



URBAN GROWTH AND MASS RAPID TRANSIT SYSTEM (MRTS): A STUDY OF DELHI METRO IN METRO CITY OF DELHI

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Abstract

Delhi is the second largest metropolitan city of India after Mumbai which is still growing. In any city smooth traffic movement is a prerequisite for its development but it is very difficult to achieve because of increase in population, commercial and industrial activities. Besides this high vehicle ownership and poor supporting public transport facilities cause serious problems of transport. Primary data related to user satisfaction is collected through a structured interview done in the area of Hauz Khas metro station in Delhi in June 2018. It is seen in the study that there is rapid growth of population in Delhi i.e. 5.64% average annual growth rate between 1981 and 2011 and the number of vehicles and road length also increased during this period but increase of length of road is not as much as the increase in the number of vehicles. Vehicles increased with about 49% annual average growth rates whereas length of road increased at about 4% annual average growth rate. It is found in the study that people are satisfied with the service as it provides a safe, secured and fast mode of transport.

Keywords: Rapid mass transit system, Population growth, Public and private vehicles, Delhi metro user satisfaction

Introduction

Urban growth in the world is on its peak especially in the countries of the developing world such as India (Kumar et al., 2007). India is the second largest country in the world in terms of population and seventh largest in terms of area and the population and population is still growing rapidly with an average annual growth rate of 1.64 per cent. According to the 2011 Census, the urban population of India is about 377.11 million which is about 31.16% of total population and there are 53 million plus cities in India where Mumbai, Delhi, Kolkata and Chennai are the four largest million plus cities. The population in Delhi has grown from about 1.74 million in 1951 to about 16.75 million in 2011 and the population density was 1,176 in 1951 which rose to 11,297 in 2011 (Directorate of Census Operations, 2011).

The major components of urban growth are natural increase of population, net migration to the cities, reclassification of settlements as urban and extension of boundaries

of cities and towns (Bhagat and Mohanty, 2009). The main cause of urban growth of Delhi is immigration from surrounding areas of Uttar Pradesh, Bihar, Haryana, Rajasthan etc. (Rahman et al., 2012). Urban growth directly influences the urban development processes such as housing, built up area, transport network etc. (Bhatta, 2009). Most Asian cities are experiencing rapid urbanisation, which results in urban congestion and increasing demand for mobility and an increase in motorized vehicle ownership (Alam and Ahmed, 2013). Transport plays an important role in the development of urban areas by providing options for travel and transport and by influencing the economic development through accessibility which it provides (Meyer and Miller, 2001).

The demand for transport in Indian cities is increasing due to the population growth and increasing household income and easy availability of motor vehicles have raised the private motor vehicle ownership in Indian cities (Singh, 2005). Due to rapid and haphazard growth of urbanisation, problems of congestion and traffic have emerged in most Indian cities. Singh (2005) noted that, during 2000, nearly 12.7% motor vehicles of India were running in four mega cities (Mumbai, Delhi, Kolkata and Chennai), while Delhi, which contains nearly 1.4% population of the country constitutes about 7% motor Vehicles of the country. Only four major cities of India have local rail system and they are Mumbai, Delhi, Chennai and Kolkata (Singh, 2005), of which Delhi's local train system holds less than 1% daily riders. The vehicle population was increased about 8.9% in India (Sausanis, 2011).

During the past few decades, there is a sudden increment in the private transport in Delhi. Till December 2002, Delhi was the only megacity in the world which was dependent almost entirely on roads as the sole mode of transport. After 2002, metro rail project gave Delhi a world-class mass rapid transit system. It is developed in three phase which was at first operational from 24th December 2002. At present all three phases are operational and it is expected that the third phase will be fully operational by end of 2018 (Fig. 1). The beginning of Metro-rail system has reduced some pressure of traffic in Delhi, but the situation is still not much in control. According to a UN report the population of Delhi got doubled between 1990 to 2014 as becomes 25 million whereas the rate of increase of DTC buses is just 43.39% from 3286 in 2000-01 to 4732 in 2014-15. Delhi has now become the fourth most polluted city in the world, with automobiles having contributing about two third in total atmospheric pollutants (HT, 2018). So there was a need of rapid, less polluted, congestion free mass transit system and Delhi metro plays an important role in this regard. So there is a need to study the role of metro for rapid mass transport system. Urban growth and transport are closely related as development of transport infrastructure leads to urban development in one way and the urban growth causes increase in demand for transport facilities in another way (Aljoufie et al., 2011). The population of Delhi is still growing and will be growing in near future, which will require more transport facilities (Goyal et al., 2006). Thus the main objective of this paper is to i) analyse the demand of rapid mass transit system in Delhi and ii) to assess the role of Delhi metro in fulfilling the demand of rapid mass transport system for easy and better movement of the people within the city.

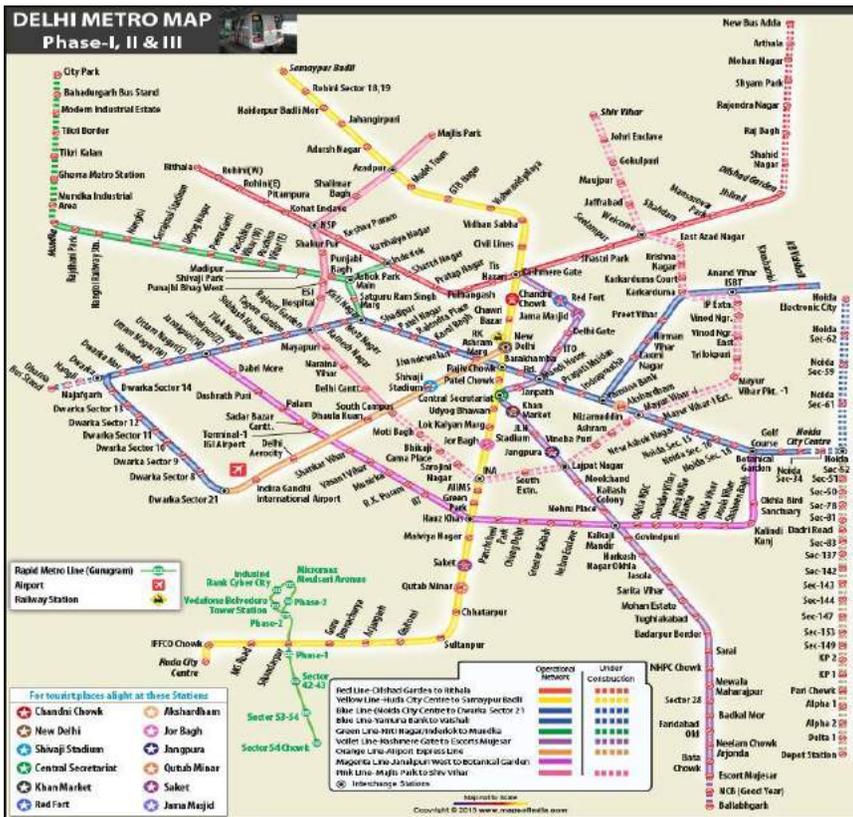


Fig. 1. Delhi Metro Route

Source: <https://www.mapsofindia.com/maps/delhi/delhi-metro-phase-3-map.html>

Study Area

Delhi is among the fastest growing cities of India and it also has the largest rapid mass transit system in India. So Huaz Khas, the junction of Delhi metro’s Yellow and Magenta line (Fig. 2) has been chosen for the field survey. Yellow line was developed in First phase whereas Magenta line was developed in Third phase of Delhi metro. The total population of Delhi is 16.8 million and it is the second largest city of the country. It is located in northern plains and is the centre of National Capital Region (NCR). The climate of Delhi is of continental type due to distance from sea coast. River Yamuna and Aravalli range are the two main geographical features of city. Aravalli hills covered with dense vegetation act as lungs of the city (Krishen, 2006), while Yamuna River provides water for drinking and other purposes. The total area of the Delhi is about 1483 sq. km and the population density of the city is about 11,312 persons per sq. km.



Fig. 2. Location of the Study Area, Yellow and Magenta line Delhi Metro

Database and Methodology

The data used in this study is collected from both primary survey as well as from secondary sources. Primary data related to user satisfaction is collected through a structured interview done in the area of Hauz Khas metro station in Delhi in June 2018. Convenient sampling is done in this study where everyday passengers who were willing to answer the questions are surveyed. Secondary data related to growth of population, urbanisation, growth of vehicles, and DTC buses and evolution and growth of Delhi metro are collected from Delhi Metro Rail Corporation (DMRC), Central Road Research Institute (CRR), Economic Survey of Delhi and Statistical handbook of Delhi (Table 1). The analysis has been done to assess the population growth, rate of urbanisation, demand for mass transport and user satisfaction with metro services on Yellow-Magenta line.

Table 1. Data Source and Parameters Derived

S. No	Data Source	Year	Parameters
1	Delhi Metro Rail Corporation (DMRC)	2004 to 2018	<ul style="list-style-type: none"> □ Ridership, □ Length of metro line □ Number of stations
2	Central Road Research Institute (CRR)	1980 to 2016	<ul style="list-style-type: none"> □ Number of public and private vehicles □ Availability of vehicles per thousand population
3	Economic Survey of Delhi	2001 to 2015	<ul style="list-style-type: none"> □ Number of DTC buses □ Fleet utilization □ Vehicles utilization □ Passenger per bus per day
4	Delhi Statistical Handbook	1980 to 2016	<ul style="list-style-type: none"> □ Length of road network

Results and Discussion

Rapidly increasing demand for public transport in Indian cities have put tremendous pressure on the existing public transport (Pucher et al., 2004) and the situation in the most metropolitan city like Delhi is rapidly deteriorating because of it. Indian cities of all sizes are facing the same issues related to transport. Despite investments in road infrastructure and plans for land use and transport development, each city faces the problem of congestion, traffic, accidents, noise and air pollution and the problems continue to grow day by day (Singh, 2012). Megacities are facing a record growth of motorized vehicles ownership (two wheelers and cars) whereas medium and small cities with different forms of intermediate public transport provided by informal sector are struggling to meet the mobility demands of city resident. In Delhi, the number of two wheelers and cars continue to rise at a very fast rate. Despite construction of flyovers and roads, the roads continue to face congestion at peak hours. In big cities like Delhi, the concept of peak hour is an old saying and it appears that all the time is peak hour. This large number of motor vehicles causes extreme congestion on roads, ever slowing speed, wastage of fuel, environmental pollution and an unacceptable level of road accidents, in spite of the roads occupying 21 per cent of the total city area.

Population Growth in Delhi

Delhi being one of the largest cities of India is also one of the largest growth centers; therefore, it attracts a large population who came to Delhi in search of livelihood, education, better standard of living and better infrastructure etc. So unprecedented growth of population takes place in Delhi, NCR. The average annual growth rate of urban population in Delhi during 1981-91 was 5.14% which became about 2% between 2001 and 2011. The 2% average annual growth is also quite high because of large population base. Share of urban population to total population of Delhi was 92.10% in 1981 which becomes 97.50% in 2011. Average annual growth rate of urban population in Delhi was quite high during 1981-91 and 1991-2001 i.e. 4.79% and 5.23% respectively. Because of decentralization of population and economic activity in Delhi NCR region average annual growth of urban population of Delhi decreased during 2001-11 (Table 2).

Table 2. Delhi- Urban Population and Urban Growth

S. No	Year	Population	Average Annual Population Growth rate (%)	Urban Population	Share of Urban Population (%)	Average Annual Urban Population Growth rate (%)
1	1981	62,20,406	-	57,29,283	92.10	-
2	1991	94,20,644	5.14	84,71,625	89.93	4.79
3	2001	1,38,50,507	4.70	1,29,05,780	93.18	5.23
4	2011	1,67,53,235	2.10	1,63,33,916	97.50	2.66

Source: Census of India (1981, 1991, 2001 and 2011)

Similarly, the annual growth of vehicles in Delhi has also increased from 4.72 per cent in 1999-2000 to 6.89 per cent in 2014-15. During the same period the number of vehicles per thousand population increased considerably i.e. from 253 to 487 (Table 3).

Table 3. Availability of vehicles per thousand populations in Delhi

S. No	Years	Number of Vehicles	Annual Growth of Vehicles (%)	No. of Vehicles per 1000 Populations
1	1999-2000	31,63,565	4.72	253
2	2000-2001	33,75,153	6.69	244
3	2001-2002	36,17,853	7.19	256
4	2002-2003	38,86,072	7.41	270
5	2003-2004	41,60,760	7.07	284
6	2004-2005	44,67,154	7.36	299
7	2005-2006	48,30,136	8.13	317
8	2006-2007	52,32,426	8.33	337
9	2007-2008	56,27,384	7.55	356
10	2008-2009	60,26,561	7.09	374
11	2009-2010	64,66,713	7.30	393
12	2010-2011	69,47,536	7.44	415
13	2011-2012	74,52,985	7.27	436
14	2012-2013	77,85,638	4.46	446
15	2013-2014	82,58,284	6.07	465
16	2014-2015	88,27,431	6.89	487

Source: Central Road and Research Institute (CRRI), 2016

Private and Public Vehicles in Delhi

Population of Delhi and its nearby cities almost doubled during 1991 and 2011, at the same time the number of registered motorized vehicles increased more than three times (SoE- Delhi, 2012). In Delhi there is mixed type of traffic composition. A large variety of about a dozen types of both slow and fast moving vehicles are plying on the road where 2-wheelers and cars/jeeps constitute the highest share amongst them (Singh, 2005). The study shows that there is increase in all categories of vehicles like cars/jeeps, 2 wheelers, auto, taxi, buses and good vehicles between 1980 and 2016. It is seen that during 1980 and 2016 share of buses decreased from 1.52% to just 0.45% whereas share of cars and jeeps increased from 22.48% to 30.77%. Another most important issue is the share of goods vehicles also decreased from 6.85% to 2.90%. The share of two wheelers is highest which is also more or less same and there is just about 2% change in their share i.e. 64.13% to 62.90% (Table 4). The analysis of data related to public and private vehicles and change in their numbers bring out the fact about issue of higher dependency on privately owned vehicles which are the major cause for traffic congestion and lack of parking space etc. So these facts shows that there is an urgent need of development of public transport system in Delhi.

Average annual growth of public and private transport have increased by 23.84% during 1981-91 and 4% during 2011-16. The number of cars/jeeps increased at 22.73%

during 1981-91 and 3.74% during 2011-16, whereas the number of buses increased by 17.72% during 1981-91 but it decreased by 2.89% during 2011-16 (Table 5). The study also shows that there is an increase of 21.56% in taxi, this mainly because of the introduction of various cabs and after 2011 app based cabs i.e. Ola and Uber etc.

Table 4. Numbers of Public and Private Transport Vehicles in Delhi

S. No.	Year	Cars/Jeeps	Two Wheelers	Auto	Taxi	Buses	Goods Vehicles	Total
1	1980-1981	1,17,213 (22.48%)	3,34,389 (64.13%)	19,947 (3.83%)	6,255 (1.20%)	7,912 (1.52%)	35,741 (6.85%)	5,21,457 (100%)
2	1990-1991	3,83,610 (21.74%)	11,91,186 (67.51%)	62,007 (3.51%)	10,026 (0.57%)	18,651 (1.06%)	99,078 (5.61%)	17,64,558 (100%)
3	2000-2001	9,20,723 (26.64%)	22,30,534 (64.53%)	86,985 (2.52%)	18,362 (0.53%)	41,483 (1.20%)	1,58,492 (1.20%)	34,56,579 (100%)
4	2010-2011	21,73,323 (31.35%)	43,42,403 (62.64%)	88,181 (1.27%)	57,958 (0.84%)	61,471 (0.89%)	2,09,370 (3.02%)	69,32,706 (100%)
5	2015-2016	29,86,579 (30.77%)	61,04,070 (62.90%)	1,98,137 (2.04%)	91,073 (0.94%)	43,723 (0.45%)	2,81,159 (2.90%)	97,04,741 (100%)

Source: Central Road and Research Institute (CRRI), 2016

Table 5. Average Annual Growth of Public/Private Transport Vehicles in Delhi (in %)

S. No	Year	Cars/Jeeps	2 Wheelers	Auto	Taxi	Buses	Goods Vehicles	Total
1	1981-91	22.73	25.62	21.09	6.03	13.57	17.72	23.84
2	1991-01	14.00	8.73	4.03	8.31	12.24	6.00	9.59
3	2001-11	13.60	9.47	0.14	21.56	4.82	3.21	10.06
4	2011-16	3.74	4.06	12.47	5.71	-2.89	3.43	4.00

Source: Central Road and Research Institute (CRRI), 2016

Road network

In contrast to the increase in the number of vehicles i.e. about 48.92% per annum from 1981 to 2016, the road length in Delhi has meagerly increased at the rate of 3.68% per annum (Table 6). In Delhi density of road is about 155 km per 100,000 population and is accommodating about 80 vehicles per kilometer. In Delhi the fringe area, which is under-developed and sparsely populated, has the maximum share of absolute road length (34%) while Trans-Yamuna, with one-fourth of the population, has only 14% of absolute road length (Economic Survey of Delhi, 2014-15).

Public Transport System Scenario in Delhi:

More and more people are depending on private vehicles for commuting between their work-place and home, because the provision of transport infrastructure has not kept pace with the demand for transport services, which leads to the problem of congestion and traffic. Besides traffic and congestion, these insufficiencies in public transport have resulted in delays and consequent reduction in speed and finally a high rate of road traffic fatalities, making driving and travelling conditions in Delhi highly unsafe.

Table 6. Growth of Road Network in Delhi (2008-15)

3	Year	Length of Road (kms)	Average Annual Growth Rate (%)
1	1980-81	14,316	-
2	1990-91	21,564	5.06
3	2000-01	28,508	3.22
4	2010-11	32,442	1.38
5	2015-16	33,260	0.25

Source: - Delhi Statistical Handbook 2016

DTC is the largest public transport entity in the Delhi NCR region. 3781 low floor AC and non-AC CNG buses and 924 standard floor buses carry about 39 lakh passengers daily by covering 7.87 average km daily (Economic Survey of Delhi, 2014-15). Study shows that between 2001 and 2015 there is an increase in the number of DTC buses but fleet utilization of DTC buses is not good compared to other cities such as Bangalore (91%) and Hyderabad (99%) (The Hindu, 2017). Utilisation of vehicles also reduced between 2001 and 2015 from 211 km/bus/day to 188 km/bus/day. On an average daily passenger carried per bus by DTC is 890.57 (Table 7).

Table 7. Performance of Delhi Transport Corporation (DTC)

S. No	Years	Fleet (No)	Fleet Utilisation (%)	Vehicle Utilisation (Km/Bus/Day)	Passengers Carried per Bus Daily
1	2001-02	3,286	71.68	211	854
2	2002-03	3,082	79.85	214	1,008
3	2003-04	3,656	85.49	224	906
4	2004-05	3,470	83.98	230	962
5	2005-06	3,469	90.51	226	973
6	2006-07	3,444	81.47	199	951
7	2007-08	3,537	82.47	177	848
8	2008-09	3,804	77.03	171	772
9	2009-10	4,725	80.99	184	776
10	2010-11	6,204	75.03	185	700
11	2011-12	5,892	84.27	199	863
12	2012-13	5,445	85.77	202	973
13	2013-14	5,223	85.51	190	952
14	2014-15	4,712	83.99	188	930

Source: Economic survey of Delhi, 2014-15

Mass Rapid Transit system (MRTS): Delhi Metro

The Mass Rapid Transit System (MRTS) is a very ambitious project, which is developed for provision of a non-polluting, capable and well-organized rail-based transport

system that is properly integrated with the road transport system. Under MRTS project Delhi metro is developed in three different phases, i.e. phase I, II and III. In 1984 planning for the metro started at that time the Delhi Development Authority (DDA) and the Urban Arts Commission (UAC) came up with a framework for development of a multi-modal transport system for the city. In May 1995, Delhi Metro Rail Corporation (DMRC) was incorporated and in 1998 construction of the Delhi metro project was started and in 2002 the first section, on the Red Line was opened. The development of the network was divided into phases, Phase I containing 3 lines was completed by 2006, and Phase II in 2011. Phase III is scheduled to be mostly completed by 2018 (Sidharatha, 2017). Total length covered by metro increased from about 74 kms to about 296 kms i.e. around 298% in a duration of fourteen years. Total ridership of Delhi metro increased at about 2065.32 % from 1.24 lakh to 26.85 lakh and the number of stations covered increased from 58 to 214 i.e. about 269 % rise between 2004 and 2018 (Table 8).

Delhi Metro User Satisfaction

To know the satisfaction of people with the service of Delhi metro, metro user survey is done near Hauz Khas metro station where Magenta and Yellow line meets. Survey of Delhi Metro passengers was conducted during the month of June, 2018 through structured questionnaire. During morning and evening peak hours of travel i.e. starting at 8 AM and 6 PM respectively, the survey was conducted. In total, 1,082 respondents have been surveyed. The survey consisted of nine questions regarding access and egress modes, origin and destination metro stations, auto ownership, alternative modes, and a question to investigate induced trips. The following sections describe the results from the different survey questions.

Table 8. Development of Delhi Metro Service

S. No	Year	Length (km)	Stations	Ridership
1	2004-05	74.40	58	1,24,000
2	2005-06	124.24	102	2,68,000
3	2006-07	124.24	102	4,84,000
4	2007-08	124.24	102	6,25,000
5	2008-09	124.24	102	7,22,000
6	2009-10	132.98	110	9,19,000
7	2010-11	225.40	163	12,59,000
8	2011-12	228.72	171	16,60,000
9	2012-13	228.72	171	19,26,000
10	2013-14	228.72	171	21,90,000
11	2014-15	228.72	171	23,86,000
12	2015-16	228.72	171	25,90,000
13	2016-17	228.72	171	27,60,000
14	2017-18	296.10	214	26,85,000

Source: Delhi Metro Rail Corporation (DMRC), 2018

Access and Egress Modes

During the survey respondents were asked about the modes used to access their metro boarding station, and the modes used after de-boarding the metro station. More than 50% of the respondents (52% - access, and 57% – egress) answered that they prefer non-motorized modes (walk, cycle and rickshaw) for their access-egress trips – with almost 44% of respondents walking. About one-fifth and one-tenth of the respondents answered that they prefer autos and buses, respectively. The preference for motorcycles and cars differs in access and egress trips. For access trips, motorcycles were used by 4.25% respondents, while cars were used by 12.20%, for egress trips, motorcycle usage reduced to 2.96 % and car usage reduced to 7.21% (Table 9).

A majority of the respondents using non-motorized modes for the connectivity of their metro trip which underscores the importance of infrastructure, which could provide safe movement of non-motorized modes and augment the current metro ridership. Moreover, the smaller share of bus use for access (11.18%) and egress trips (11.37 %) may be an indicator of inconvenience, due to the changing of modes, additional wait times and expenses.

Table 9. Access and Egress Mode in Delhi Metro

S. No	Mode	Access mode		Egress mode	
		Number of Respondents	Per cent of Respondents	Number of Respondents	Per cent of Respondents
1	Walk	473	43.72	477	44.09
2	Cycle	17	1.57	5	0.46
3	Rickshaw	70	6.47	142	13.12
4	Motorcycle	46	4.25	32	2.96
5	Auto	223	20.61	225	20.79
6	Bus	121	11.18	123	11.37
7	Car	132	12.20	78	7.21
Total		1,082	100.00	1,082	100.00

Source: Primary survey, 2018

Alternative Mode

During survey respondents were asked about the alternative mode they use for the trip if metro facility is not available. About 37.52% respondents said they use their own vehicle for the trip and about 13.31% use bus. Auto is the most preferred choice in the absence of metro as 48.06% respondents said they use auto as an alternative mode for the trip (Table 10). Auto is the most preferred mode of transport other than metro because there is no need to wait for auto whereas in the case of bus one may have to wait for 10-15 minutes. Besides this it also helps to avoid crowd whereas DTC buses are very crowded especially during office hours.

Vehicle Ownership

Vehicle ownership is mainly enquired to know the reality and compare the secondary data collected from CRRI to the primary data. The commuters were further asked to mention the type of vehicle, which they own. About 40.30% mentioned having no vehicles, about 59.71% mentioned that they have their own vehicles to commute i.e. cycle, motorcycle and cars (Table 11).

Table 10. Alternative Mode of Travel in Delhi

S. No	Mode	Number of Respondents	Per cent of Respondents
1	Walk	9	0.83
2	Cycle	4	0.37
3	Rickshaw	3	0.28
4	Motorcycle	165	15.25
5	Auto	520	48.06
6	Bus	144	13.31
7	Car	237	21.90
Total		1,082	100.00

Source: Primary survey, 2018

Table 11. Vehicle Ownership in Delhi

S. No	Mode	Number of Respondents	Per cent of Respondents
1	None	436	40.30
2	Cycle	16	1.48
3	Motorcycle	318	29.39
4	Car	312	28.84
Total		1,082	100.00

Source: Primary survey, 2018

Metro Ridership (Induced Trip)

The surveyed respondents were asked whether they would still commute from one end to another end of the city or they would prefer to stay in close - by areas of their work place (known as induced trip), if the metro services were not available. In order to estimate the number of trips that an individual takes a Metro ride, almost 13% of respondents said they would not travel if metro facility is not available (Table 12). Whereas a large part of the respondents i.e. 83.46% said yes, they will travel from one end to another end of the city for work and for other activities also even if the metro is not available. In Delhi private cabs (other than app based) are also available which people use to commute on sharing basis especially for satellite townships like Gurgaon, Noida and Faridabad etc.

Table 12. Metro Ridership

S. No	Response	Number of Respondents	Per cent of Respondents
1	Yes	903	83.46
2	Maybe	39	3.60
3	No	140	12.94
Total		1,082	100.00

Average Trip Length

To determine the travel distance of the commuters, respondents were asked during the survey to point out their boarding and destination metro stations. Travel distance on the metro route has been calculated using this information. For this the latitude and longitudes of all metro stations were located on Google Earth and then the distance between two

consecutive metro stations were calculated by drawing the straight line between the two stations. This is a safe approximation because the alignment of metro stations is mostly made as a straight line between two stations. It is seen in the study that on an average, a commuter of Delhi metro travelled a distance of 19.85 km with 7.95 standard deviation (Table 13).

Table 13. Percentage of Respondents for Different Travel Distance Categories

S. No.	Distance (km)	Number of Respondents	Per cent of Respondents
1	0-5	53	4.90
2	5-10	127	11.74
3	10-15	195	18.02
4	15-20	241	22.27
5	20-25	167	15.43
6	25-30	106	9.80
7	30-35	89	8.23
8	35-40	60	5.55
9	40-45	36	3.33
10	45-50	8	0.74
Mean (μ)		19.84	10
Standard Deviation (σ)		7.95	11

Source: Primary Survey, 2018

About 83.37% of all the respondents travelled more than 10 km of distance on the metro, with about 65.52 % in the 10 to 30 km range. These results provide important insight into the travel characteristics of metro users where only 15% people take a trip of less than 10 km. So it can be said that metro users travel longer distances (Fig. 3).

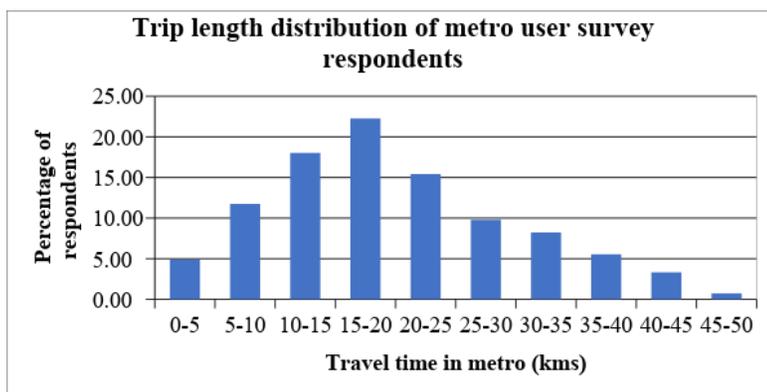


Fig. 3. Metro Trip Length

Average Trip Fare

Applying the information of the origin and destination of metro stations, the fare paid for each trip was calculated using the fare chart available on the Delhi Metro website. About 92% respondents spend more than 20 rupees and about 54% respondents spend more than 30 rupees on travelling in Delhi metro. Respondents who spend between 20 to 30 rupees are highest i.e. 37.80 % (Table 14). If we compare the average metro fare with AC city bus fare, the metro fare is higher by 15-20 rupees, but still people prefer to travel by metro because of lesser time and smooth ride by metro compared to the bus.

Table 14. Metro Fare Paid by Respondents

S. No.	Fare (in Rupees)	Number of Respondents	Per cent of Respondents
1	< 10	21	1.94
2	10-20	66	6.10
3	20-30	409	37.80
4	30-40	301	27.82
5	>40	285	26.34
Mean (μ)		32.1	-
S.D (σ)		3.8	-

Delhi metro is the second most unaffordable metro in world after Hanoi (Roy and Gandhiok, 2018). A study carried out by the Centre for Science and Environment (CSE) suggested that because of increase in metro fare in 2017, the average commuters in Delhi spend about 14% of their household income on metro fare and the fare hike had led to 46% drop in ridership (TOI, 2017) because the projected ridership of Delhi metro is 39.5 lakh riders for the year 2016 but it is only 27 lakh in 2018 (CSE, 2018). If we compare the ridership of 2017 and 2018, it is seen that there is about 2.72% decline in riders (DMRC, 2018) as shown in Fig. 4.

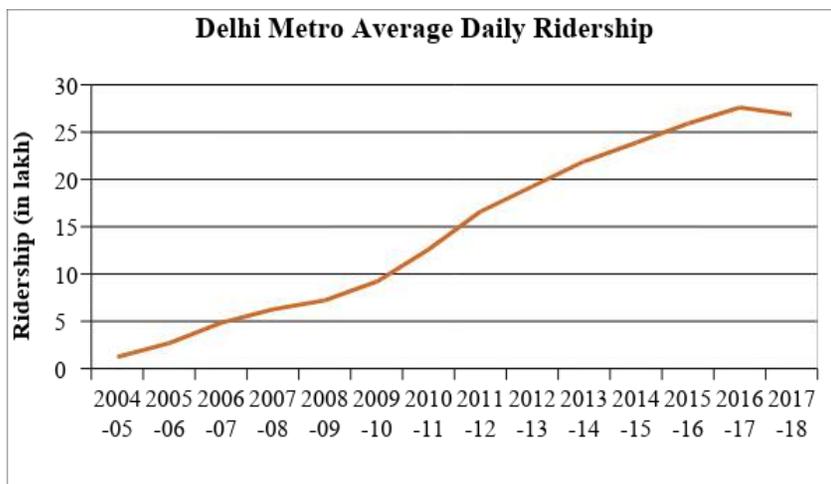


Fig. 4. Average Metro Riders in Delhi

Conclusion

Transportation in metropolitan cities is seen as lifeline because it can improve the speed and efficiency of the city and help in progress. This study focuses on analysing the need of mass rapid transport service (MRTS) in Delhi and its viability as an alternate option for better commuting. It is seen in the study that there is rapid growth of population in Delhi i.e. 5.64% average annual growth rate between 1981 and 2011. At the same time the number of vehicles and road length also increased during this period but increase of length of road does not take place as compared to the number of vehicles. Vehicles increased with about 49 % annual average growth rate whereas length of road increases with about 4% annual average growth rate. Therefore, the problem of traffic congestion increased which can be solved by promoting the public transport facility especially underground metro. But in Delhi DTC is the body responsible for public transport but sufficient number of DTC buses are not plying. In such a situation, mass rapid transit system is developed in the form of Delhi metro which is showing fast increase in ridership. At present it is approximately 27 lakh but it was expected that there will be 45 lakhs ridership by 2019. To know the satisfaction of people with the service of Delhi metro, Delhi metro user survey is done near Hauz Khas metro station where magenta and yellow line meets. It is found in the study that people are satisfied with the service as it provides safe, secured, smooth and fast mode of transport. But it is seen in the study that to avail the service of metro still users have to be dependent on the road network to reach the metro (access mode) and from metro to their destination place (egress mode). But the most important benefit of metro service according to the respondents is that it reduces the time travel on an average, survey respondents travelled a mean distance of 19.85 km. So Delhi metro helps to some extent in hustle free movement of people, traffic congestion and also helps in reduction in choking air pollution of Delhi. Therefore, it can further be concluded that metro transport is the best option in future for city transportation be it medium or big cities of India.

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