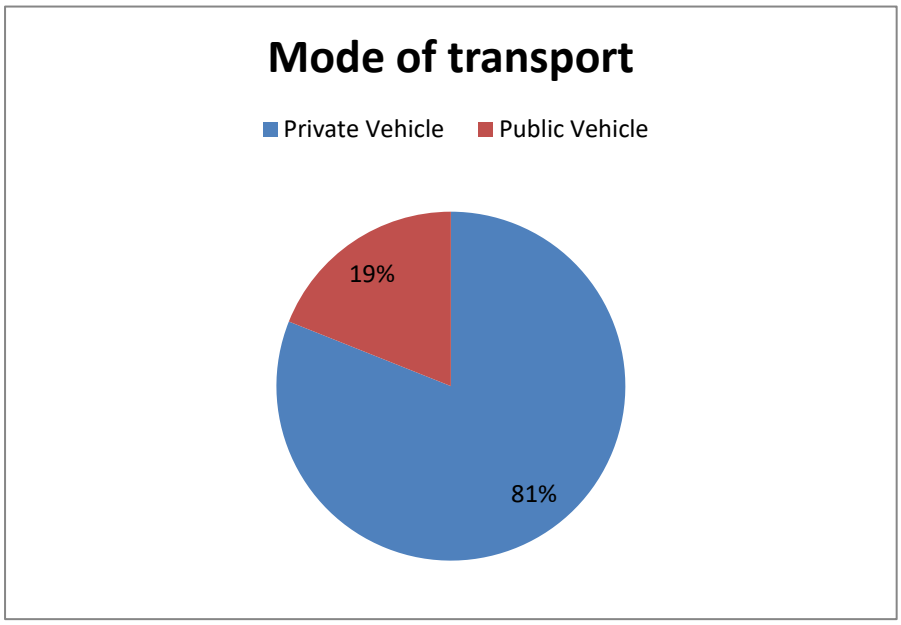
The traffic survey at study area reveals that the total vehiclas which passes through the area was 106093.While in 2015 this number was 86382. Peak time in morning is 10 to 11 am, when 7476 passes Badachawraha. In afternoon 1 to 2 pm 10275 vehicles passed the crossing and 7509 vehicles passed from 6 to 7 pm., the movement of cycle (933) is maximum form 9 to 10 am, in evening peak time of bicycle is from 6 to 7 pm highest concentration of car is found in evening time. The number of cars keeps on increasing from morning to evening. The peak time of car have been found on 3 to 4 pm. concentration of buses is more from 9 to 1 pm, peak time of buses is 12 pm tp 1 p.m.The ratio of bike is almost consistence from 7 am to 10 pm peak time of bikes 1 to 2 pm.

Table-7-Vehicle passed throughout the day in study area(2018)

Time od 24 RS	Car	Bike	Auto	Bus	Cycle	E shaw	Ricksha	Total
0000-0100	436	589	37	2	59	27	46	1196
0100-0200	184	224	17	1	15	16	30	487
0200-0300	111	107	13	3	11	2	19	266
0300-0400	68	68	9	1	9	7	11	173
0400-0500	49	55	12	0	17	10	23	166
0500-0600	102	175	34	3	81	23	53	471
0600-0700	160	436	191	25	125	54	120	1111
0700-0800	508	2165	131	67	364	160	307	3702
0800-0900	516	3015	409	86	540	226	420	5212
0900-1000	566	2972	529	88	933	222	339	5649
1000-1100	532	4463	735	80	855	327	484	7476
1100-1200	568	4237	876	89	414	432	583	7199
1200-1300	918	3371	774	93	514	262	362	6294
1300-1400	766	7683	675	87	426	187	451	10275
1400-1500	849	5329	672	71	568	254	1072	8815
1500-1600	1147	4378	590	74	360	124	450	7123
1600-1700	924	4526	739	60	306	150	423	7128
1700-1800	796	3532	626	55	474	77	269	5829
1800-1900	834	5132	579	48	380	294	242	7509
1900-2000	820	3267	509	25	339	103	190	5253
2000-2100	902	2539	440	0	282	114	295	4572
2100-2200	859	4481	368	4	227	102	222	6263
2200-2300	680	1188	154	2	126	72	184	2406
2300-2400	448	759	79	2	115	29	86	1518
Total	13743	64691	9198	966	7540	3274	6681	106093

Source- 24 hrs. video recording

Figure5: Mode of transport



According to data there are 81 %commuters used private vehicles (car,bike,cycle.).while 19% peoples used private vehicles (Auto,Rickshaw,E-Rickshaw,Bus).

Public Transport

Opinion about reserved ladies seats

We asked questions from the commuters about the ladies seat reservation and if the ladies used their reserved seats in buses efficiently.,results showed that 73% female denied for this. While 27 % accepted

Opinion about government bus

And we asked our question to commuters that , if JNURM government buses are run across city to provide transport facility to the passengers on their availability, 73% peoples says yes while I got negative answer from 27% people

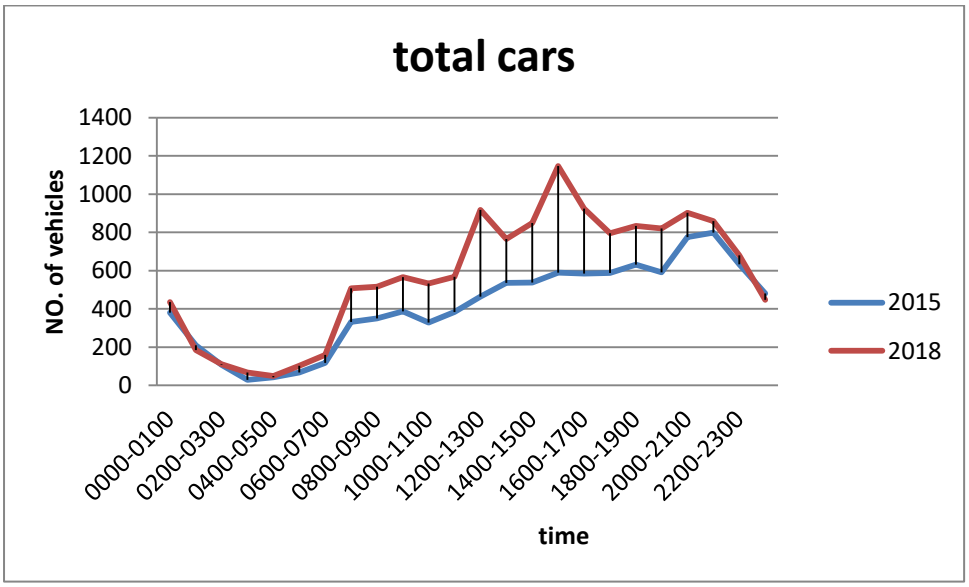
Primary means of transport

The survey we conducted in bada chauraha ,who used different primary means of transport where percentage of auto was 66.6% e-rikshaw was 20% bus was on 3rd preference with 10% rikshaw 3.33 %

Preference of public transport

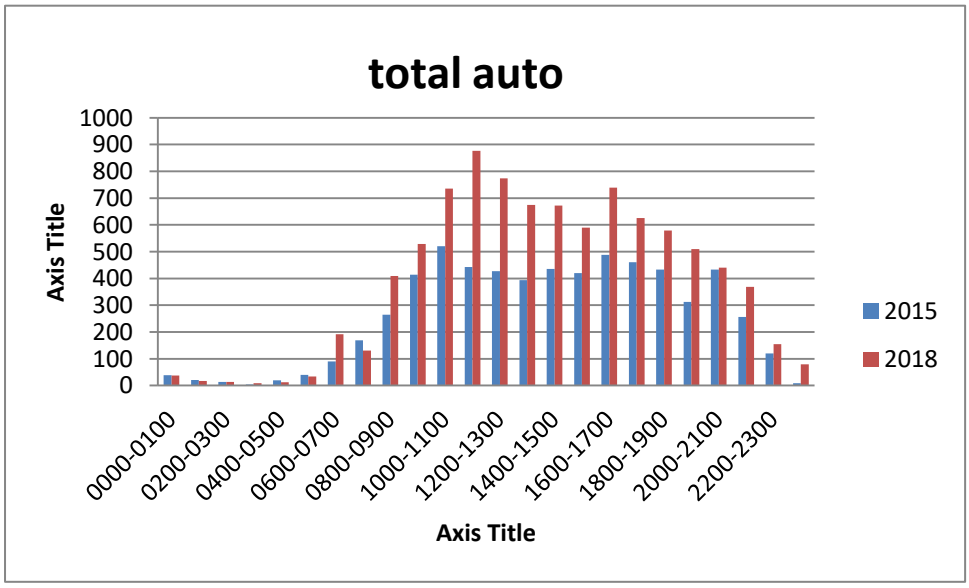
People travelling in public transport preferred various mode of transports where auto was the most prefered having percentage 66.6% cab percentage 3.33%

Figure:6- movements of car



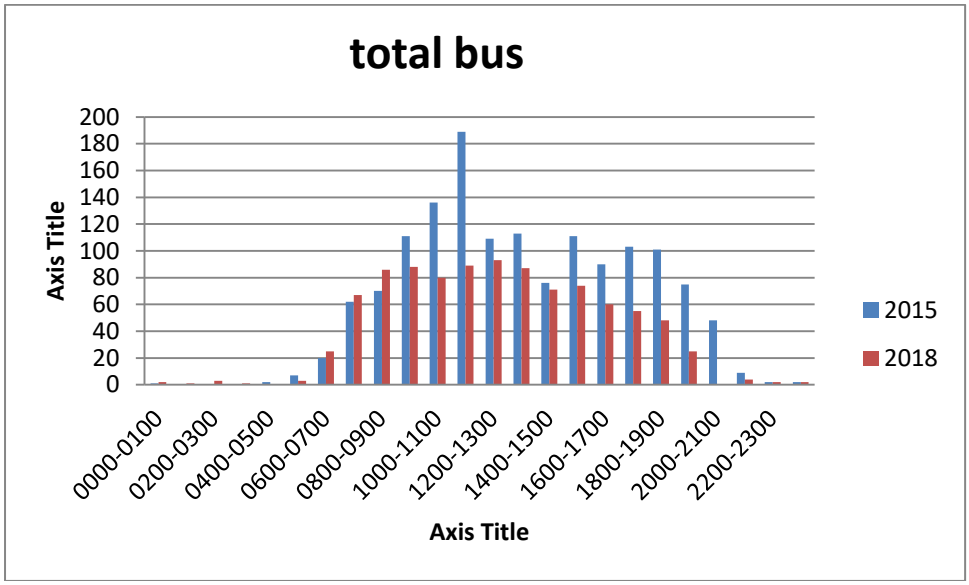
By the help of this graph we can find out movements of Cars in 24 hrs. And differentiate vehicles in no. between 2015 -2018.and how many cars are increased in previous 3 years. 3p.m to 4p.m is peak time for car when 1147 cars passes

Figure:7- movement of Auto



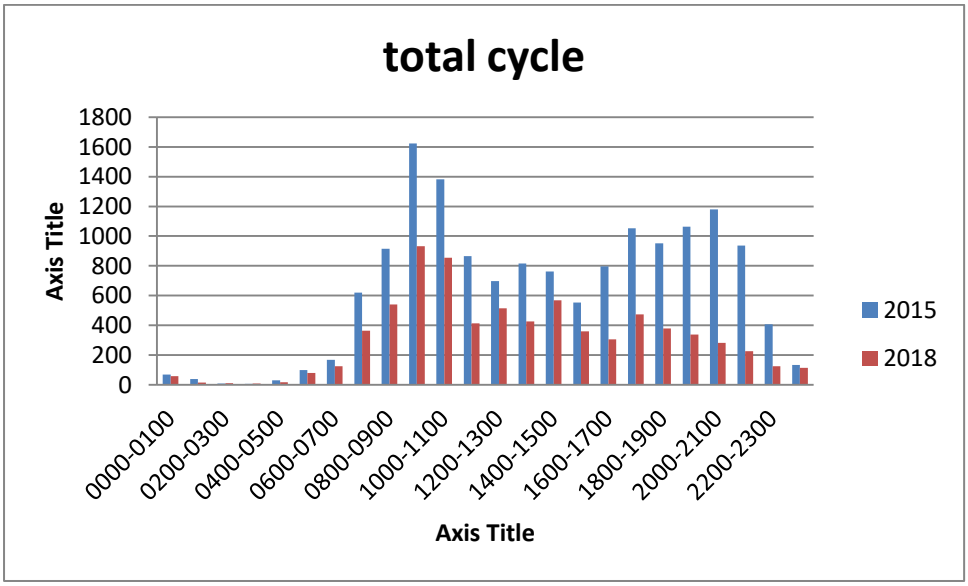
There are total 9,198 auto which passes through study area(2018). in morning peak time number of auto is 876 .while in evening peak time it is 739 from 4p.m to 5p.m. And in 2015 this Quantity was 6276 (2015)
We can see differnce in vehicles no. Between 2015 and 2018

Figure:8 movement of bus



There are total 966 buses which passes throgh study area in 24 hrs. Peak time for bus is 12p.m to 1p.m when 93 buses passes. In evening pek time this number was 48 6p.m to 7 p.m.By the help of this graph we can find out difference of buses b/w in 2015 & 2018Total buses in 2015 are 1437.Highest amounts of Buses are b/w 12p.m to 1p.m.

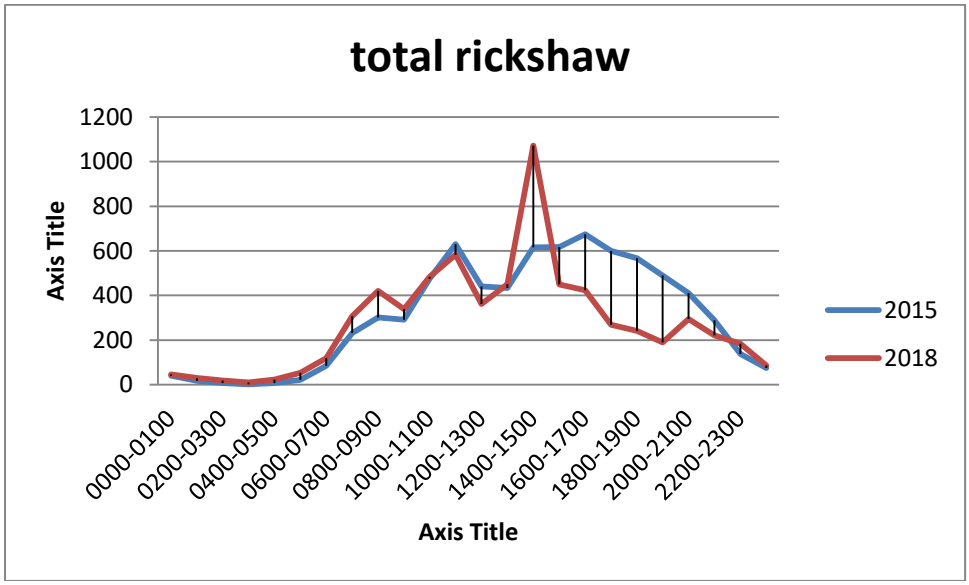
Figure :9- movement of cycle



Total 7,540 cycles passes through study area Bada chauraha .in peak time(morning) 9a.m to 10 a.m number of vehicles are 933. Whle in evening peak time this no. Was 474 on 5p.m to 6p.m.
In 2015 these no.was 15183 in 24 hrs.

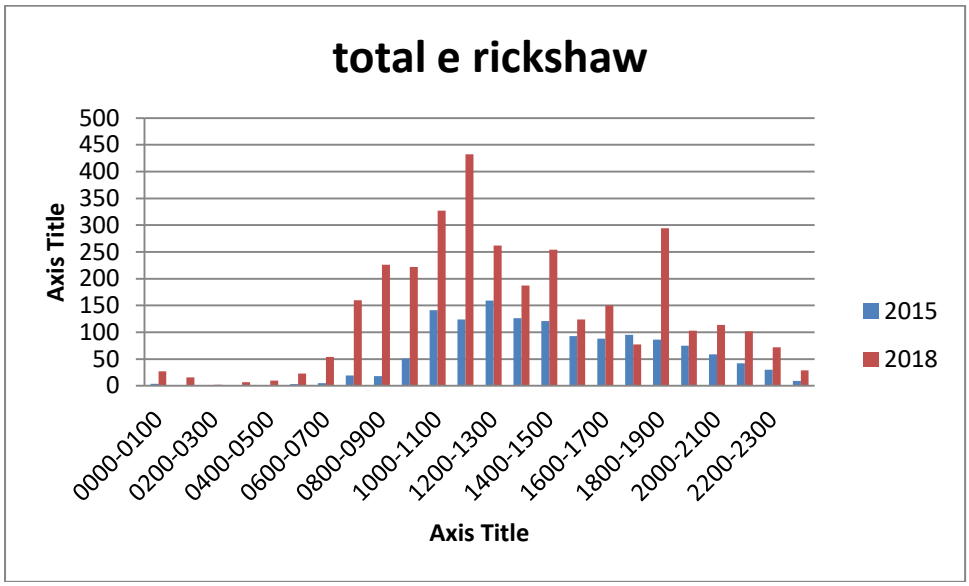
In comprative study Cycles is declining rapidly. From 2015 to 2018

Figure:10-movement of rickshaw



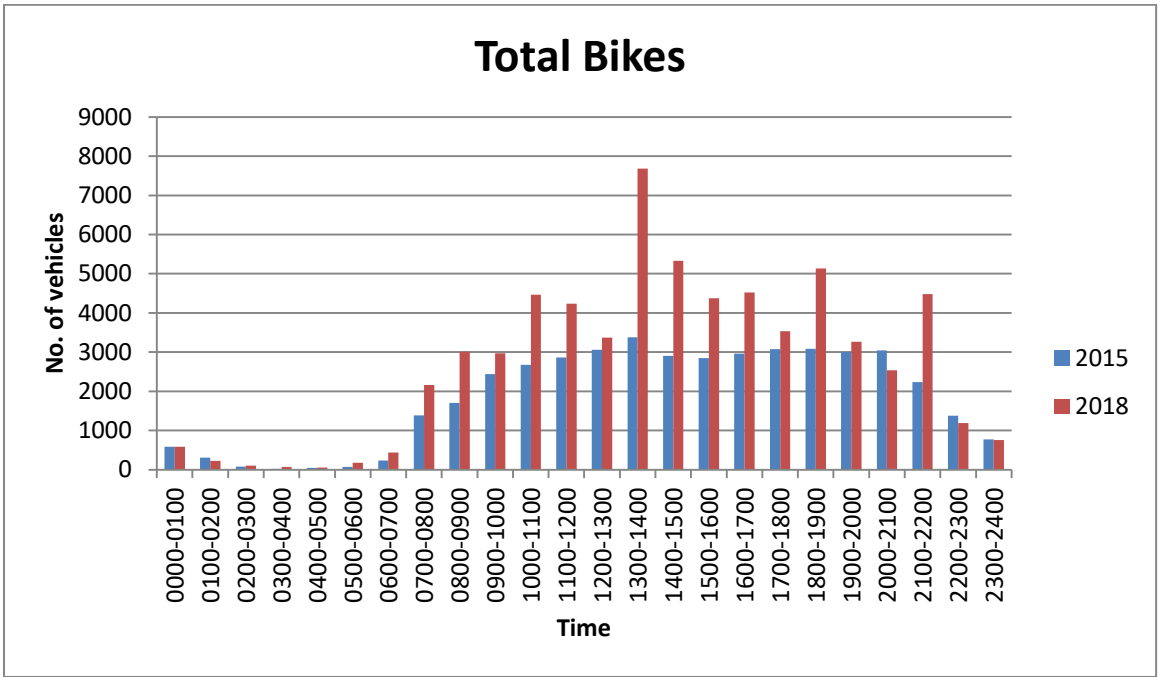
6,681 rickshaw passes through study area. In pek time (morning) 420rickshaw passes .whole in evening peak time this number is 295 .
In 2015 , 7462 Rickshaw passes through Bada Chauraha.

Figure:11- Movement of E-Rickshaw



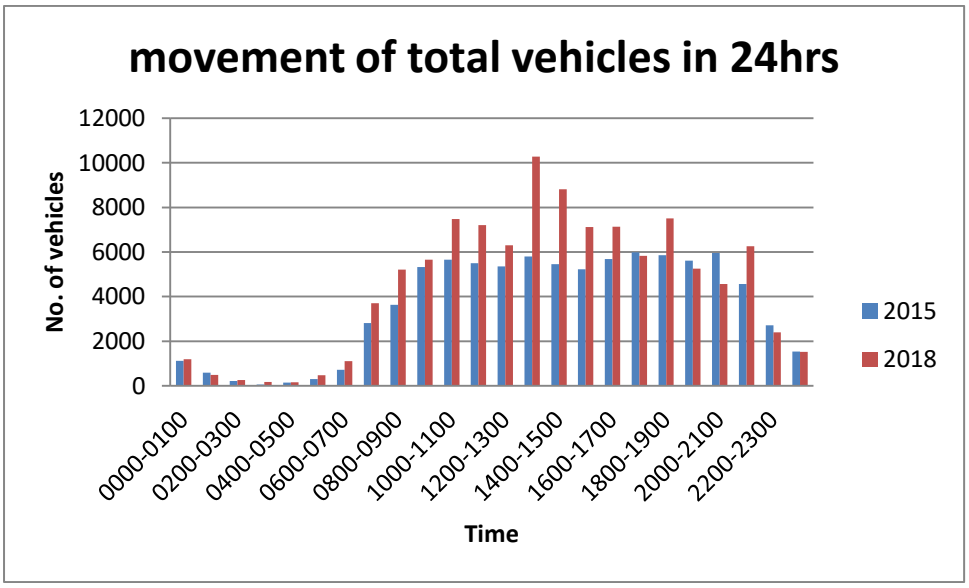
There are 3,274 E-Rickshaw passes through study area. In morning peak time 11a.m to 12p.m 432 vehicles passes through Bada chauraha.in evening peak time 294 passes.
In 2015, 1349 vehicles passes throgh Bada Chauraha 24 hrs.

Figure:12- movement of bike



Total 64,691 Bike passes through Bada chauraha.in peak time this no. Is 7683 1p.m to 2p.m
In evening time 6 to 7 p.m no. Of bikes is 5132.
In 2015,this no. Was 44186.

Figure:13-movement of Total vehicles in study area



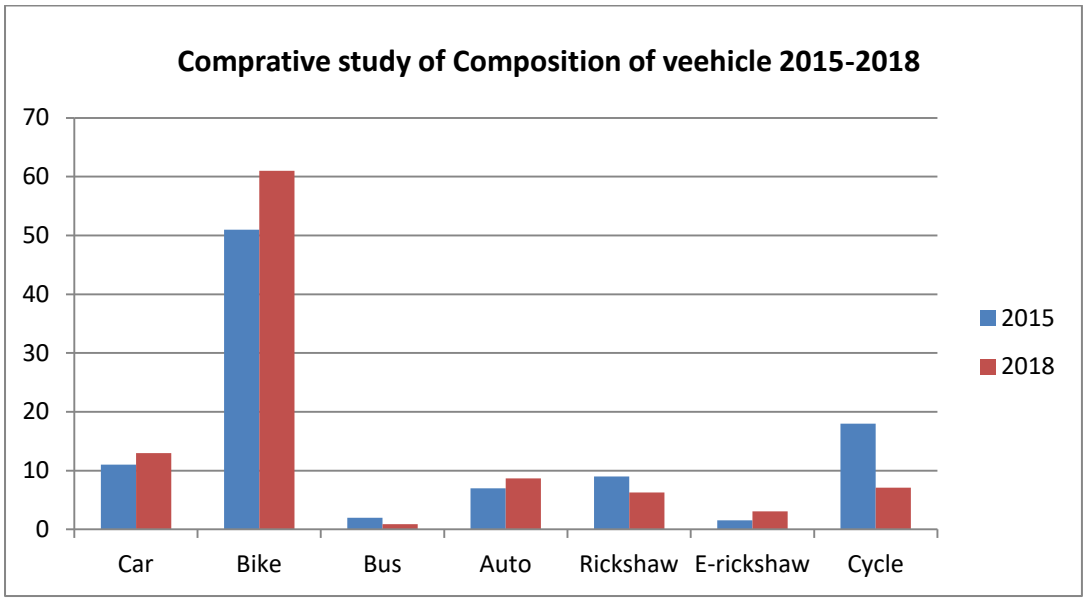
We compare our collected data from 2015.then we found that there is a huge difference in vehicles in 2015 tottal vehicles were 86382.while inpresent time there are total 106093 vehicles passes through study are.we found that there is 46.55% more auto increase comparison tp 2015.and 38.20% buses increase from 2015. And there is also 46.40% bikes are more than 2015.

About 72.07% Vehicles passed between 10 am to 09 pm. This is 23.21% more than the available road capacity. Maximum congestion occurs between 5-6 pm, when the percentage of vehicles is 29.41% higher than road capacity. This stands the major cause of traffic congestion.

Composition of Vehicles

The composition of various vehicle have been studied in the study area out of total 106093 vehicle bike account for 60.97% of total vehicle which followed by cars. Which account for 12.9% after then auto stands 3rd 8.66% in vehicular percentage with 12.95%. Rickshaw accounts for 6.29% of total vehicle.. Buses accounts for .91% of total vehicle. E-rickshaw, which are new to city accounts for 3.08%of total vehicles.cycle is on 4th with 7.1% of Total Vehicles.

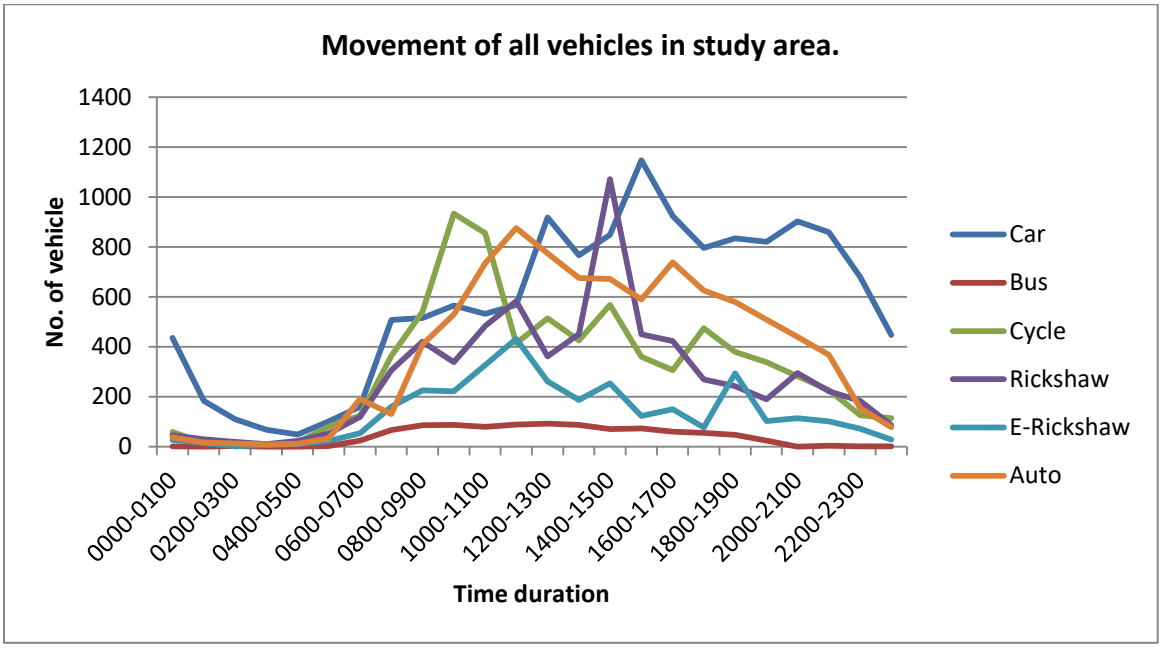
Figure:14 : Composition of vehicles in study area In(%).



According to study (2018)60.97%Bikes are in Total vehicles & 12.95% Car ,8.66% Auto,7.1% Cycles and 6.29%Rickshaw and 3.08% E-Rickshow passes through Bada Chauraha. According to Latest Study bikes are highest in no. While Cars are on 2nd and auto stands on 3rd

While in 2015 , 51%Bikes 18% Cycle 11% Car 9% Rickshaw 7%Auto of total vehicles(in study Area) were operated on this rout

Figure:15- movement of diff. Types of vehicles in study area



In this graph movement of all vehicles(Car,Bus,Cycle,Rickshaw,E-Rickshaw,Auto) throughout 24 hrs. In study area Bada chauraha ..

The peak time is 10a.m to 11 a.m when 7476 vehicles passes through study area (Bada Chauraha).In morning 4a.m to 5 a.m is time when least only 166 vehicles passed.

Road Infrastructure of study area

For the purpose of the study the whole study area has been divided in to Five sections and transport infrastructure of each section has been studied. The total distance of this section is 3.1 kms. The table below shows all section with distance of study are

Table-8: Divided sections of Road in study area.

SECTION OF ROAD	DISTANCE (km)
Chunniganj to Lal Imli	0.40
Lal Imli to Parade	0.42
Parade to Bada Chauraha	0.75
Bada chauraha to S.B.I	1
S.B.I to Phoolbagh	0.30

Table-9: Road Infrastructure of Study area.

Section Of Road	Lane	Average Width (mtr)	Road In Use (mtr.)	Encroachment in (mtr.)
Chunniganj	2	14.80	8.2	6.60
Lal Imli	2	16.1	10.3	5.8
Parade	2	16.3	9.3	7
Bada chauraha	2	17.5	9.6	7.9
S.B.I	2	14.6	13	1.6

The average width of all the section of study area has been studied. The average width of Lal Imli is maximum, while Chunniganj Lal Imli S.B.I section contains least width, There is Lowest Width in S.B.I With very low encroachment.

The section of road In Chunniganj is encroached by 44.59% in average. This is further declining the road capacity. 36.02% road in lal imli , 42.94% in parade, 11% near Reserve bank, 45.14% Badachawahara, are encroached by Buses, Autos, Rickshaw, E-rickshaw and Wanders.

The road quality of these section are good but the problem of encroachment is extremely high in these section out of total available rood are about 36.44% area has been encroached and only 63.56% area is available for commuters. Thus the capacity of road decline sharply.

Encroachment further declines the capacity of road and the problem of traffic becomes more severe.

Passenger Car Units (P.C.U)

Passenger car unit (PCU), is a metric used in transportation engineering, to assess traffic flow on highway. A passenger car unit essentially the impact that a mode of transport has a traffic variables (such a headway, speed, density) compared to a single car. For example typical values of PCU are as follows.

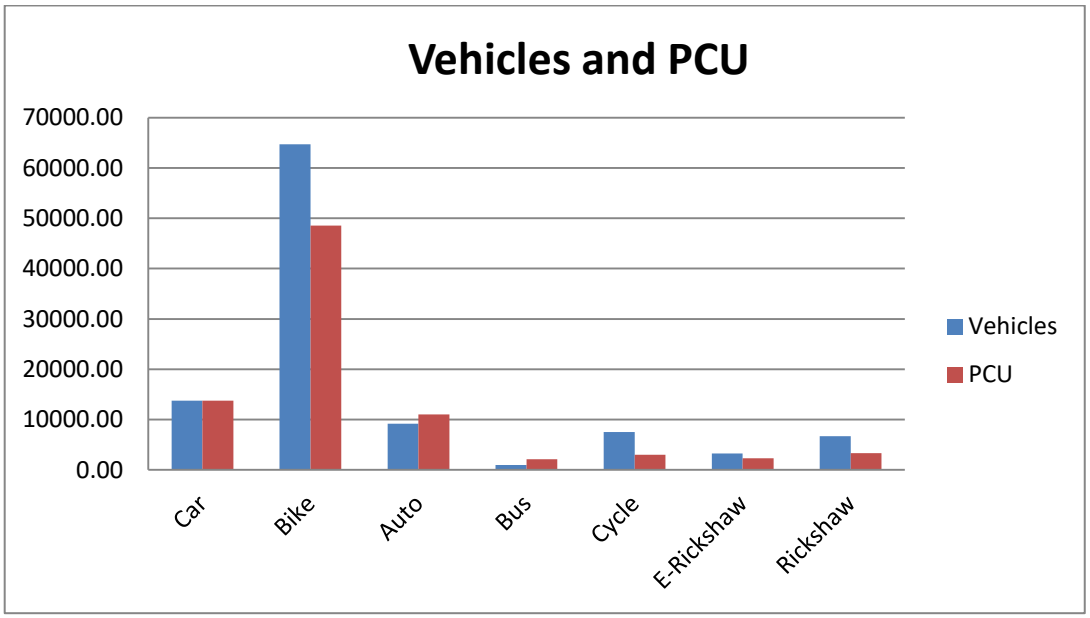
Table10 : Calculation of PCU.

Vehicle Type	PCU **(If Less than 10 % of total vehicle)**	PCU **(If above 10 % of total vehicle)**
BIKE	0.5	0.75
CAR	1	1
TRUCK	2.2	3.7
RICKSHAW	0.5	2
CYCLE	0.4	0.5
AUTO	1.2	2
BUS	2.2	3.7
OTHERS	2.5	3.3

Source: Indian Road Congress (1990).

According to our study we found that The Passenger Car Units of the study area are 84072.35 Bike consumes most of the PCU with 48518.25 PCU, which accounts for 57.71% of total PCU followed by cars which consumes 13743 PCU which is 16.35%. Auto consumes 11037.60 P.C.U which accounts for 13.13%. Cycle consume 3016 PCU . Rickshaw consumes 3340.5 PCU .while E-Rickshaw consume 2291.80 PCU&PCU Cunsumption of Bus is 2125.

Figure:15 Vehicles and PCU



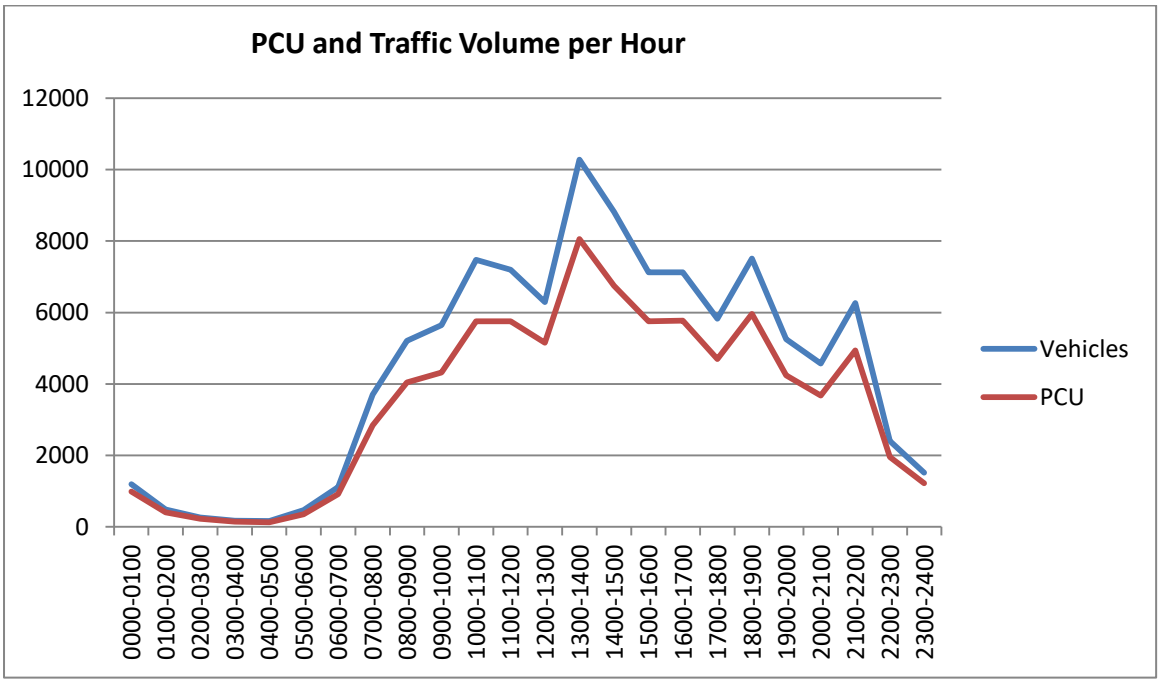
Source: Based on 24 hrs video recording at Bada Chauraha, Kanpur.

While according to study (2015). Bike consumes most of the PCU with 33139.5 PCU, which accounts for 40.64% of total PCU followed by cars which consumes 9944 PCU which is 12.19%. Cycles stands 3rd in PCU and accounts for 7591.5 PCU which is 9.30% of total PCU. Auto consumes 7513.20 P.C.U which accounts for 9.23%. Autos are followed by Rickshaw.

Road Capacity

During morning peak time from 10 to 11 am the traffic load is 18.38% more than the road capacity. If all public transport (Auto,E-Rickshaw,,Rickshaw) other than buses are prohibited in this area, and buses takes 124 trip more than its actual trip than the traffic load will be equal to the road capacity.

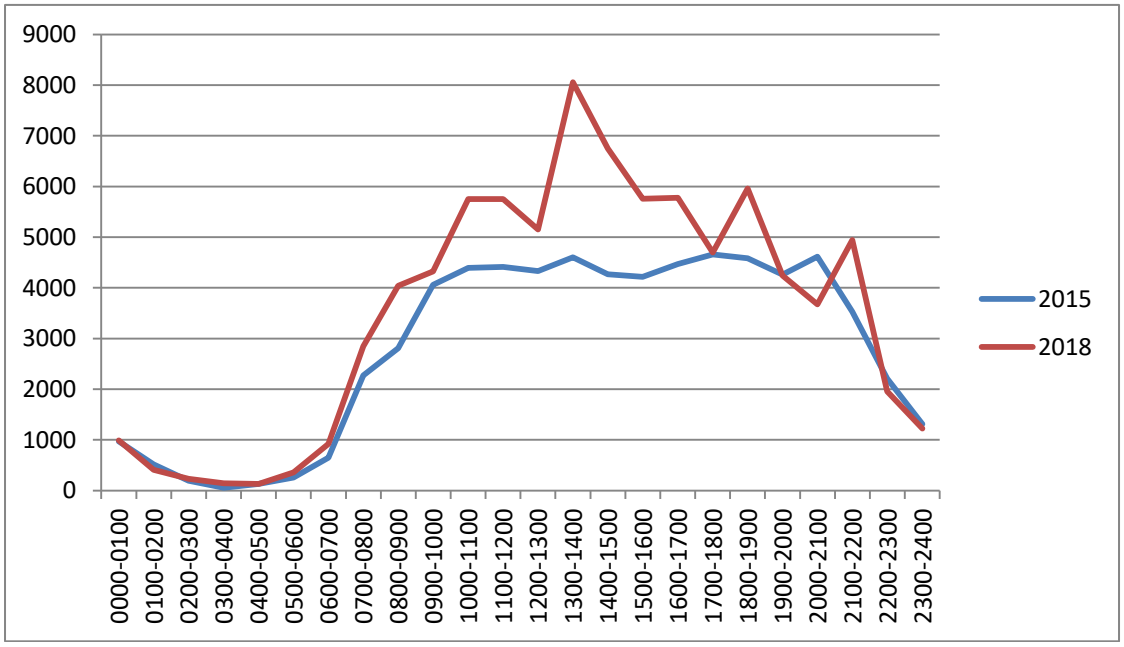
Figure 16: Traffic volume and PCU of study area. 2018



According to Study PCU value is increasing ,with traffic volume .there is Direct relation b/wtraffic volume and PCU value.

In graph highest PCU Velue is bw 1p.m To 2 p.m and we described it before that bw 1p.m to 2p.m is time when traffic volume is hig

Figure17- comprative study of pcu value B/W 2015 & 2018



According to study traffic volume becomes more Compative to 2015. And PCU value is also high more than 2015.

Road Capacity

During morning peak time from 10 to 11 am the traffic load is 18.38% more than the road capacity. If all public transport (Auto,E-Rickshaw,,Rickshaw) other than buses are prohibited in this area, and buses takes 124 trip more than its actual trip than the traffic load will be equal to the road capacity

PCU and Traffic congestion

Traffic volume and PCU of study area is reflecting the condition of congestion and possible cause. PCU of the area reflects the status of congestion in area. High PCU is cause of high congestion and vice versa. Because a mix of traffic cannot be concerned as cause of high congestion unless PCU has not been analyzed. The Chart above indicates that the gap between actual traffic and PCU increases sharply in day time increasing the congestion condition.

Conclusion

The chapter attempts to analyze the role of infrastructure on traffic congestion. All calculated traffic data has been converted into corresponding PCU to understand actual problem of traffic. The problem of encroachment has also been studied and found that due to encroachment the capacity of road decreases sharply. Because the ratio of road capacity decreases even more rapidly that decrease in road capacity, the problem of traffic congestion becomes more serious.

Chapter 4

RECOMMENDATIONS AND CONCLUSION

Transport demand in most of the Indian cities has increased substantially due to increase in population as a result of both natural increase and migration from rural areas and smaller towns. Availability of motorized transport, increase in household income, and increase in commercial and industrial activities has further added to it. Unfortunately, public transport systems in Indian cities have not been able to keep pace with the rapid and substantial increase in travel demand. well-organized bus transport services are limited to few big cities only. Qualitatively, the available public transport services are overcrowded particularly during peak hours and involve long waiting periods. As a result, there is a massive shift towards personalized transport, specially cars and two-wheelers, and also proliferation of various types of intermediate public transport modes, such as auto-rickshaws and taxis. The increasing use of private motor vehicles in cities has been rapidly changing their modal-split structure. Motorization may have brought a higher level of mobility to the high-income segments of urban population, but its adverse impact in the form of congestion, air pollution, and traffic accidents is also substantial. Although these impacts are inherent to motorization, the excessively high level of impact faced by many Indian cities has a lot to do with the lack of effective public policy. The city cannot afford to cater only to the private cars and two-wheelers and there has to be a general recognition that without public transport in general and bus transport in particular cities would be less viable. Although rising income of the people is one of the most important reasons for change in modal-split structure, the more important reasons are to be found in the public transport system itself. Speed, service quality, convenience, flexibility and availability favor adoption of private mode as the main mode of transport. Given the opportunity, people reveal widely divergent transport preferences, but in many places city authorities favor a basic standard of public transport services. It is often thought to be in egalitarian to provide special services such as premium or guaranteed seats in return

for higher fares. As a consequence, those who can afford private vehicle are successively leaving public transport. Until recently the main function of public

transport was to satisfy the individual needs of the less affluent members of society, but now it has to contribute for congestion relief and environmental preservation. This requires a fundamental change of emphasis to fulfill its new role of attracting enough people away from the cars, two-wheelers, auto-rickshaws, and taxis. The problem of acute road congestion, rising air pollution, and a high level of accident risk faced by metropolitan cities of India is taking serious dimensions and worsening the people's quality of life. Without vigorous action, this problem would intensify, as rising population over the coming decades and the goal of growing economic prosperity put more pressure on the system. Reducing traffic congestion, vehicular emission, and accident risk requires a comprehensive strategy. The main objective of such strategy should be to provide and promote sustainable high quality links for people, goods, and services to, from and within the city. Strategy should be designed in such a way that it reduces the need to travel by personalized modes and boosts public transport system. This requires not only increasingly stringent emissions standards, specifications for clean fuels, proper maintenance of in-use vehicles, optimal pricing of transport services, demand as well as supply side management measures, but also a complete overhaul of public transport system

CONCLUSION

The study found that the total number of vehicles passing through Bada Chauraha is 106093. The peak time of traffic movement is 1-2 PM when 10275 vehicles passes from this area, which is 9.68% of total vehicle. The peak time in morning is 10-11AM when 7476 vehicle passes from the crossing which account for 7.04% of total vehicle. Least number of vehicle have passedon 4-5 AM in morning which only 0.15% of total vehicle. The movement of cycle is maximum from 9-10 AM in morning and 5-6 PM in evening. The movement of car from the area is surprisingly or the numbers keeps on increasing from morning 3 AM to evening 10 PM. The peaks time of car is 1147 cars passes the area. When studying the composition on of vehicles, bikes accounts for 60.97%, cycles 7.1%, cars 12.95%, rickshaw 6.29%, auto 8.6% and buses 0.9% etc. The available infrastructure in area is considerably good. The whole study area of 3.27 km, have divided into 5 segments. Bada Churaha & Parade have maximum width while Lal Imli , Chunniganj ,S.B.I has least width. The problem of encroachment is common on the section but Parade section has problem of encroachment 7Mtr., while Lal Imli section is encroached by 5.8 mtr.out of 16.3 Mtr.available road. Least encroachment is found inS.B.I main branch.To understand the effect of traffic congestion, the whole traffic data converted to PCUs. For this purpose the standard PCUs adopted by Indian Road Congress has been consider which provides different PCUs. If the percentage of certain type of vehicle is 10% or higher than 10%. The PCUs the study is 81550, bikes consumes most of the PCU with 25876.4, which accounts of 45.82% of total PCU, cars accounts for 24.33% of total PCU. Cycle accounts for 2.67% and auto accounts for 11.40% of total PCU. Car consumes 1 PCU because it has been considered of standard. Bikes, Rikshaw, Cycles consumes less PCU than cars. While truck, auto, bus and others consumes more PCU than cars.Higher number of PCUs indicates traffic congestion and less PCU indicates low congestion. The gap between graph of traffic volume and PCU is extremely high in day time from 9 AM to 11PM, which indicates high level of congestion. While the gap is less from 11PM to 9AM.

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