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Planning for Equity in Public Transit: A study of Mass Transit in Delhi

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Abstract - *Equity refers to the distribution of the cost and benefit of a certain resource, project, plan or policy over a different group of people. It is the justice of whether the distribution of the cost of the project impact is appropriate. The decisions often taken in the transportation planning process have significant impacts. These decisions lack the equity considerations which has a diverse impact over different people especially the group which is disadvantaged. Public transit not being a predominant mode of transport still offers basic mobility to all the group of people and providing access to those who can't afford or lack sufficient economic resources. It is the key to reduce traffic congestion with greater environmental benefits and helps in making communities sustainable. Equity in Public transit plays a wider role as the decisions made on public transit may affect the disadvantaged group more with those having lesser opportunities and lesser ability to adapt to the impacts rather than the people who can adapt to the change. For the disadvantaged, they may lose access over public transit and it may affect in a much wider way by impacting employment and economic development. The paper draws attention to the transport equity issues in case of Delhi by analyzing different equity impacts, evaluating the existing transportation equity, recognizes the institutional vacuum and recommends prompt consideration of equity in Delhi Metro and DTC buses.*

Key Words: Equity, Public Transit, Accessibility, Mobility, Subsidies

1. INTRODUCTION

Equity refers to the distribution of the cost and benefit of a certain resource, project, plan or a policy over different group of people. It is the Egalitarianism and justice of whether the distribution of the cost of the project impact is appropriate and fair. It helps to offer alternatives or choices to those who have access to less. Moreover, the impact is much on the people who lack the sufficient economic resources and have disadvantaged status. A group or an individual is said to be disadvantaged when it falls in the dimension of being deprived of accessibility based on the location it is living, is differently-abled, have lower economical or social status or has the caregiving responsibilities etc. The more the individual or group falls in these dimensions, the more is the degree of impact of any project, plan or policy measure. Based on the type of the decision, the impact may differ on different group of people.

The decisions often taken in transportation planning process have significant impacts. These decisions when lack the equity considerations has diverse impact over different people especially the group which is disadvantaged. The expenditures for the transport is the major and above all the expenditures a household, government agency or a firm do. Hence, when public resources allocated or any decisions made irrationally can favour one group over the other, may cause detrimental impact on social and economic opportunities along with hindrance in the economic development. Along with that, it can widen gaps in access to transportation options for people having low income and people of color (TransitCenter, 2018). They can embed existing inequities more deeply into our communities; create new inequities; or, at their best, alleviate some of the more pernicious dimensions of inequality even if only at the margins. Transport serves as a significant "gateway" service that either can bolster or erode all of the factors that support a high quality of life (Blair A. Ruble and William Chernicoff, 2019). Since past, the equity issues has not been evaluated due to its wider complexity which has exacerbated the existing social and equity concerns.

Public transit not being a predominant mode of transport still offers basic mobility to all the group of people and providing access to those who can't afford or lack sufficient economic resources. It is the key to reduce traffic congestion with greater environmental benefits and helps in making communities sustainable. Transit investment projects have been identified as both accessibility and mobility enhancing (Handy, 2005). "Accessibility" may be defined as the description of proximity to destinations of choice and facilities offered by transportation systems (Black, 1977) while "Mobility" can be defined on the basis of distance measure between origin and destination, time taken to travel and amount to be paid for travelling. The initiatives taken by the government to enhance the mobility will enhance accessibility. Mobility, like consumption of all other goods and services, is very unequally distributed amongst city dwellers (Vivier, n.d.) therefore equity issues has to be incorporated in planning. Although the residents in the cities moreover rely upon private cars whie share of public transport and the people who are dependent are quiet less which is 18.1 percent in India as by UITP. According to the survey more than 50% of the workforce (excluding domestic and agriculture) continue to work at home or travel to their workplace by foot in the

absence of adequate transport facilities (Singh, 2016). Though the reasons might be many, the dimension of equity is still to be considered.

Equity in Public transit plays a wider role as the decisions made on public transit may affect the disadvantaged group more, with those having lesser opportunities and lesser ability to adapt to the impacts rather than the people who can adapt to the change. For the disadvantaged, they may lose the access over public transit and it may affect in a much wider way by impacting employment and economic development. It might be difficult to consider transport equity because there are various types and factors to be considered along with its impact and intensity of the impact on the society. It is complicated to understand the equity concerns over different group of people in the society based on gender, social class or economic status etc. and categorizing them on different basis. A certain decision taken based on equity in public transit, can be equitable for a certain group of people while inequitable for the another. Therefore, these concerns may lead to the conflict within the society widening the existing social, economic and gender gaps.

Based on different parameters the equity has been classified into, horizontal, vertical with regard to income of the group or individual and vertical with regard to mobility need and ability of individual or group of people. When the people have same ability and need called as horizontal equity; when people differ by their social class and income, their needs will be different too called as Vertical (with regard to social class and income) and special mobility need for specially-abled people can be Vertical (with regard to mobility need and ability) equity. In case of horizontal equity there are lesser chances of conflicts as the needs and ability are same while in case of vertical equity can cause more tension among the disadvantaged people as project impact is more on them and they have lesser ability to adapt.

These disadvantaged people based on the income are moreover dependent upon transport modes which are environment friendly such as cycle or walk or can be shared public transport if they have more economic affordability. In the century of development where people are seeking for motorization, their efforts need to be appreciated by the coming policies, plans and projects.

The disadvantaged people based on the Gender especially women, scared of sexual harassment and other personal insecurity threats deter women from walking, reducing their independence, health and affordability (Litman, 2019) describes the article "'Paying to Stay Safe': Why Women Don't Walk as Much as Men." It recognizes the fact that if the communities are walkable and compact, the woman ensures greater safety and security. Hence, these concerns cannot be faced by all group of people in the society, each disadvantaged group have different issue which has to be dealt, while considering all other factors of equity planning. If the necessary issues of equity are incorporated and resolved in the decision making, this will help in reducing the existing conflicts and gaps among the society. "This can lead to prioritizing transportation investments that better enable people to meet their day-to-day needs—getting to work, school, the grocery store, the doctor's office, and social and leisure activities and allowing people to meet these needs creates long-term economic opportunities and helps people escape poverty"(TransitCenter, 2018). The more gap can be seen in urban areas where the social inequality is much more and the transit opportunities can be seen as the way of economic development. 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 (Alam, 2013).

Accordingly, this paper brings the overview of transport Equity issues in Delhi's Public Transit by focusing upon equity impacts, evaluating the existing transportation equity considering on the basis of various group of people, recognizes the ways to incorporate equity analysis into transport decision making and recommends prompt consideration and a trade-off for Delhi Metro and DTC bus users.

2. City Profile and Connectivity

Delhi is known as the 'capital of India' and second most populous urban agglomeration in the world having the population of 16.8 million and urban population as 93.18% (as by Census, 2011) with an area of 1483 sq. Km. Along the river Yamuna, Delhi has been one of the fastest growing cities in the country, clocking over 47% decadal growth from 1991-2001, more than double the national rate (Department of Urban Development, 2006). Uttar Pradesh and Haryana are the neighbouring states.

The administrative structure has the dual jurisdiction of State government as well as Union Territory with highest par capita income in India. Due to rapid pace of urbanization the rural populace is decreasing from 9.49 lakh in 1991 to 4.19 lakh in 2011as more people are migrating the urban area. The Delhi metropolitan area lies within the National Capital Territory of Delhi, which has five local municipal corporations- North Delhi Municipal Corporation, South Delhi Municipal Corporation, East Delhi Municipal Corporation, New Delhi Municipal Council and Delhi Cantonment Board (DCB) (Planning Department, 2018).

The city also acts as a major centre of trade and commerce and is the nodal point for five national highways and intercity rail corridors, carrying large volumes of heterogeneous passenger and goods traffic (Department of Urban Development, 2006). The city is known for trade & Commerce and has 5 national highways, intercity rail corridors which carry large amount of goods and passenger traffic all over India. Though railway carries only 1% of the total local commuters while predominant dependency is majorly on the roads. The major urban corridors are NH1, NH2, NH8, NH10, NH24, NH24 byepass, NH57, NH58 and Loni road which is the state highway connecting Delhi to other towns of the country. With the increase in level of urbanization, the road length (km lane) has been increased from 14,316 km to 31,373 km from 1981 to 2009. The road network is 2102 km per 100 sq.km making it as a largest road networks in India (Sanjiv N. Sahai, 2009).

3. Role of Public Transit in Delhi – Delhi Metro and DTC

Over the years, the growth of the city is based on ring radial pattern making the transport system well-developed and thus availability of buses and MRTS. As by the data of the Ministry of Road Transport and Highways, the number of registered buses in New Delhi are growing at a slow pace (Alam & Ahmed, 2013) hence reducing the transport share from 64% to 54% from the period of 2001 and 2010 while the increase in private vehicles has been increased by 40% to 46% respectively. The capital city has highest number of registered vehicles in 53 million-plus cities with 7.45 million vehicles as by March, 2011 which has been increased by 109.86 lakh (in which 64% are 2W and 30%are cars and jeeps) as by Economic survey of Delhi, 2018-2019. The registered vehicles has followed the compound annual growth rate of 1.20% which was 5.21 million in 1981. The Delhi Master Plan for the year 2021 is focusing upon the use of both rail and road systems as the future multimodes for the transportation system by aiming to enhance public transport ridership by 80% and reducing private vehicles by 20%. As by the Plan, the major nodes of the city has to be distributed (work centres) by looking into the major transport nodes which will help in the development to be polycentric and poly-nodal and possibly development would come along the major transport corridors or transit systems. In the year 2001, the passenger trips were 13.9 million and it is estimated that in the year 2021, the passenger trips in the capital city will shoot to 27.9 million leading to rise in transport demand. With the change in behavioural patterns due to higher income and changing lifestyle the travel demand will increase and average trip length being 10.2 km, the existing road infrastructure is not enough to cater hence there is a dire need of efficient and accessible public transit to meet the needs of the future population. As by Rationalization of Bus Routes in Delhi, GNCTD (2011) today, only 1% of the total population uses the rail for meeting the existing travel demand while buses has been the choice of commuters more as 34% of the people uses it.

Table -1: Per capita trip rate (veh.) growth trends in Delhi

Purpose	1969	1981	1986	2001	2021
Work	0.29	0.31	0.65	-	-
Education	0.08	0.22	0.29	-	-
Others	0.12	0.19	0.14	-	-
All	0.49	0.72	1.08	0.87	1.2

Source: RITES 1994; RITES, Planning for Mass Transit System for Delhi 1989; Transport Demand Network for NCT of Delhi – RITES. 2010, quoted in Rapid Assessment of travel patterns in Delhi - horizon year 2030 & 2050, May Forecast Study and Development of an Integrated Road cum Multi-Modal Public Transport 2017

3.1 Delhi Metro

Delhi metro rail project as the 2nd project after the Kolkata metro rail project which has come up in the year 1984. For the metro rail project in Delhi, the autonomous body was created by GoI and GNCTD in March, 1995 called as DMRC (Delhi Metro Rail Corporation) for its construction, operation and management which is registered under Companies Act, 1956. The Mass Rapid Transit System is an grand development model meant for the NCR that aims at "providing a non- polluting and efficient rail-based transport system, properly integrated with the road transport system" (IL&FS ECOSMART, 2005). The construction of the DM started in 1998 and the first operation began in the year 2002 for the stretch between Shahdara and Tis Hazari of 65.1 km in which 13.1 km was underground while 51.9 km was surface with 59 stations completed in 2006. The second Phase of the MRTS comprised of 124.93 km length with 86 stations which has been opened in 2008 and completed in 2011 including expansion till NCR with 16.62 km rail network. After that, massive expansion of the Delhi Metro has been done in various parts of the city to meet the transport demands and to decrease the vehicle congestion on the roads. The Planning has been done in such a manner so that the metro could reach in the areas with high density of population so that the travel behavior of large populace could be changed. Phase-III, additional corridors and NCR extensions of 160 km route length with 109 stations (including 42.337 Km of route length with 30 stations of NCR) were planned to be completed by Dec. 2018 (except extension to

Dhansa is scheduled to be completed in December 2020) (Planning Department, 2018). Today, Delhi Metro has the total length of 373 km with 271 stations which is not only limited to Delhi but also NCR region comprising of the states of Uttar Pradesh and Haryana. It is the world's first rail project to earn carbon credits under the Clean Development Mechanism of the United Nations Framework Convention on Climate Change for reductions in energy consumption and CO2 emissions (Goel & Gupta, 2015). DMRC saved 112,500MW of power by using regenerative brakes in the trains, and reduced carbon emissions by 630,000t yearly ("Delhi Metro Rail System, India," n.d.) helping in combating global warming. As by DMRC Annual report, during the year 2017-18, average ridership per day was 25.38 lakh daily while total ridership catered was 9,260.69 lakh.

3.2 DTC Buses

DIMTS under the cluster scheme and DTC jointly provide the bus services in Delhi. Till 2003, buses constituted about 1% of the total number of vehicles, but catered to 60% of the total traffic load, while personalized vehicles account for 93.73% of the total vehicles but cater to only 30% of the total traffic load (Planning Department, 2005).

DTC has been recognized in 1971 under the Delhi Road Transport Laws (Amendment) Act. The act has been passed by looking into the inadequate functioning, inefficiency and high revenue leakage of Delhi Transport undertaking (DTU) taken by the Planning Commission of India. It primarily worked on the objective of "To provide or secure or promote an efficient, economical, reliable and properly coordinated system the road transport in Union Territory of Delhi and any extended area". Till 1992, Delhi Transport Corporation (DTC) was the primary agency for providing the mass transport service, when private buses under the control of the Transport Department were first introduced to supplement the DTC fleet (Ghugh, n.d.).

As by Economic Survey of India 2018-2019, DTC is having the fleet of 3951 while Cluster buses with fleet of 1744 and DMRC bus fleet of 174 non AC buses.

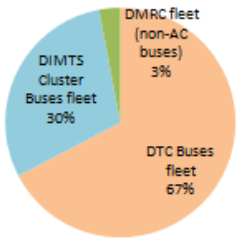

Figure 1: Public Bus fleets in Delhi
Source: Economic Survey of Delhi, 2018-19

There are total 17 clusters initiated by DIMTS with 650 routes in which both private stage carriage and DTC is operating with 60:40 ratio (Gupta & Dameniya, 2017). The average distance covered being 218 km/bus/day and 190 km/bus/day of cluster buses and DTC buses respectively. The role of DTC is very important as it is expected to own and operate at least 50 per cent of the buses (Gaurav Dubey, 2017).

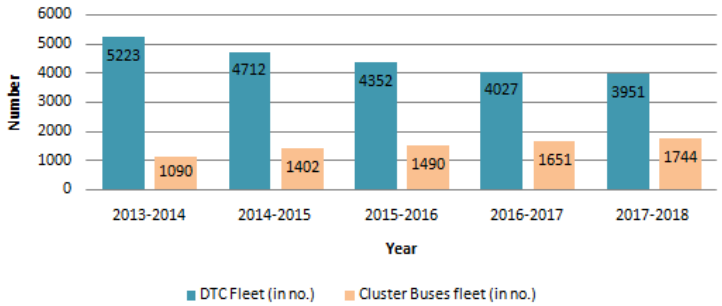

Figure 2: Fleet of Cluster and DTC buses in Delhi
Source: Economic Survey of Delhi, 2018-19

4. Equity in Public Transport- Delhi Metro and DTC

To enhance the metro ridership, the operational route of metro is increasing while after the year 2017-2018, Delhi metro faced flak from the passengers. It is evident from the Figure 4 1: Ridership versus Fleet size of Delhi Metro, the ridership of

Delhi metro has been reduced from 27.61 lakh to 25.37 lakh in the year 2016-2017 and 2017-2018 respectively while in the same period the operational route has been increased.

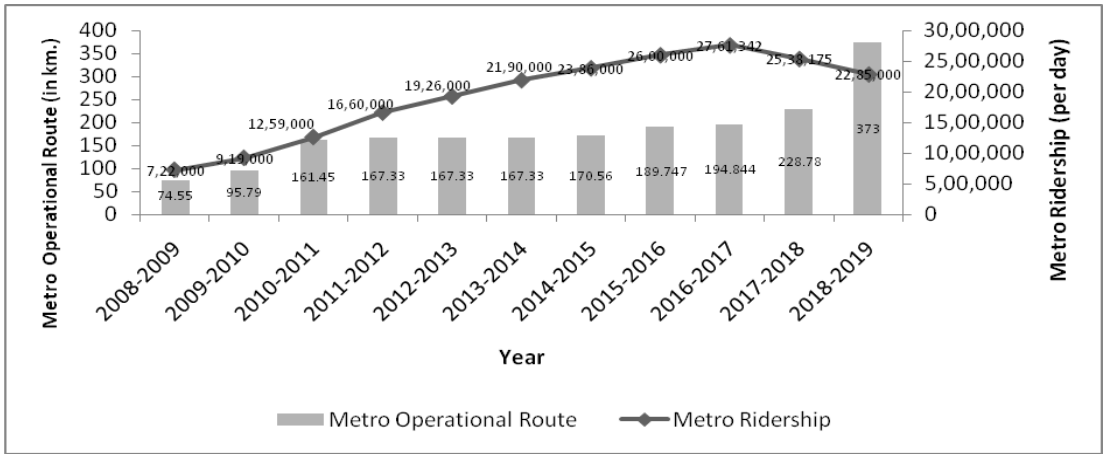

Figure 3: Ridership versus Fleet size of Delhi Metro

Source: Economic Survey of Delhi, 2018-19; DMRC Annual Reports

The lowest ridership has been observed in the year 2018-2019 i.e, 22.85 lakh in the same corridors. In May, 2017 the first fare hike of Delhi metro after 8 years has taken place leading to fall in ridership. Another fare hike has happened in the same year in October.

The fare has hiked due to increase in input cost of energy by 105%, staff cost by 139% and repair/maintenance as 213%. It raised its fares twice in 2017. It is estimated that the increase in fares varied from 25% to 117%, depending on the length of the journey (CSE, 2019). Delhi Metro is the 2nd most unaffordable transport system in the world (DATTA, 2018). The current fare structure of the Metro is reportedly Rs 10 up to 2 km; Rs 20 for 2-5 km; Rs 30 for 5-12 km; Rs 40 for 12-21 km, Rs 50 for 21-32 km; and Rs 60 for journeys beyond 32 km (Business Today, 2019). The sudden drop in ridership of Delhi Metro—approx by 3.9 lakh passengers between April 2017 and April 2018, is only symptomatic of lack of policy for pricing of all transport services and lack of strategy for funding and increasing ridership of these systems.

DMRC's fare policy (as per the Fourth Fare Fixation Committee's Report) justifies increase in fare due to increase in DA, inflation as measured by consumer price index (CPI), etc., and increase in minimum wages (to justify affordability). Fare revenues were found to be adequate to meet the operating expenditure of DMRC upto 2016–17 but fare hike was still recommended by the FFC called 'cash available for depreciation' to meet debt servicing expenses plus recover asset replacement cost through an augmentation in fare revenues and surplus should be maintained after meeting all expenses and debt liability. This could be used to pay off the Japan International Cooperation Agency (JICA) loan, whose repayment has kicked in recently after the ending of the moratorium period of 10 years for principal repayment. Generally, it cannot be extrapolated to justify affordability as it ignores the realities of affordability for people employed in the informal economy. Robust willingness-to-pay surveys and estimation of income profiles of users are not conducted to adequately inform the fare revision process and the likely consequences. Only the fourth FFC undertook a willingness-to-pay survey by putting advertisement at stations, but a sample size of 498 vs a daily ridership of 28 lakh cannot be said to have provide adequate data. Often, official increase in minimum wages is not observed on the ground.

If the 7 per cent cap on annual fare hike, as suggested by the fourth FFC, is taken into account, per trip (considering an average trip length of 12.9 km) cost in DMRC would be Rs 31 in 2017 (as it was Rs 18 in 2009). This is lower than the Rs 40 actually recommended by the Committee after the second fare hike in October 2017.

A Bus, if it is reasonably full it can displace anywhere from 5 to 50 other motorized vehicles (BUS SYSTEMS FOR THE FUTURE, 2002). The DTC fleet has been analyzed since 1990 to 2018, it has been observed from 1999-2000 there is a shift from diesel buses to CNG bus while the number has been increased from the period of 2007-2008 due to Common wealth games held at Delhi in the year 2010. Around 921 new buses has been procured in 2009-2010 and 1479 new buses has been procured in 2010-2011. The cluster buses has been introduced in the year 2010-2011 which lead to decrease in the DTC's fleet.In the year 2012-2013, the highest ridership is seen i.e, 46.77 lakh.

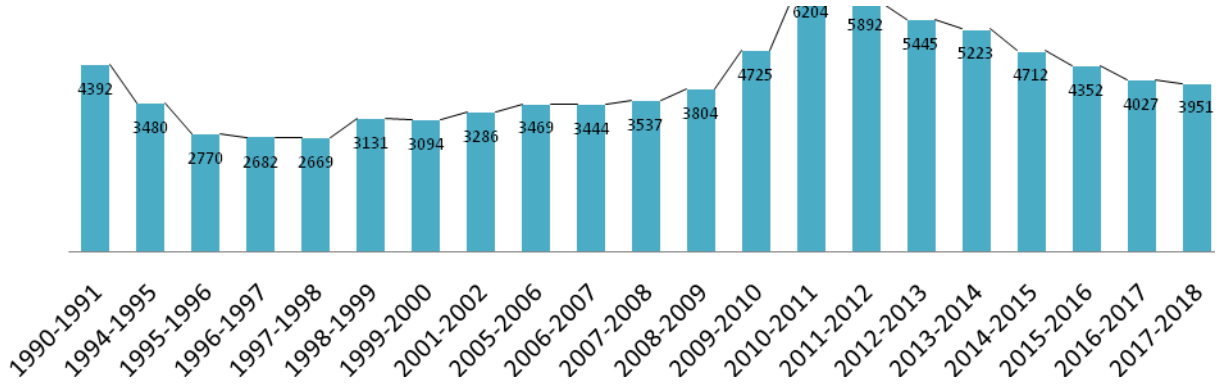

Figure 4: DTC's Fleet size over the years

Source: Economic Survey of Delhi, 2018-19

After 2010-2011, DTC has not introduced any buses while since 2011 the cluster buses have been evolved with 1744 buses till 2018.

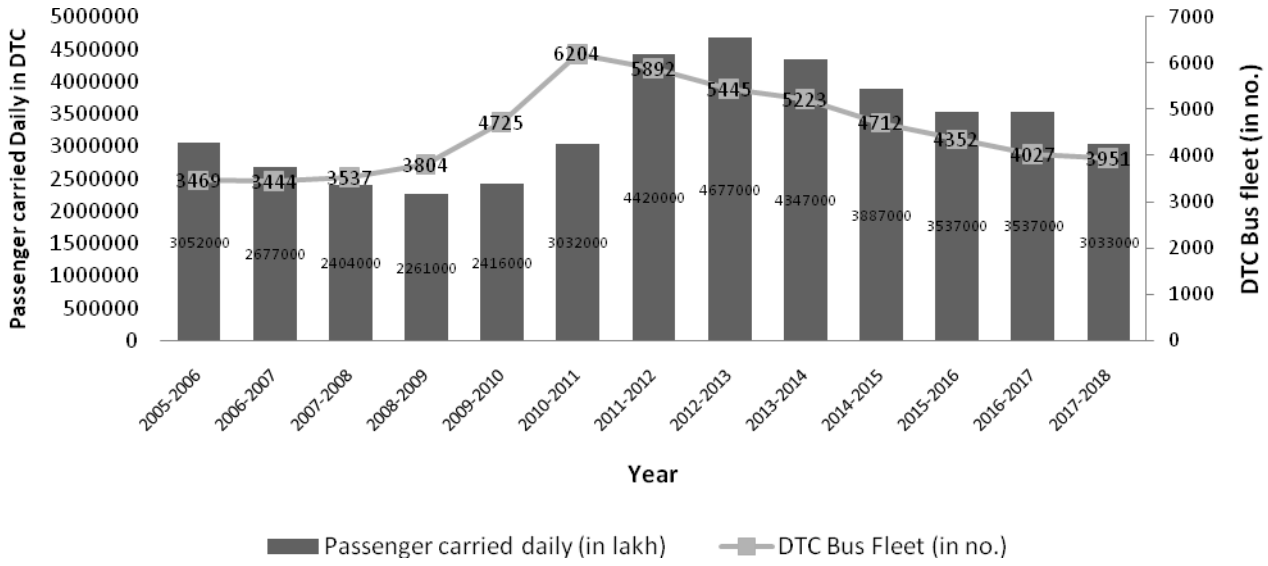

Figure 5 : Ridership versus Fleet size of DTC Buses

Source: Economic Survey of Delhi, 2018-19; DTC Operational Statistics (2016,) quoted in Waiting for a Bus by CSE, 2017

As by different standards, for instance, according to JnNURM has the norm of 50 buses/ lakh for megacities with populace of more than 4 million; Service level benchmark of MoHUA considers 60 buses per lakh of population while Ministry of Finance and Asian Development Bank's toolkit essentially meant for PPP projects has the criteria of 60 buses per lakh population with certain other criteria such as at least 225–275 km should be the productivity of the bus, average waiting time to be to not to be more than 10 minutes with 95% confidence of punctuality etc. Experts also point out that if a city has a large network of bus rapid transit routes and is able to make sure consistent service with minimum waiting time and speed, then the number of buses needed can be reduced, thus reducing the capital expenditure as well (Gaurav Dubey, 2017). Considering the norms, as per reforms of JnNURM 8350, SLB of MoHUA 10020 and following the criteria of toolkit of Ministry of Finance and Asian Development Bank 10020 with the enhancement of other factors to be done in Delhi for efficient bus service. Today, Delhi have total bus fleet of 5695 which has to be increased this year and in future years also.

While since the year 2013, with the depreciation of buses and lack of replacement of old buses the ridership is declining with 8.8% rate per annum. Overall, it has dropped by as much as 34 per cent.

The daily passenger load per bus in Delhi has come down from 952 passengers in 2013–14 to 927 in 2015–16 . Concurrently, the stated load factor has also come down from 86.63 per cent in 2013–14 to 82 per cent in 2015–16. According to the latest data available (November 2016 statistics), the system handles 30.33 lakh passengers regularly in which 13.36 lakhs (45%) are ticketed passengers. The rest of 16.22 lakh (55 per cent) passengers are those estimated to be traveling using passes. As per the same statistics, there are a total of 1.81 lakh passes issued at present for city buses, which give an absurd estimation of each pass-holder traveling roughly nine times per day due to which there is inflation in the trip number. Essentially, this estimation points towards some discrepancy which if corrected may bring down the official estimates of daily ridership down significantly. This means either the statistics is incorrect or there are several commuters who enjoy their free trip.

4.1 Income Disparities

In 2016, a survey has been conducted by DMRC which showed 100,000 rupees a month is earned by only 2% of the population using metro while 10% users earn 50,000 to 100,000 rupees a month and approx. 82% earn less than 50,000.

As per FFC, 30% of metro commuters earn 30,000 per month. if DMRC's own contention of 30 per cent of its commuters being in the Rs 20,000 per month income bracket is used, then affordability ratios are not convincing. Journeys for most residents in Delhi or other cities is not merely about two metro trips a day but interchanges and additional costs incurred to access public transport systems. If the integrated journey costs, including last mile costs, are considered, then commuters in the bracket of Rs 20,000 monthly income have to spend 19.5 per cent of their monthly income on transport, making it unaffordable. However, the percentage increase in fare has been justified by the fourth FFC by linking the fare increase to increase in DA.

Table 2: Affordability of 30% of Commuters of DMRC

Particular	Details
Monthly Income of 30% commuters of DMRC as per Fourth Fixation Committee	Rs 20,000
Average trip length as per Census 2011	12.9 Km
Fare for average trip length	Rs 40
Affordability Index	Rs 40 (per trip) X 3 trips per day X 26 days =3120 (15.6% of 20, 000)
Integrated Affordability Index (considering last mile cost as 25% of total trip cost)	Rs 50 (per trip) X 3 trips per day X 26 days = 3900 (19.5% of 20,000)

Therefore, 15.6% income is spent only on metro while 19.5% of the income is spend by 30% of commuters on travelling in metro which makes it unaffordable.

Globally it is accepted that not more than 10–15 per cent of household incomes should be spent on transport for it to be termed affordable. If 20% of the population is spending 10% income is accepted as a benchmark of affordability.

An unskilled daily wage labourers in Delhi will spend, around 8% of their income on travel by a non-AC bus, 14% by an AC bus and 22% by the Delhi Metro. Except in case of non-AC bus services in Delhi, the lower income group needs to spend more than 10 per cent monthly income on premium transportation services. If the costs of integrated journeys are considered, the proportion of income spent on transportation rises further. Additional trips required to access schools and health facilities increase these costs significantly. This indicates that premium public transport services are beyond the reach of lower-income groups.

Minimum wages (Rs per day)*		Monthy income (Rs)**		Average trip length (in km)***	Fare of respective mode		Monthly expenditure on Public Transport (in Rs)*****	Percentage of transportation expenses over total income	
Skilled	Unskilled	Skilled	Unskilled		Mode of Public Transport	Fare (Rs per trip)****		Skilled	Unskilled
648	534	16848	13884	12.9	Non-AC Bus	15	1170	7	8
					AC bus	25	1950	12	14
					Metro	40	3120	19	22

* Minimum wage Notification of Delhi,2018
** Estimated considering 26 working days in a month
*** Census 2011
**** Prevailing Fare of 2018
***** Considering three trips per day by accounting two working trips and one non working trip by dependent in 26 working days

Also, as per the survey conducted in November, 2019 for 146 respondents at different stations comprising 58.4% male and 41.1% females have been considered in which 67.1% people make daily trips. The respondents belonged to different income groups so their total number of trips, trip length, and purpose of making trip were be different as shown in Figure.

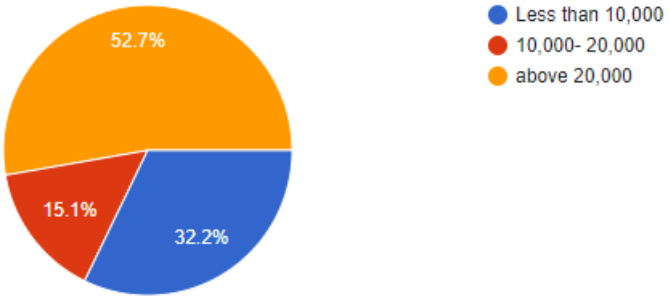

Figure 6 : Income distribution of respondents

Considering the average number of trips and average trip length by different income groups, the monthly expenditure on metro has been calculated as shown in Table. It has been assumed 6 trips per week is done by dependent on every person who is earning.

Table 3: Preferences and percentage of income spend by different income groups

Particular/ Income	Less than 10,000 per month	10,000 to 20,000 per month	More than 20,000 per month
Average Total number of trips	6	5.4	8
Average Trip length	9.2	10.4	10.1
Fare (in Rs)	30	30	30
Total number of trips (including dependent)	36	34.2	42
Monthly expenditure on Public Transport (in Rs)	1080	1026	1260
Percentage of metro transportation expenses over total income	21.6%	8.2%	6.3%
Integrated Affordability Index (considering last mile cost as 25% of total trip cost)	1350 (27%)	1282 (10.26%)	1687.5 (8.4%)
Distance of metro station for predominant metro users	500mts -2 km	500mts. -2 km	0-2 km

It is evident from the data, people earning less than 10,000 per month spends 21.6% of their income on metro, 10,000 to 20,000 per month spends 10.26% of their income and 8.4% money is spend by those who earn more than 20,000 per month. Also, the total number of trips and trip length increase with the increase in the earning per month. It is evident that people with low income make lesser trips and tend to do multiple tasks while doing one trip so as to reduce their transport expenditure. If last mile connectivity cost is also added the trip expenditure increases more. People earning less than 20,000 per month make trips which are mainly work based while in case of people earning more than 20,000 make work based and recreation based trips. Also, the people which has metro station within 2 km proximity use metro more rather than people who live far.

The argument that the Metro is a special service for a specific income class and the income group for which it became unaffordable may use bus services instead does not hold, as integrated strategies demand that for public transport to be viable, all modes should be affordable. To a commuter, what matters is the overall journey cost that is determined by the cumulative effect of several interchanges between different modes. It is an accepted fact that periodic fare hikes are needed in all systems to keep them solvent, to prevent inefficiencies, and to raise money for upgradation and maintenance. Fares are adjusted to recover increase in costs for fuel, maintenance and wages, but there is a limit on how much can be passed on to the commuters.

Some part of operational costs and the larger capital costs (depending on the type and scale of the system) are also expected to be mobilized through non-fare means.

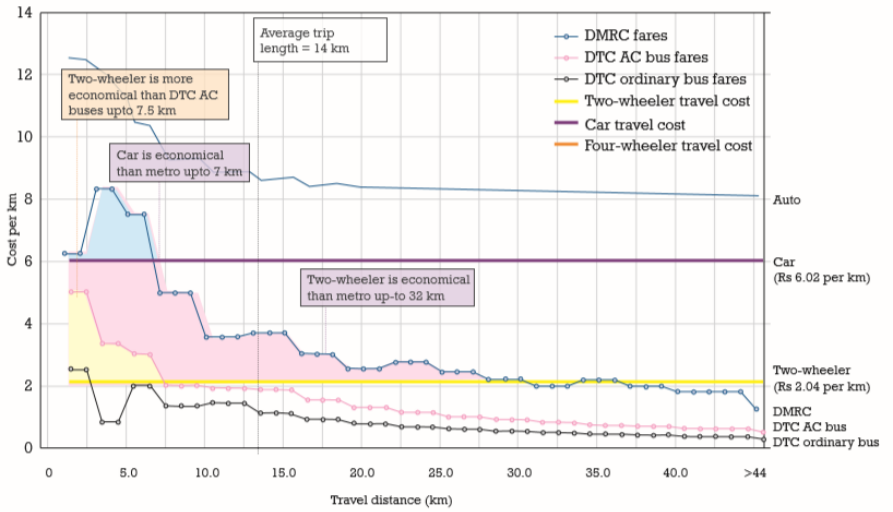

Figure 7: Mode wise Travel Cost (Source: CSE)

Lower income group are moreover dependent upon walking, bicycle or public-transit while cars and Two-wheelers are associated with High Income group. If fare hike persists, HIG can afford the fare hike as well as can switch to other modes like that of car which is more economical than metro upto 7 km, 2-W which is economical than metro upto 32km. On the basis of survey conducted, people use metro because of time saving, comfort and economic feasibility. If this feasibility does not exist, the people will stop using metro at some point of time. Considering the fact approx. 82% users earn less than 50,000, it is evident that they don't have any other alternatives to commute other than metro if the fare hikes are persistent. Therefore, it is required to rationalize the fares fares in such manner that the metro users should be from every income group and there should be no disparities.

4.2 Gender Disparities

As by Census, 2011 Delhi has the sex ratio of 861 women per 1000 men. A report by IIHS stated "Female Labour Force Participation Rate (the % of female population aged 15+ in the workforce) in Delhi in 2011-2012 was 11.2%, substantially below the national average of 25.51%". This means there are comparatively very less females in public locations as very less of them go to work each day. Also, IIHS has pointed out the average salary of male and female workers has a stark difference in Delhi. Stating the fact of 2011-12, females earned 98 Rs./day while men earned 265 Rs/day. This shows the gender gap and equity issues between different genders.

Also, the number of casual female workforce reduced in 2011-12 from the year 2004-05, the reason could be non-affordability and lack of access to public transport systems due to fares. In New Delhi 2016, a study brought that "85% men and 64% women feel that public transportation were 'designed to accommodate men more than women', and only 27% women felt safe using public transport out of 33%, compared with 51% of men". Also, several researches has been done which showed the evidence of correlation of gender gap and crime against women.

On the basis of survey conducted on November, 2019 women are using metro mainly because of Comfort and Time Saving especially those who earn more than 20,000 per month.. It is evident from the data in Table 4: Preferences and percentage of women and their expenditure on transportation that women tend to make lesser trips but the trip length is comparatively more which means they commute for different purposes at one time and covers multiple destinations. They tend to spend more time in home due to parental responsibilities and other necessary works which they have to do.

Also, it can be observed from the data, women who earn less than 10,000 per month tend to travel less than a women who is earning more than 20,000 per month. The reason may be unaffordability to metro which may push them to rely on other inexpensive modes which are also quiet slow in nature. The women who earn less than 10,000 spends approximately 21.6% of their income in just commuting through metro which is highly unacceptable and will lead to change in mode. Women when has to save money prefer walk ability over any other mode. Women are not financially free to make a decision of moving out and how often they have to go.

Table 4: Preferences and percentage of women and their expenditure on transportation

Particular/ Income	Less than 10,000 per month	10,000 to 20,000 per month	More than 20,000 per month
Average Total number of trips	6	8.3	8.6
Average Trip length	9.57	9.7	10.4
Fare (in Rs)	30	30	30
Total number of trips (including dependent)	36	34.2	42
Monthly expenditure on Public Transport (in Rs)	1084	1290	1320
Percentage of metro transportation expenses over total income	21.6%	8.6%	6.6%
Integrated Affordability Index (considering last mile cost as 25% of total trip cost)	1354 (27%)	1612 (10.7%)	1650 (8.2%)
Reason of using metro	Economic Feasibility, Comfort, Time Saving	Comfort, Time Saving	Time Saving, Comfort
Distance of metro station for predominant metro users	500mts -2 km	500mts. -2 km	500mts. -2 km

The Indian cab aggregation company Ola has come out with a survey titled "What Do Women and Girls Want from Urban Mobility Systems?" Women in lower income groups prioritized affordability over comfort, women with consequently HIG preferred to travel in more personalized spaces which is also evident in Survey conducted in November, 2019. Also, if more of the income is spent on Metro trips, for last mile connectivity they do not have any other option than walking to save money. 77% Indian women feel things should be done to enhance last mile connectivity because safety is major concern before accessing and after egressing the facility.

Many women from marginal income group have a preference to work close to the place where they are residing so that they can save the amount to be spend upon transport and prefer walking over any other mode which are costly. In case of women who work far, there are three facts:

•The shift from private transport to public transport is not for those who prefer comfort over affordable public transport
•In case of LIG women, public transport is unaffordable, Women opt out of job or readily reduce the amount of trips by public transport and switch to walking or other affordable modes.
•The women who make shorter trips use IPTs, or prefer walking.

In case of Buses, the routes are not rationalized. There are routes which have very less frequency of buses while there are routes who have back-to-back buses. These frequency of the buses on these bus routes are considered on the basis of commuters using the facility, pressure from local politicians and the 'wisdom' of DTC officials. On the basis of Route Rationalization done by DIMTS, bus routes did not extend more than 25. DTC buses are not reliable in the case commuters are not aware about the arrival time of the bus and it is completely unpredictable. Passenger Information System (PIS) are only available in BRT corridors while other 5,000 bus stops does not have any. The DTC had installed PIS display boards in Lutyens' Delhi, but the service never became operational(Mathur, 2014).

Therefore, on the routes where there is lesser bus frequency, a commuter will choose any other mode of transport to save time and working hours. According to "Unlocking Cities: The impact of ridesharing across India", cost of time spend in congestion across Delhi is 9.6 Billion dollar. Considering the Mohr's effect, the commuter has to look for possible alternatives in which he/she could spend less amount of money but has to be time saving.

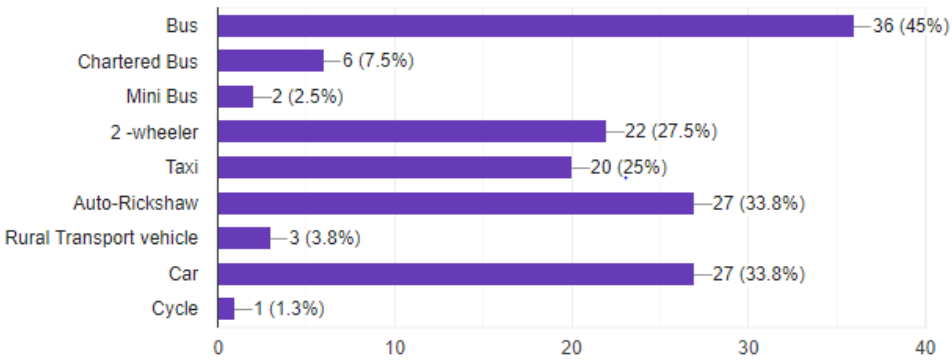

Figure 8: Mode used by Commuters earlier before switching to Metro

It is evident from (Figure 8: Mode used by Commuters earlier before switching to Metro) that major commuters who has been using metro has been shifted from Buses and Cars. Depending upon the trip length a person who owns a car or any other vehicle (especially HIG) has to decide if that person has to use the metro or not. Metro has proved to be great time-saver in that case but has failed to provide affordable commuting for LIG people who use to travel from DTC buses due to rational fares. DTC buses which are affordable but due to less fleet has lead to commuter, with no option. For a women, DTC bus is comparatively less safer than metro and in that case if women is preferring metro, she has to spend more money which can't be the efficient option. Higher income group has the flexibility to switch to other modes while LIG has to use the same system only because of affordability factor but this lead to loss of working hours and additional time in commuting.

5. Strategies and Recommendations

To overcome with the issues of equity in Public transport, the problem has to be seen from a wider perspective which not only can deprive one section of the society but also can cause social instability. There could be several measures which could be adopted for the efficient public transport system which would be equitable and rational in nature.

Like in case of metro all the operational expenses have been met by fare hike, fare hike can't be the solution alone because this will lead to modal shift from public to private transport which will again lead to loss for the public transport system and there would be no use of public transport. Subsidies may be needed to meet the deficit to keep public transport affordable per se and vis-à-vis private modes.

These subsidies can be provided at demand level and supply level. In case of India, supply side subsidies are provided, to the operator like that of Metro operator or State transport undertaking. For instance, in Ahmedabad's bus rapid transit (BRT) system, since 2013 there is no fares hike even after having official provisions do so. The revision of the fare happened when fuel hike happened and threshold of Rs 0.25 per passenger km of DA has been crossed. Below that, the organization can make up for the productivity improvement and so that amount of passengers should not get reduced. At the demand side, the concept of free public transport is used. Free public transport can be free for specific set of people in the society or for all sections of the society at a certain period of time. There are several examples of free public transport, "free public transport on the Leiden-The Hague bus corridor is one of them in which buses were free only on Mondays till Fridays which has lead to 40% increase in public transport". In Netherlands, free public transport for all students were there which they provided free transport daily for a year. The scheme has lead to increase in public transport usage by students from 11% to 21%. Not only outside India, within India BRTS Ahmedabad has introduced free ride to its commuters for first 3 months so as to enhance the ridership.

Though Delhi metro offers free ride for children under 3 feet but no specific section of the society is targeted. Delhi government proposed the scheme of providing free ridership to women in DTC and delhi metro both to enhance their ridership. The focus was to foresee the equal access of women and men in public spaces of Delhi and to enhance the safety of women. Such kind off initiative will help women to participate in public interactive spaces. But the question arises does all the women need the free public transport?

Looking into the data analysis in table: Preferences and percentage of women and their expenditure on transportation, the women who earn more than 20,000 per month are spending less than 8% of their income on transport. Therefore, they have the capacity already to make trips in metro. The most disadvantageous group are the women casual workers having income less than 20,000 per month (especially falling into the bracket of less than 10,000), and the women who are unable to afford travelling in private vehicle as the ability to take the metro to a job which is slightly far could mean the difference between

financial independence or lifelong servitude and in extreme cases, abuse. This will be the freedom for them and it will prompt them more to step out. Most significantly, women can choose the rational modes and routes for travelling which will give power to women to rise above scarcity. Not only that, the girl child will not be losing her access to education and other opportunities as she could afford making a trip from public transport.

It is not justified that poor only needs subsidy on transport sector while there would be several other goods and services which are also major necessities in their life, for which they will ask for subsidy. How can we make a judgment that the funds allocated for transport subsidies will help in social inclusion comparing it with other goods? Or, why can't as an alternative to subsidizing goods/services, their income can be increased so that they can decide on which good/service they want the subsidy?

Poor people are poor in multidimensional way, they are not just 'transport poor'. Therefore for all the basic necessities like that of food, electricity, water etc. they are poor. It depends upon household to household which necessity they are seeking and what are their constraints. Therefore, monetary transfer is the best alternative to help them rather than giving them sectoral subsidies which are very tough to aim for and let them decide on what sector they want to spend that monetary benefit. Also, the operation of welfare system in the country for underprivileged have better mechanism than only transport subsidies. In principle then, equity and distributional concerns should perhaps be addressed by the general welfare system of a country and through the use of direct monetary transfers.

Chile in 2006 came up with the concept of direct compensatory payments as an alternative for transport subsidies with the rise in cost of commute due to hike in oil prices. The scheme benefitted 40% of the residents of Chile by not only giving them freedom of using that payments but also they could use them for other expenditures also.

The idea of monetary transfers is better, as may be the case the subsidy provided to any member of the household (children, women etc) may be unavailable due to which they will lose the opportunity to use the subsidy as no other person can avail that. Also, it is more preferable to transfer the amount into female household member rather than male as women are comparatively more known about the needs.If transport subsidies still has to be given then it should be according to the number of trips undertaken by individuals, considering what factors may increase or decrease the number of trips so as to analyse the elasticity of demand w.r.t fares.

Not only that, Urban transport investment plans need to take into account that Indian cities are still far from reporting stabilization, and effective and substantial shifts towards public transport systems. The economics of this transition will have to be addressed along with strategies for urban and transportation planning other than focusing on what discussed earlier are:

•Develop an ecosystem of alternate sustainable means of finance for public transport authorities
•Commit to multi-year subsidy support for public transport linked to productivity improvements by the authorities
•Adopt scientific fare adjustment mechanisms
•Contain private vehicle proliferation through mode integration
•Use integrated demand aggregation to solve the last mile problem
•Introduce congestion charges along with rationalized parking policy
•Introduce demand-side disincentives and taxation
•Rationalize taxes to reduce burden on public transport
•In the long-run, move towards demand-side subsidies

3. CONCLUSION

In order to foresee the growing mobility requirements of the rising population, public transport systems should be robust, reliable and efficient enough. Planners should be certain about the benefits and cost of public transport system even when they are going to introduce them to the society. As each and every infrastructure is build to enhance the lives of the people in the society but its inequitable distribution may lead to social instability. Therefore, there is dire need to study transport equity so that benefit to one should not be cost to another. For maintaining the same, several rational strategies has to be adopted as stated in section 5.

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