

# SUSTAINABLE AND EQUITABLE TRANSPORT SYSTEM IN DELHI: ISSUES AND POLICY DIRECTION

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## Abstract

The paper highlights the current scenario of transport related, policies and planning and existing transport infrastructure and services in Delhi. It presents a critical analysis of transport planning and practices as per the proposed master plan through transport related expenditures on various components of transport. It suggests that development of NMT infrastructure, operational and physical integration of public transport systems viz. Delhi Metro and Urban Bus services are required for better mobility linked with adequate pathways for NMT. Transport related services are also important and needs examination in detail. The paper provides an outline of transport related services in Delhi and suggestions for proper guidelines and standards to be formulated for operators such as mini bus operators, shared auto and E-Rickshaw.

## INTRODUCTION

The transport sector plays a crucial role in the development process of a country. It has a direct impact on living standards both in terms of economic as well as social well-being. Demand for transportation related services is generally a derived demand for other economic and social activities such as activities related to health, education, employment, etc. Transport infrastructure needs are assessed based on the demand scenario of such activities which form the potential market for transport infrastructure and services. It is in this context, that the provision of transport related infrastructure and services varies in accordance with its market potential. Accordingly, characteristics of the mobility needs of the people form the basis of the types of infrastructural needs and characteristics of the required transportation services.

During recent times, mobility needs of the people, due to increasing economic activities, have been insatiably increasing across the globe in general and across the developing world in particular (Acharya, 2005). This phenomenon is ubiquitous in megacities in Asia. Modern mechanization of transportation systems further fueled this phenomenon and heavy motorization is evident in these cities. Thus, motorized transport is fulfilling these insatiable transport needs. In turn, transport systems have become environmentally unsustainable and are now one of the major contributors of greenhouse gas emissions worldwide. Thus, a sustainable and equitable transport system is one that provides mobility related facilities and services while minimizing emissions both at local and global level and also serve as safe, reliable and economical means of mobility for all the sections of society including elderly, women and disabled persons (Black, 2010).

In addition, the absence of mass transit systems and the domination of privately owned vehicles on the roads results in the state of poorer and prohibited usage of the public infrastructure which creates inequitable transport system. This coupled with negative externalities like rise in accidents and increasing level of pollution caused by such transport systems negatively affecting both users and non-users of the existing transport system. This phenomenon is equally true in Delhi. Despite the major improvements in public transport systems, India's capital city, Delhi is still suffering from these ills affecting both the provision of infrastructure and its related services.

Delhi is a hub for personal motorized vehicles in India. Total motorized vehicles in Delhi comprised of more than 4.6 per cent of the total at national level in 2012 whereas in the case of cars and two wheelers, Delhi accounted for more than 12 per cent of total cars and 22 per cent of total two wheelers in the country respectively in 2012 (Ministry of Road Transport, 2013). Within Delhi, car and jeeps accounted for more than 30 per cent of the total registered motorized vehicles in the city

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(Government of Delhi, 2014, pp. 201). Given the concentration of motorized vehicles, traffic congestion and declining air quality is evident in Delhi. As per the recent survey by the Centre for Science and Environment (CSE), air pollution levels are not only increasing but also adversely affecting those who are contributing in reducing the pollution, in this case the users of non-motorized transport (CSE, 2015). Delhi Master Plan, 2021 also states that this situation of increasing motorization is likely to worsen due to increasing economic activities and the pressures of population growth, likely to be at 2.9 per cent annually during 2016-21 (DDA, 2007).

To tackle an insatiable demand for transport, strategies have been developed by the master plan for the development of the city which also includes small steps as demand side management like rationalization of parking charges. Major steps such as demand side management measures are still on the policy discourse. Facilitating environmental friendly transport modes like non-motorized transport (NMT) is an alternate approach to the same at least for shorter distances which has also been included in the priority areas of the master plan. However, as a result of low levels of investments in NMT, last mile connectivity and less capital intensive public transport systems, passenger mobility is less eco-friendly and the use of NMT is unsafe. Moreover, transportation systems in the city are disintegrated at both physical and operational levels. For example, Delhi's public transport like bus and metro rail clearly present a state of disintegrated systems. Physical integration implies combining the infrastructure of the two facilities. At present there is a lack of space for bus stations to be connected with the metro rail through suitable pathways. At the operational level, the commuters of both metro rail and public buses are compelled to use separate tickets, passes to travel in the city. The separation manifests also at the management of the operational of these two services which could lead to diseconomies in the scale of operation leading to financial losses to both consumers and the economy as a whole. Those most significantly affected are the poor in society who are using public transport, non-motorized transport and who have a smaller propensity to spend on travel. Therefore, transportation planning and policy needs to be revisited in terms of both sustainability of the system and equity in services in Delhi (DDA, 2007).

The objective of this paper is to analyze these very important aspects of Delhi's transportation systems. The paper presents a critical analysis of transport planning and practices for the given state of transport demand in the city. It examines the state of transportation infrastructure in Delhi with a view to derive conclusions about its sustainability and equity in the approach of transport development. Finally, it presents recommendations to frame appropriate policies for developing equitable reliable, safe and environmentally sustainable city transportation system.

## **1. STATE OF TRANSPORT DEMAND IN DELHI**

As stated earlier, transport is a derived demand. It has close linkages with other economic and social activities. At the macro level, overall economic performance also determines the level of transport demand in the city. Delhi's economy has grown at more than 9 per cent average annual growth rate during 2005-15 (Economic Survey of Delhi, 2014-15). The expansion of economic activities resulted in increase in the population from migration. Table 1 shows that during 1980 to 1990, the population increase in Delhi was about 2.8 million (Government of NCT of Delhi, 2014). During the 1990s, this increase mounted to 4.2 million. However, this trend has been found to be slower between 2000 and 2011. The total increase in the population was estimated to be 3.3 million, lower than the increase during previous decade. Delhi's gross population was 6.2 million in 1980 which rose to 16.7 million in 2011- a more than two and half times increase in the size of the population of Delhi during the last 20 years. The increase in the size of the economy was estimated to be about nine-fold during the same period. Per capita income of Delhi increased by more than 20-fold during 1980-2011 (Government of NCT of Delhi, 2014).

This change is catalyzing Delhi's transport planning as well. Per capita income of Delhi was increasing at a 7 per cent average annual growth rate during 2005-11. In 1980, per capita income in Delhi was US\$ 92.6 which increased to US\$ 2562.2 in 2011, an almost 28 times increase in the per capita income (Government of NCT of Delhi, 2014).

**Table 1. Macroeconomic Indicators**

Indicators	1980	1985	1990	1995	2000	2005	2010	2011
Population in million	6.2	7.3	9	9.1	13.2	15	16.5	16.7
Population density (persons/sq km)	4180.7	4922.5	6068.8	6136.2	8900.9	10114.6	11126.1	11297.0
GDP growth (per cent change on YoY)	N.A	4.7	10.2	11.1	4.1	11.6	14.8	19.2
Per capita income (US\$)	92.6	127.2	225.3	437.9	740.8	1101.3	2171.3	2562.2

Source: Estimated from various sources like Economic Survey of Delhi, Population data of CSO, Labour Department, and Government of Delhi (Statistical Handbook). The estimates are based on data in Rs. The estimates assume \$ 1 = Rs. 58

Note: The growth rate and per capita income is at current price and Years are the financial year in Indian context with 31 March ending month.

It is also recognized that rise in per capita income leads to increases in the size of household holdings of personalized vehicles if other things remain constant. This is reflected in the trend of in the size of personalized vehicles and changing composition of motorized vehicles in Delhi (Table 2). An unprecedented increase in demand for urban mobility was noted by Master Plan-2021. The city's ownership of cars increased in absolute number from 400,000 in 1990 to 870,000 in 2000 (Government of NCT of Delhi, 2014). This further increased to 2173,000 in 2011 (Government of NCT of Delhi, 2014). In terms of cars per 1000 persons, the number has also increased from 64.3 in 1990 to 134.1 in 2011. The same is also noted in the case of motorcycle per 1000 persons from 197 in 1990 to 288 in 2011 (table 2). Alternatively, total number of buses, the backbone of Delhi's public transport, has not increased in the same proportion when compared to private vehicles. Delhi's urban transportation has been moving towards domination by private vehicles during the last three decades.

**Table 2. Trend of Motorized Vehicles in Delhi**

Motorised Vehicles	1990	1995	2000	2005	2010	2011
Total Vehicles (in 000)	1810	2430	3350	4470	7230	7350
Truck (in 000)	100	130	160	120	240	130
Passenger Car (in 000)	400	580	870	1431	2013	2173
Motorcycle (in 000)	1220	1620	2180	2840	4400	4342
Others (in 000)	90	110	140	150	390	390
Population (in million)	6.2	7.3	9	9.1	15.9	16.2
Cars per 1000 persons	64.3	78.9	96.6	149.4	138.1	134.1
Motorcycle per 1000 persons	196.9	221.6	242.7	312.1	276.4	287.8
No. of Buses*	4392	2770	1932	3469	6204	5884
No. of Non-AC Buses*	4392	2770	1932	3469	4954	4609

Source: Various Issues of Economic Survey of Delhi, Government of Delhi and Ministry of Road Transport and Highways, Government of India.

\*buses are owned by Delhi Transport Corporation (a public sector unit) only

Note: Years are the financial year in Indian context with 31 March ending month.

Master plans were developed to guide the futuristic expansion path for towns in Delhi. This started with the Delhi Development Act, 1957 and later Master Plan of Delhi in 1962 (DDA, 2007).<sup>2</sup> The Master plan was revised in 1990 to focus on developing urban spatial structure. The revised master plan had ten year perspective planning. This later revised in 2007 as Master Plan-2021.

In addition to the perspective planning for urban development, these master plans also focused on transport related policies. As per Master Plan- 2001, 14 million passenger trips daily was assessed to be originating and it was hoped that public transport would cater to the majority of these

<sup>2</sup> Delhi Master Plan-2021, The Perspective for Year 2021, <http://delhi-masterplan.com/>, accessed on 25 May 2015

trips. The expected number of trips is likely to be more than 28 million by the year 2021. This projection also includes 2.3 million non-motorized trips.<sup>3</sup> The notable difference between these two plans is the recognition of the importance of NMT. Master Plan 2021 suggests that 7.4 per cent of the projected daily passenger trips would be trips generated by NMT (table 3).

**Table 3. Modal Split as Envisaged in Delhi Master Plans ( per cent)**

<b>Modes</b>	<b>2001</b>	<b>2021</b>
Rail	8.57	0.5
Bus/Tram/Light Rail	65.97	46.3
Personalised Fast modes	12.26	36.7
Hired Fast Modes	3.27	
Hired Slow modes	0.65	4.1
Bicycle	9.28	5.0
Other NMT		7.4

Source: Delhi Master Plan and RITES, 2010

As per the assessment of Delhi Master Plan-2021, daily transport demand is likely to increase from 13.9 million passenger trips in 2001 to 27.9 million passenger trips in 2021. Based on the projected demand scenario of transport, it is also estimated that, 55000 km road infrastructure would be needed against the availability of 28000 km roads by 2021. In view of this, it would be important to see that how the basic infrastructure is being built for reliable, safe and environmentally sustainable transport system in the city. This is examined in the next section in terms of investment in transportation sector in Delhi.

## 2. INVESTMENT IN TRANSPORT INFRASTRUCTURE

As noted earlier, by 2021 about 28 million passenger trips is expected to be originated on a daily basis. Of these, the majority of the trips are envisaged to be catered for by public transport which includes bus and metro services in Delhi. This makes the case for improving the infrastructure of public transport in Delhi. In this direction, successful construction and operation of metro rail, as a mass transit, has been initiated. In addition, the experiment for bus rapid transit corridor was also undertaken by the government and different modalities of the same are under examination but no progress has been reported and no provision of expenditure has been made in the budget for the year 2015-16 of the Delhi Government.

**Table 4. Annual Plan Expenditure in Delhi ( per cent share)**

<b>Sectors</b>	<b>2002-03</b>	<b>2003-04</b>	<b>2004-05</b>	<b>2005-06</b>	<b>2006-07</b>
Ports & Light Houses	0.0	0.0	0.0	0.0	0.0
Civil Aviation	0.0	0.0	0.0	0.0	0.0
Roads and Bridges	40.4	44.5	55.0	60.5	66.2
Road Transport	59.6	2.8	11.2	1.8	4.2
Inland Water Transport	0.0	0.0	0.0	0.0	0.0
Other Transport Services	0.0	52.6	33.8	37.6	29.6
<b>Sectors</b>	<b>2007-08</b>	<b>2008-09</b>	<b>2009-10</b>	<b>2010-11</b>	<b>2011-12</b>
Ports & Light Houses	0.0	0.0	0.0	0.0	0.0
Civil Aviation	0.0	0.0	0.0	0.0	0.0
Roads and Bridges	39.2	52.2	61.8	52.9	46.5
Road Transport	27.5	16.0	0.0	46.5	23.3
Inland Water Transport	0.0	0.0	0.0	0.0	0.0
Other Transport Services	33.4	31.8	38.2	0.6	30.2

Source: Planning Commission, Government of India, 2011-12 is approved outlay

<sup>3</sup> ibid.

In case of NMT, which is envisaged to play critical role in the future as a link to public transit systems, as outlined in Delhi Master Plan -2021 it also needs critical attention. This would need expenditure in improving NMT infrastructure. It is also important that major infrastructure for NMT is provided at municipal level; however, a city level outlay dedicated to NMT is also required due to India's planning characteristics which follows top down models. Transport related expenditure of the government indicates a low level of expenditure made in the area of NMT. During 2002-07 (10<sup>th</sup> Five Year Plan) and 2007-12 (11<sup>th</sup> Five Year Plan), expenditure on roads and bridges dominated (table 4). Expenditure on roads and bridges includes outlay on construction of roads and construction of bridges. Expenditure on road transport includes expenditure incurred by the transport department primarily in strengthening the transport related institutions. Expenditure under the head of other forms of transport, expenditure on street lights, construction of infrastructure for NMT, foot-over bridges, etc. is included. During 2002-07, maximum expenditure was estimated on account of roads and bridges. A similar trend is noted in during 2007-12. To understand the actual position of NMT in these expenditures, it would be important to examine the agency wise expenditure.

In 2002-07, a large investment was envisaged by various departments. Transport department of the Government of Delhi estimated an outlay of US\$ 506.7 million, of which 49 per cent was likely to be devoted for the mass rapid transit system. Total outlay was envisaged to be US\$ 939.1 million of which 54 per cent was likely to be expended by the transport department. Local authorities that are supposed to facilitate transport infrastructure for non-motorized vehicles accounted for only 11 per cent of the total outlay approved (DDA, 2007). During 2002-07, major targets were the rapid bus transit system, road expansion and Metro Rail Transit System (MRTS). In this context, the approved expenditure for the different agencies was US\$ 27.6 million for PWD (28.7 per cent of the total outlay), US\$ 12.9 million for Municipal Corporation of Delhi (MCD) (13.6 per cent of the total outlay) and US\$ 53.5 million to the transport department (57.1 per cent). The rest of the allocation was approved for New Delhi Municipal Corporation (NDMC) (Government of NCT of Delhi, 2013).<sup>4</sup> Expenditure on account of Public Works Department (PWD) was limited to projects like development of parking, Transport Nagar (an area exclusively dedicated to transporters with transport related facilities like parking, transporter's offices, repair and maintenance facilities, etc.), construction of road under bridges, etc. Limited expenditure was planned for strengthening of pedestrian and NMT infrastructure.<sup>5</sup> US\$ 17,241 was approved for the period 2002-07 for this cause. This is about 0.02 per cent of the total outlay approved for transport sector.<sup>6</sup>

Similar trends are seen during the 2007-12. The approved outlay for the transport sector during the period was Rs. US\$ 3,202 million of which US\$ 1,341.3 billion was approved for transport department wherein major expenditure was approved for restructuring of the DTC. In addition, expenditure was approved for rapid transit corridors and development of the metro rail in Delhi. 0.06 per cent of the approved outlay under the transport department was meant for encouragement of pedestrian and NMT vehicles. PWD accounted for 47 per cent of the approved expenditure under the transport head during 2007-12. Of these approved outlays, major projects were related to the construction of bridges and development of roads. Such a small allocation for NMT in the planned expenditure suggests a slower pace of the development of NMT infrastructure from top in the State Government's allocation and which is negligible at the municipal level. While an increase in the planned expenditure on urban transit system and related infrastructure is essential for better and faster passenger mobility, it is also essential that adequate NMT infrastructure be developed to link these systems for reliable and safe mobility of passenger which is also economical to them.

### 3. STATE OF NMT INFRASTRUCTURE

In Delhi, the present state of NMT infrastructure needs a thorough investigation with respect to the proposed accessibility plan. Planning of transportation infrastructure is guided by this principle as outlined in Delhi Master Plan-2001. As envisaged, the transport requirement for the future would be designed with the goal to provide accessibility to social infrastructure that includes education, health, market and other facilities. As per the proposed accessibility plan, the people of Delhi should

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<sup>4</sup>Government of Delhi, Plan Documents, Available on [http://www.delhi.gov.in/wps/wcm/connect/DoIT\\_Planning/planning/plan+documents/scheme-wise+write-up+v1/transport](http://www.delhi.gov.in/wps/wcm/connect/DoIT_Planning/planning/plan+documents/scheme-wise+write-up+v1/transport) (Note: US\$ 1= Rs. 58 as conversion factor)

<sup>5</sup> Ibid.

<sup>6</sup> Ibid. pp. 361

enjoy easy, safe and reliable access to major services relating to health and education located within walking distances (table 5). However, such facilities are usually located at distances demanding for the use of motorized transport. Therefore, an alternative is to make such facilities easily accessible by public transport to ensure having easy and safe access. This could be done through the provision of a reliable and safe urban transport that is adequately connected with NMT infrastructure at closer distances. These were two of the priorities of the Delhi Master Plan-2001.

In both the scenarios, revamping of the transport infrastructure and services would be required in Delhi due to the fact that development of NMT infrastructure is still to be taken up in the city as a mandate. Although, NMT serves for shorter distance travel, yet it has important role in providing last mile connectivity to major public transport in Delhi such as Metro and Buses and has the potential to improve the connectivity of passenger trips originating at the city level.

**Table 5. Proposed Accessibility Plan**

Proposed Accessibility Plan	Master Plan-2001	
	Distance Km	Approx Walking Time (minutes)
Crèche/Nursery School (Nearest)	0.3	5
Primary School	0.5-0.8	10
Higher Secondary School	1-1.5	20
Tot Lot	0.20-0.30	5
Park	0.5-0.8	10
Play Area	1	20
Bus Stop	0.5-0.8	10

Source: Delhi Master Plan, 2001

It is notable that the proposed plan for accessibility indicates that some of the social infrastructure would be planned within the reach of non-motorized transport like walking and cycling. Therefore, the phase of planning for transportation during 1990-2001 and after 2001 was required to be in this direction in addition to infrastructure relating to transit systems. This aspect is not reflected in the expenditure during the planned period after 2001. During this period, expenditure on the transport sector reflects that the lions share went to road infrastructure and bridges. A little was spent on other transport services and improvement of NMT infrastructure which was equally important for better accessibility to public transport running on these roads. For the development of an environmentally sustainable transport infrastructure a balanced expenditure would be required on both transit oriented transport facilities and also on NMT infrastructure to ensure the level of development of both are comparable and achieves the stated objectives.

At present, the presence of discontinued footpaths discourages pedestrian usage. It is found that major obstacles other than discontinued footpaths are “*potholes, open manholes, poor maintenance of paver blocks, trees, parked vehicles, street furniture like light poles, electric wires, and discontinuity due to driveways*” (Goel and Tiwari, 2014). No uniform design standards are also followed for footpaths resulting in the creation of obstacles for the disabled to use for travel. These problems for pedestrians are further escalated by the presence of long foot-over bridges. There is no uniform design standards followed for the construction of foot-over bridges in Delhi. This leads to the creation of unsafe and non-reliable walking for people including the elderly, children and the handicapped. This results in avoidable accidents most of the time.

An alternate way is to examine the trend of transport related assets assessed by the household survey. As per the census report of Delhi, 2011 a high proportion of households possess a cycle (non-motorized transport vehicle). On average 33.6 per cent of total households have a cycle in Delhi. Relative to this, private car ownership by the households surveyed was reported to be 19.56 per cent. Ownership of a two-wheeler was relatively high at 39.26 per cent. Table 6 presents this scenario in various districts of Delhi. In all the districts two-wheeler is dominating in households. However, in districts like East Delhi, New Delhi, North East Delhi, North West Delhi, West Delhi and

South West Delhi they have a high proportion of households possessing non-motorized transport vehicles.

When we compare the results of the household survey of 2011 with the survey of 2001, it is found that there is significant decrease in number of households having bicycles between 2001 and 2011. It simply outlines the fact that less has been done for the development of NMT infrastructure. At the Delhi level, 37.6 per cent of total households surveyed in 2001 had a bicycle which reduced to 30.6 per cent in 2011. Similarly, during these two periods, the number of household which are using two wheelers had increased. In 2001 28 per cent of the households that had two wheelers rose to 38.90 per cent in 2011. Such an increase is also experienced in case of cars from 13 per cent to 20.7 per cent between the two survey periods (Government of NCT of Delhi, 2015). This trend is alarming and needs to be tackled urgently. It may be construed that if public transport is not attractive in Delhi, the scenario after ten years would be worse. This trend is happening even in the situation when a large scale of expenditure is made in public transport and roads.

**Table 6. Transport Related Assets Possessed by Households (in per cent)**

District	Bicycle	Two-Wheeler	Four-Wheeler
Central	15.76	31.89	20.31
East	28.17	45.32	26.78
New Delhi	37.25	32.96	24.86
North	25.18	34.13	15.07
North East	35.06	40.09	10.78
North West	37.08	38.24	16.77
South	28.88	36.61	23.65
South West	41.94	42.98	18.69
West	31.09	41.78	24.91

Source: Census, 2011

As we have already noted that cars and two-wheelers together carry a major portion of daily passenger trips. Walking and cycling even for shorter distances remain negligible. This scenario is a result of the lack of availability of infrastructure for NMT in these districts. Non-availability of NMT infrastructure has two fundamental consequences. Firstly, the city is not able to utilize the available potential of cycling which has characteristics of sustainability and if adequately linked with public transport systems then it also possess the potential characteristics of inclusivity. The second consequence is limited growth in the potential of NMT as well. In fact, it has experienced negative growth between the household census of 2001 and 2011. Limited data is available on mobility patterns in Delhi. This is an important area for further investigation in how mobility pattern are affected by the changing composition of transport related assets.

The majority of populations in Delhi are dependent on motorized transport for their daily commute. It has been estimated that about 4.5 million daily passenger trips was originated by bicycles in 2006 in which 74.7 per cent was the trips for below 5 km of distances (Arora, 2011). In another study, major cyclists are found to be factory workers accounting for 21 per cent of cyclists. Furthermore, travel distances were up to 10 km for cyclists (Tiwari and Jain, 2008). However, NMT infrastructure for factory workers is severely neglected. The reason behind this neglect is the spatial characteristics of industrial and residential locations of industrial workers. Industrial areas are located along main highways; the residential areas are located in slums (Arora, 2011). This is one of the reasons that the average travel distance of factory workers are too high, up to 10 km daily. In addition to the long travel, cyclists used to travel on major arterial routes on which speeds are usually high. Moreover, poor management of corridor traffic flow and traffic systems do not provide smooth passages to pedestrian and cyclists wherein all road users share same carriageway. These result in fatalities due to accidents on roads (Tiwari, 1999). In addition to this problem, most of the time, the carriageway is also shared by street vendors. A clear separation of pedestrian ways from motorized urban roads would be essential in order to accommodate street vendors at a stretch other than urban roads. Some step was undertaken earlier in this direction but failed to achieve major breakthrough. Bicycle Master Plan (BMP) was developed for Delhi with the objective to develop a network of cycle corridors. However, the progress in this direction remains negligible. An attempt was made to develop a separate cycle track along the Bus Rapid Transit Corridor in 2008.

#### 4. STATE OF PUBLIC TRANSPORT INFRASTRUCTURE

Public transport has two major components viz. bus transport and metro rail. These two major transport systems are playing a vital role in facilitating public transport in Delhi. In fact, both the systems are the lifeline of the people of Delhi. At present, the average ridership of Delhi metro is reported to be 2.4 million per day (Government of Delhi, 2015, pp. 174). Ridership on Metro Rail is further expected to increase up to 4.0 million per day after completion of the final stage of construction of DMRC. On average, daily ridership on DTC is 3.8 million passengers (Government of Delhi, 2015, pp. 181). RITES (2010) points out that there is a need to integrate the two major public transportation systems in the capital.

**Table 7. State of Transport Facilities in Delhi**

Items	Units	2000	2005	2006	2007	2008	2009	2010	2011
General roads investment	Mil \$/year	102.4	115.9	170.2	235.6	327.6	448.5	591.4	427.1
Road network length (Total length)	Km	28508	31183	30923	30985	31199	31229	31183	31969
MCD Road Network	Km	24885	27139	27139	27139	27139	27139	27139	26459
Bus Rapid Transit route length	Km					5.8	5.8	14.5	14.5
Buses	No.	1932	3469	3444	3537	3809	4726	6204	5884
Non-AC Buses	No.	1932	3469	3444	3537	3284	3726	4954	4609
AC Buses	No.	-	-	-	-	525	1000	1250	1275
Release of fund Delhi Metro (end of march)	Mil \$/year			69.8	63.1	117.5	153.0	144.8	219.4
Share of equity in Metro funds (per cent)				85.8	84.1	67.0	82.4	98.2	
Cumulative Length of Delhi Metro	Km	0	-	33	65	68	75	156	162

Source: Government of Delhi, Planned expenditure on road transport and roads, ASRTU Statistical Abstracts and Economic Survey of Delhi, Various Issues  
bridges (Rs. 58 = US\$ 1)

Table 7 presents that general expenditure on roads increased by more than four-fold during 2000-11. Road networks have increased both in case of total road networks and roads managed by municipal corporations in Delhi. A gradual improvement in the capacity of city buses may also be seen which has now more than 5,000 buses plying the roads in Delhi. In case of Delhi Metro, rapid expansion is noted in terms of its length and final phase of the construction of metro rail network is underway.

The presence of public transport infrastructure is quite encouraging in Delhi. However, the basic flaw is the disintegration in the management of public transport systems. Both Delhi Metro and Delhi Bus services are not integrated with each other at the physical and operational levels. For successful public transport in Delhi, there is an urgent need for vertical and horizontal integration of these two transport systems. A recent survey of passengers using Delhi Metro indicates that major portion of the user walk from home (Goel and Tiwari, 2014). When asked about mode of choice after reaching destinations, a higher number of users replied that they were using non-motorized transport (in this case walking). Limited number of users of Metro use cycling for the last mile connectivity. On the other hand, bus and auto constitute more that 30 per cent of the users of metro for last mile connectivity.<sup>7</sup>

There are two major conclusions that can be construed from this outcome of the survey. The first and foremost is the provision of adequate walking and NMT infrastructure for the users of metro

<sup>7</sup> *Ibid.*

rail in Delhi and the second one is integration of bus transport with metro for the users of bus and auto.

There exist several models for integrated multimodal transportation in case of urban mobility. For example, operational integration in terms of a single ticketing system for more than two modes is in operation in cities like Adelaide, Auckland, Singapore and Greater Stockholm. In case of physical integration, a suitable example for Delhi is Singapore. However, it is argued that prior to the operational integration, it would be better to create a physical infrastructure in order to achieve the motive of physical integration between two modes of transport. At present, physical integration between metro and buses merely exist in improper ways. Operational characteristics of bus rapid transit systems other than the physical infrastructure indicate that operational integration between metro and buses may be persuaded prior to the creation of infrastructure for physical integration.

## **5. PROVISION OF TRANSPORT RELATED SERVICES**

Provision of transport infrastructure defines the quality of transport services as well. Non-integrated public transport systems provide space for other players in providing transport related services to users. Major service-providers other than bus and metro rail are auto rickshaw, electric vehicles, mini bus operators and private cab operators. These operators provide both last mile connectivity as well as door to door transport. These players work as both feeders to public transport and also as alternate to the same. Cabs and auto rickshaws play a major role as alternative means of transport. In the case of operators like mini buses and shared auto rickshaws, service standards are not defined and are not being governed by any mobility standards. Presence of such operators in the domain of public transport makes public transport uncomfortable for travel. In addition, a new player is added in this category i.e. electric rickshaw (popularly known as E-Rickshaw) which also needs to be regulated with proper service and operational standards.

Service quality has a critical role in attracting users of private and personalized vehicles and other modes for intra-city travel on public transport. Services include proper schedules, good bus stations, bus stops friendly to users even in the case of disabled users, safety measures for women, reducing congestion on roads by eco driving measures and easy ticketing services, etc.

DTC which manages bus transport in Delhi publishes its time table for various bus routes on its website. These information need to be published on bus stations providing information for bus services to the specific routes at which the station is situated. This may further be augmented to time to time audit of buses for its schedule adherence. Alternatively, geographical information systems may also be developed using intelligent transport system for timely and reliable bus transport in Delhi. Some progress has been made and GPS enabled tracking system is now used in DTC buses. Operational services of public buses in Delhi require a major overhaul in its transport management. DTC is still running a loss and does not have the resources for augmentation in such services. In its budget for the year 2015-16, the Government of Delhi proposed about 20 per cent of the total outlay to the transport sector. This allocation is the second largest allocation after allocation of 24 per cent of total outlay in education. Major priority areas for upgrading the public transport are to improve service quality including high priority for women's safety and adding more buses to DTC.

## **6. THE WAY AHEAD**

In order to make reliable, safe, environmentally sustainable and economical transport system, Delhi as a capital city needs a policy directions towards developing NMT infrastructure as a support to the existing public transport systems and integration of operation between bus transport and metro rail.

In case of NMT, there is a need for planned expenditure in this direction. NMT infrastructure is required to be viewed not only as a support infrastructure for urban transit but also as a separate and alternate mode for travel for shorter distances. It would mostly be managed and developed by municipalities in Delhi which would require funding from State and Central Governments as well. It is recommended that the governments could set up an institution for developing NMT infrastructure which needs to be funded by both central and state governments.

Addressing the issue of public transport, it was noted that metro rail is carrying 2.4 million passengers daily. Similarly, 3.8 million passengers are daily travellers of DTC buses. A survey report suggests that only 11.2 per cent of bus users ride the metro. A clear indication is the operational and physical integration of the two institutions. The two corporations, DMRC and DTC would require working in this direction. It would be useful for establishing a special purpose vehicle in order to perform integrated operation of metro and bus services with larger equity participation from Metro Rail. This may be taken up after completion of the third phase of the construction of metro rail in Delhi which is likely to be completed in December, 2016.

Finally, it is important to define the service standards of other transport providers such as shared auto and mini buses. Proper infrastructure facilities are also required for such operators. These operators play a vital role in facilitating linkages to the nearest transit oriented public transport such as metro and urban bus services under DTC. More recently, electric rickshaw has also been introduced in Delhi to provide services for last mile connectivity. Such facilities are also required regulation and infrastructure support which needs to be taken up in policies and planning related to transport in Delhi.

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