Importance of efficient Multi – Modal local connectivity at transit hubs for effective implementation of Delhi Transit Oriented Development Policy 2012

Moushila De¹, Shailja Sikarwar², Vijay Kumar³

Abstract

The urban sprawl and the rapidly increasing number of private vehicles demand for a new approach towards planning of a city. During the last few decades, more cars, congestion and related urban transport problem arise and increasing crime is also important thread for the society. Providing best local connectivity options can reduces the cases of various transport related issues and also helps in the prevention of crime. Transit Oriented Development is such an approach through which local connectivity can be improved. This paper is an attempt to understand the existing local connectivity issues in the selected case study stations. For understanding the existing local connectivity issues, four Delhi metro stations (Saket, INA, Vishwavidyalaya and Sultanpur) that falls with mid, high and low ridership with residential, institutional and mixed landuse were selected. The study further focuses on comparative analysis of local connectivity i.e., which stations provide better local connectivity modes than other stations and also on expenditure patterns i.e., the lower is the expenditure pattern the better is the local connectivity. The paper also focuses on problems faced by commuters in the selected case study stations. Based on the research, broad level proposals and station specific proposals for a single metro stations are given to enhance accessibility of local connectivity in the selected case study stations for efficient transit oriented development. These paper also focuses on the implementing agencies, those will improve and implement local connectivity for efficient transit oriented development in the selected case study stations.

Keywords: Transit Oriented Development, National Urban Transport Policy, Integrated Multi – Modal Transportation System, Intermediate Paratransit systems, Non – motorized vehicle, Pedestrianisation

Introduction

Transportation is often referred to as the “lifeblood of cities”, because it provides the essential link among activities and in the long run to a large extent, it helps shape the city” (Vuchie 1999). A good urban transport systems helps promote urban economy, enables social interaction, increases productivity of resources, provides mobility to people, enables accessibility to opportunities, and sets direction and patterns of growth (Ranganathan N.1999). There have been innovations and improvements in the recent decades towards making the city more mobile i.e. increasing mobility by increasing roads and not the transportation system itself in a way, due to this reason cities have more or less become a car centricity. There are only few feeders in the world that operates systematically, for example Bangkok’s mass transit. But in India especially in Delhi, haphazard supply of alternative modes around mass transit stations including the rise in

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private vehicles have led to chaos and disruption around metro station. It is the reason behind congestion on access roads to metro station. There have been research and study on the major haul of transport while very less emphasis has been given to the local connectivity, especially in Delhi in terms of pedestrian network. An ideal last mile connectivity should facilitates a user to user it from his origin to destination. Therefore, it is necessary to improve local connectivity for efficient transit oriented development.

The Research

The research is about to study the necessity of local connectivity in transit network and to study the local connectivity around various metro stations of Delhi. These research is further results in the improvement of existing modal split for local connectivity to metro stations. These research has further focuses on increase ridership of metro feeder transit, thus improve physical and financial performance.

Best practices all over the world

There are many cities in the world, who has implemented local connectivity designs in their transportation network. Few of the case studies that has been taken for literature review are as follows:

- Los Angeles transportation system
- Singapore transportation system

<table>
<thead>
<tr>
<th>Table 1. Brief of First / Local strategic plan, Los Angeles</th>
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</thead>
<tbody>
<tr>
<td>First / Last Strategy</td>
</tr>
<tr>
<td>• Respond to the challenges faced by transit users with a focused infrastructure improvement strategy, “the Pathway”.</td>
</tr>
<tr>
<td>• Path networks increase speed of active travel, reduce point to point distances, and support multimodal transfer activity.</td>
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<td>Pathway Network and Improvements</td>
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Source: Los Angeles County Metropolitan Transportation Authority

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<th>Table 2. Brief of Singapore transport system</th>
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</thead>
<tbody>
<tr>
<td>MRTS Network</td>
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<tr>
<td>Rail oriented (MRT)</td>
</tr>
<tr>
<td>Residential areas within 10 min radius.</td>
</tr>
<tr>
<td>Bus</td>
</tr>
<tr>
<td>Frequency &lt;10 min interval.</td>
</tr>
<tr>
<td>Pedestrian</td>
</tr>
<tr>
<td>400 mts radius</td>
</tr>
</tbody>
</table>

Source: Planning for first and local connectivity in a mass transit users in a metropolitan city (SPA thesis 2015)

Policies and Guidelines related to local connectivity in India

Transport policies in the past were almost silent on the importance of local connectivity for transit systems. While transport policies did talk of promoting public transit systems, multi-modal integration and non-motorised transport, they were by large silent on the LMC aspect.
of transit systems. In recent years, however, policies do recognize the significance of both LMC and NMT. (Table 3 End of the article)

First /Local connectivity in Delhi

In the last decade, the Delhi Metro has changed the way we travel and the mass rapid transit system carries more than 26 lakh commuters every day across its network spread over 200 kms in Delhi NCR. Despite all its comfort and dependability, a large section of Delhites still prefer private transport because the important question of last-mile connectivity still remains unsolved. Delhi, as the capital city has seen huge investments to boost and augment its transport network and expand its rapid transit system. However, the aspect of providing cheaper and convenient “local connectivity” to public transport users is an area of much neglect in the city. The metro provides a safe, efficient and comfortable journey but the trouble begins once we step out of its sanitised environment. The issue of last-mile connectivity has been a challenge for successive governments. While feeder bus services do exist in certain areas in the city, their services are limited to a few and selective stations. A certain part of the demand is met through para-transit modes such as autorickshaws. In order to make public transit systems more accessible to the commuter, planning for transit systems and LMC needs to be dealt with in a holistic and integrated manner. Presently only 41 out of 138 stations of Delhi MRTS are served by feeder services.

• Cycle rickshaws can also be found at almost every metro station. These cycle rickshaws are ideal for trips upto2km. NGO Uthaan has offered to operate bicycles and battery operated electronic rickshaws for metro commuters in Gurugram. Generally, these rickshaws offer service upto 2.5 to 3kms. Green projects started by DMRC, in which a commuter can hire a bike / bicycle from station and can drop it off at designated spots. Rent for commuter is set at Rs.10 for first 4 hours.
• As per DMRC projections, it targets to make most MRTS station walkable. The TOD documents by UTTIPEC 2013 determines two influence area zones for MRTS Delhi for which walkability would be improved such that the completed future metro loop network would serve 60% of Delhi area within 5 mins walking distance. But considering existing user demand, it is found that catchment of any metro station is beyond the 800 mts radius for which we need to improve the transit connectivity to stations i.e., the first and last segment of a trip that a metro user makes. Study says that without adequate first and local connectivity, a user may shift on private conveyance to complete his/her trip leading to more traffic on road.

Figure 1. (a) Delhi metro ridership as per March, 2013 and (b) Delhi metro network with cycle hire and Feeder Bus Service Station

Source: (a) DMRC Website, 2017 and (b) Impact of Metro on mobility patterns in Metropolitan city, case study Delhi
A study by RITES for — Forecasting travel demand for Delhi estimates that annual travel demand is growing in Delhi by 9.5% and thus under supply of organized local modes force people to commute by personalized vehicles, thus creating more congestion on roads. There is a shared cycle scheme under operation at few metro stations of Delhi which is underutilized. One major demerit of the cycle scheme is that a person has to return it back to the stand he hired it from. This discourages a person to consider cycling from metro station to his place of destination.

As per UNEP study of local mode choice across Delhi 2011, the share of carbon trip increases for modal split in NCR w.r.t. Delhi whereas segregated modal split for Delhi shows 2% increase in non-carbon modes. A breakdown of local mode choice across various zones of Delhi that includes North Delhi, South Delhi, East Delhi, West Delhi, North west Delhi, Central Delhi, New Delhi, Gurugram and Noida shows that walking auto is the next most preferred mode for local commuting by users to and from Metro. Whereas, Cycling is the least preferred options by users to access metro station.
Amongst 55% users using non carbon modes of travelling to metro, majority of walking i.e., 40% is done by users from three areas namely Central West and New Delhi, 40% of cycling is done by users only in South and New Delhi. 40% of NMT users are from East, West and Central Delhi. This also indicates availability of infrastructure that facilitates use of more nonmotorized transport in these areas.

Analysis of landuse plans and criteria for selection of stations

To enhance the accessibility of local connectivity in the selected case study, it is necessary to study the overall public transport scenario in Delhi that is supported by local connectivity status and its relation to current mass transportation ridership pattern of Delhi. Few yellow line Delhi MRTS i.e. Delhi metro stations are taken for the study of existing local connecting scenario and these study are based on following parameters such as ridership, landuse, local connectivity modes etc.

There are a total of 147 stations in Delhi metro, out of which 4 stations are identified for detailed analysis of enhancing accessibility of local connectivity in the selected metro stations of yellow line Delhi metro.

The criteria for selection of station for enhancing local connectivity are as follows:

- Ridership data up to January 2017 was obtained from DMRC, on the basis of these data, it was easy to find out which stations have highest ridership and which station has lowest ridership and footfalls.
- Quick interchange quality assessment i.e. availability of local connectivity modes through Reconnaissance survey.
- Abutting landuse around yellow line metro stations.
- Trip generating and trip attracting metro stations through reconnaissance survey.
- Activity intensity around the stations.
- Typology of the stations.

<table>
<thead>
<tr>
<th>Stations at Trip Producing areas</th>
<th>Stations at Trip Attracting areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saket, Sultanpur</td>
<td>Vishwavidyalaya, INA</td>
</tr>
</tbody>
</table>

Analysis of landuse plans in the selected case study stations

The main criteria for locating a mass transit station in a specific location are the mass/people that a station targets to serve. For serviceability of a station, landuse becomes a prime factor, thus a micro level landuse assessment is done for 4 metro stations. The mobility of these people from one location to another is directly a function of the landuse pattern of the area that results in the ridership of that station. Based on the landuse pattern of the area, Saket metro station, Sultanpur metro station, INA metro station and Vishwavidyalaya metro station are categorized into trip producing area or trip attracting area, also categorized into high, mid and low ridership. It also explains the factors affecting the impact of local connectivity on metro ridership.
These landuse plans have been prepared based on transit oriented development concept where influence area has been divided into 3 zones i.e., 500m for walking, 1 km for walking and bicycles and 1.5 km for other feeder modes.

**Issues identified from the data collected and analysis from IPT/NMT operators, Private vehicle users and Metro users**

- Even though an existing need of multi modal integration is felt in Delhi, there is no existing norms, guidelines and framework supporting the importance of local connectivity.
- Vishwavidyalaya as the name denote University with an institutional land use surrounding has the good quality of local connectivity modes, but pedestrian safety is almost nil in Vishwavidyalaya. Direct access need to be provided for pedestrian and NMT from the station to Delhi University. There is no requirement of further private mode amenities, as the existing facilities are not completely exploited. The station has a huge potential of NMT and pedestrian priority, hence ROW of the roads in the influence area should be dominated by NMT.
- Sultanpur has few good options available for access and dispersal of passengers, but the conditions of road is very pathetic, so the existing roads in Sultanpur needs to be strengthened, so that more number of people can walk or use local connectivity options.
- Saket among most of the stations of Delhi, has the good options available for access and dispersal of passengers, but there is a lack of integration among all these modes. Even in Saket, the conditions of roads are not so good, so roads needs to be strengthened and improved to control traffic congestion.
- In INA although roads are available in a very good conditions but INA metro station needs more option of local connectivity. Because available modes are not so good. If a person travel from Railway colony or R.K. Puram then he/she has to wait for minimum 20 minutes to board in a bus.

**Observational Analysis**

An observational analysis was done to understand the overall scoring of the stations according to the available facilities, user requirement for the improvement of local connectivity quality. The comparative analysis of available facilities and user requirement of all the selected case study metro stations are as follows:
More than 60% of current metro users (in the survey conducted) mentioned problems related to LMC. The average time spent and cost incurred in LMC is considerably significant (more than 30%). Inconvenient and unsafe walking and cycling conditions are also deterrents. More than 50% of private mode users point to reasons directly or indirectly related to LMC, for not using public transport to reach metro or not using metro. More than 80% private mode users are willing to use public transport if provided efficient feeder services. Properly planned and well-designated spaces allocated for auto-rickshaw/ cycle-rickshaw stands at the metro stations are a rarity, it is almost nil.

**Broad level strategies to improve Local Connectivity for efficient Transit Oriented Development in the Delhi metro**

**Framework for Enhancing accessibility of local connectivity around Delhi metro mass transit station**

The framework for enhancing accessibility of a mass transit station shall be carried out in 5 approaches and the objectives of each approaches are as follows:

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### Table 5. Overall scoring of the stations according to the available facilities

<table>
<thead>
<tr>
<th>Facilities</th>
<th>Saket</th>
<th>INA</th>
<th>Vishwavidyalaya</th>
<th>Sultanpur</th>
</tr>
</thead>
<tbody>
<tr>
<td>Options available</td>
<td>3.5</td>
<td>3</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Pedestrian amenities</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Bicycle amenities</td>
<td>3</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>IPT amenities</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Feeder bus</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Private mode amenities</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Information</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Overall safe feeling of the area</td>
<td>2.5</td>
<td>3</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>NMT amenities</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

Note: (1. Poor, 2. Satisfactory, 3. Good, 4. Very Good, 5. Excellent)

### Table 6. User requirement for the improvement of integration quality

<table>
<thead>
<tr>
<th>Facilities</th>
<th>Saket</th>
<th>INA</th>
<th>Vishwavidyalaya</th>
<th>Sultanpur</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parking</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Bicycle rent</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Feeder Bus</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Car Pooling</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Park and Ride</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>NMV amenities</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Pedestrian amenities</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Safety</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Comfort</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Note: (1. Poor, 2. Satisfactory, 3. Good, 4. Very Good, 5. Excellent)
Seamless Integration with CNG Feeder Buses, E-Rickshaw, Taxi routes and infrastructure (Dispersal policy of Local connectivity)

It is important to seamlessly integrate feeder bus, rickshaw and taxi services with mass transit stations in order to reduce waiting times and discourage the use of private vehicular modes for local connectivity and hence demand for vehicular parking. These provide an opportunity to increase the catchment areas of mass transit, especially in lower density station areas. These services should be characterized by short distance routes and high frequency services. The strategies for integrating Delhi metro with CNG based feeder buses, E-Rickshaws, CNG based Grameen Seva and other infrastructure are as follows:

- Provide and coordinate feeder bus services and routes within the station area to minimize waiting times.
- Adopt bus priority measures to encourage use of feeder bus services and ensure efficient movement to and from the station area.
- Facilitate access by auto-rickshaws, battery based cycle-rickshaws, E-Rickshaws, Cycles and taxis.
- There is a need of designated parking in every station for NMT vehicles such as E-Rickshaws and para transit, TSR zone is also needed in every metro stations. Propose rickshaw or taxi stands (as relevant) at major destinations along with resting, drinking or seating facilities and also washroom facilities.
- Charging station should be provided near metro stations especially for battery operated vehicles such as E-rickshaws etc. It is necessary to abolish the manual cycle rickshaw.
- In every metro station, total number of 100 parking spaces should be provided for E-Rickshaws and other multi-modal environmental friendly modes. DMRC should be linked with multi modal modes with various contracts. DMRC should be charged Rs. 10 per km from the multi mode operators.
- There should be scheme for monthly paid for Dispersal passengers. Operating cost, service cost, capital cost and seed fare per mile will be charged from passengers.
Pedestrian and NMT priority

Prioritizing NMT access aims to reduce walking and cycling distances, create connected and complete networks, improve pedestrian and cycling infrastructure and create a high quality public realm that supports street level activity and uses. The Strategies and guidelines for pedestrian and NMV priority in transit oriented based influence zone are as follows:

- To reduce conflict with motorized modes in transit oriented influence zone priority must be given to NMT users and pedestrians. Strategies can include setting speed limits for motorized traffic, prioritizing pedestrian movement at intersections and redesigning streets to facilitate NMT and pedestrian movement.
- Cycle repair shops, E- Rickshaws charging stations, retail stores, street vending, public toilets and day care centres amongst others need to be acknowledged. It is necessary to Enforcement and regulation of the stoppage of E – Rickshaws and other NMV. It is also necessary to provide license to all NMV modes such as E – Rickshaws, Cycle Rickshaws etc.
- Provided a multi-utility zone of minimum 1.8m is needed around the transit oriented development influence zone within pedestrian infrastructure to accommodate vending areas, trees, bus shelters, utilities, seating etc. and include the parking bay within the footpaths especially for high concentration of pedestrians and vending activities. The vending areas need to be supplemented with amenities like public toilets within 15 minutes walking distance, shade, seating areas and dustbins.

Figure 7.(a) Proposed Pedestrian and NMV tracks and (b) Footpath designs
Source: Better streets, better cities: A guide to street design in urban India, ITDP, December 2011

- Cooperative of NMV modes is need to be formed and collaborating with the local bodies, the non-government bodies and the rickshaw pullers, E- Rickshaw owners in Delhi and need to be organize them. The cooperative also need to propose the required change in the NMV modes laws of the Delhi for the safe, secure and efficient movement of the NMV modes in the Delhi. The cooperative will also look into the socio- economic issues of the NMV modes owners. DMRC may link with the cooperatives. The NMV modes routes in a Delhi may be divided into zones and each zones to have at least E- Rickshaw stands. In each zone the E- Rickshaws owners and battery operated rickshaw pullers can be formed in groups and sub groups and each groups to have a maximum of 5 to 6 sub- groups.

Enhanced Safety and Security

- It is necessary to propose crossings at distances not more than 100m. Speed limits for vehicles needs to be considered. It is necessary to minimize conflict points between motorized road users and pedestrians and cyclists especially at intersections.
- Improved street lighting can contribute towards increased safety. It can prevent road traffic crashes, injuries and fatalities. Street lighting not only reduces the risk of traffic accidents, but also their severity. This would also aid the safety of pedestrians, especially women, after dark. The street lights should need be placed in the multi-utility. zone, clear of pedestrian walkways. It can be coordinated with other street elements such as trees, hoardings etc., so that they do not impede proper illumination.
Encourage natural surveillance through street eyes, encourage mixed uses and discourage single land use zones. It is necessary to provide amenities and encourage building uses to address women’s unmet needs. It is necessary to ensure that there are amenities like day care centres and public toilets within 15 minutes walking distance with sufficient toilet seats for women and children; encourage building uses such as grocery stores, pharmacies etc. that can improve women’s convenience.

Conduct Gender sensitization trainings, Advocacy campaigns and Self defence training. It is necessary to incorporate community in the total safety and security process. They can gives suggestions in improvement of the area specially in context of safety and security and also they can participate in the complete process. It is also necessary to ensure that station agents and other staff have a highly visible presence for the safety and security of the people.

Parking Management

The parking or no parking zones can be demarcated to ensure safe access for non motorized trips, prioritise public transport and IPT, preserve special characteristics of areas such as heritage precincts, and access open/public spaces.

One of the most important tools for good on-street parking management is pricing. Pricing nudges long-stay users especially to park off-street and improves the willingness to pay for off-street parking. Limit commuter parking expansion by prioritizing feeder bus, auto-rickshaw (and taxi) services.

Parking policy for metro stations should be formed to discourage increased private vehicle stations. For example initiatives as high parking rates, parking hours/day, parking days/month and designating drop off and pickup areas can be introduced. It is also necessary to limit commuter parking expansion by prioritizing feeder bus, auto-rickshaw (and taxi) services.

It is also necessary to provide Sufficient, Secure Parking for Bicycles at Station Entrances.

An Enhanced Public Realm

It is necessary to undertake activity counts and map different types of Street activity and uses. While station areas are likely to witness large volumes of people, the role of streets as public spaces needs to be acknowledged or proposed by designing for multiple users, which offers various users the flexibility to access and use public streets and public spaces in a variety of ways.

It is also necessary to create a Secure, Comfortable and Identifiable Public Realm and propose different types of seating and waiting depending on surrounding context.

Dustbins must be provided at all intersections, near all public gathering points, bus stops etc. or at a distance of 30-40m from each other, whichever is lesser. It is also recommended that dustbins be placed near vending areas as and when possible. It is also necessary to propose street lighting for carriageway and pavements.

Universal Accessibility is needs to be proposed for all sidewalks, crossings, parks, public spaces and amenities— for people using wheelchairs, strollers, walkers, crutches, handcarts, bicycles, aged people, visually or hearing impaired, and pedestrians with temporary mobility impairment or injury.
Environment related measures

- Avenue tree plantation is a must on all streets of Delhi specially near station area in order to provide shade and comfort to pedestrians.
- Thick plantation needs to be done. The houses which has setbacks can be used for plantation inspite of huge walls or boundaries.
- Intensive pollution check needs to be done on a regular basis. Monitor of environmental parameters also needs to be done.
- Air purifying mask to be provided to the cyclist and pedestrian on either free of cost or in a half price to the commuters to prevent from air pollution in Delhi.

Improved Feeder Bus Service for Enhancing local connectivity

- All feeder bus should be CNG based i.e.. Eco friendly, therefore it will contribute in the clear air process of Delhi. Connecting bus service must be frequent and reliable. The bus route structure should be clear and direct. Route deviations should be avoided.
- There should be minimal and predictable wait times between modes. Passengers tend to consider time spent waiting for a bus, train or metro rail as more burdensome than time actually spent travelling. Providing real time information about transit arrival times helps alleviate passenger uncertainty of bus arrival and reduce the wait time burden.
- Route branching should be minimized. It is better to operate fewer services with short headways than may services with long headways. The use of coordinated ticketing can avoid the inconvenience and cost penalties of purchasing separate tickets or fares. There should be Feeder bus services for Women. Doubling of station bus access frequencies is needed.

Suggestions for the improvement of IPT (Intermediate Para-Transit systems) services for enhancing local connectivity

- It is necessary to recognise and legalise IPTs. All the IPT vehicles should be CNG based i.e.. environmental friendly, which contribute in the controlling air pollution in Delhi. Market intervention is needed in IPT sector.
- Municipal corporations, municipalities and panchayaths (local self-governments) shall be given the power to take decisions on IPT regulations. Permits shall be given and norms laid down by these bodies for seamless mobility.
- The mandate of IPTs shall be to act as a feeder system to other transport systems. This requires integration at different levels. From Android apps to GPS systems, private players are quick in adapting the latest technologies which increase the efficiency of the transport systems and provide better customer satisfaction.

Saket Station level strategies to improve Local Connectivity for efficient Transit Oriented Development in the Delhi metro

Station area improvement in Saket metro station to ensure accessibility of local connectivity

- For the enhancing accessibility of local connectivity in the selected case study stations it is necessary to improve stations area as well as catchment area of that particular metro stations i.e.. Saket. For station area improvement, it is divided into two parts i.e..(i) within station, (ii) Outside station access area of station i.e.. the immediate influence (1.5 km radius) area which considers the access and transit area of a station.
- Within Station includes provision of safe and
comfortable infrastructure improvement, creating pedestrian amenities, enhancing bicycle usage by creating cycle sharing stands, lighting and finally informatory signage to help user navigation at station. Outside station area infrastructure includes Bus Stops, IPT stops, continuous and connected pedestrian network, information board with feeder timings etc.

To enhance, the accessibility of LMC, designated IPT and NMT parking has been proposed both sides of Saket metro station. As E-Rickshaw is not available in Saket Metro Station, so E-Rickshaw designated parking has been proposed near Saket metro station Gate No.1. A multi utility zone of 200m has been proposed near Saket metro station, so that street vendor does not encroach footpaths and parking of NMT and IPT. Other than street vendors, seating facilities, drinking water and public toilets, street lights, dustbins, E-Rickshaw charging station, cycle repairing shop and passenger information system has been proposed in Multi Utility zone. Other than these, park and ride facilities for bicycle has been proposed near Gate No. 2 Saket metro stations which will cater 50 to 70 bicycles at a time.

Improving and Enhancing NMV and Pedestrian facilities at Saket Metro station

According to Zonal Development plan F, the width of Mehrauli Badarpur road is 60 R/W, but it lacks basic NMT track and multi utility zone, therefore following cross section has been recommended for Mehrauli Badarpur road outside of Saket metro station which are as follows:
The typical proposed cross sections of above mentioned roads near the Saket metro station depict the fact that existing road network are neither pedestrian friendly nor NMT friendly. Therefore, the existing roads near the Saket metro station needs to be redeveloped for better pedestrian and NMT facilities. As the ridership of Saket metro station is considered among highest ridership in Yellow line metro station, therefore, the road conditions around Saket metro station need to be improved for enhancing accessibility of local connectivity.

To encourage bicycle, it is necessary to propose few cycle stands near Saket metro station, so four bicycle sharing stand has been proposed near IGNOU university in IGNOU road, near Made easy coaching centre in Western Marg, near Saket district court and last one near PVR Saket. The area that has been chosen for public sharing bicycle stand has considered as commercially and institutionally very important destinations.

Planning for Feeder and Distribution system at Saket metro station

To enhance accessibility of local connectivity of Saket metro station, various route were identified based on the existing origin destination pattern of users using Saket metro Station.
Three alternative scenarios are developed in Saket metro station i.e. (a) Scenario 1- Walkability improvement, (b) Scenario 2 – Improvement in Transit connectivity, (c) Composite Scenario – improving both walkability and transit connectivity. Various routes has been proposed and recommended based on primary survey conducted and mostly on users and operator opinion.

Implementing and Funding Agencies

These project is impossible without Inter – departmental coordination. Institutional framework is necessary for implementing these agencies for LMC project. The Funding agencies and schemes who will contribute for this project are as follows:

- Delhi Metro Rail Corporation.
- Delhi Development Authority.
- Delhi Integrated Multi-Modal Transit System (DIMTS) Ltd.
- State Government NCT Delhi through state budget.
- Delhi Transport Corporation.

The following agencies will work together for these project:

Figure 16. Proposed routes for Enhancing local connectivity around Saket metro Station

### Table 7. Implementing agencies for the project

<table>
<thead>
<tr>
<th>Integration of Modes</th>
<th>Delhi metro rail corporation (DMRC), Delhi Integrated Multi-Modal Transit System (DIMTS) Ltd, Delhi Transport Corporation (DTC).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedestrian Improvement</td>
<td>Municipal Corporation of Delhi (MCD), Public Work Department (PWD), United Traffic and Transportation Centre (UTTIPEC).</td>
</tr>
<tr>
<td>CCTV cameras</td>
<td>Delhi Police.</td>
</tr>
<tr>
<td>Street lights</td>
<td>Municipal Corporation of Delhi (MCD).</td>
</tr>
<tr>
<td>Parking Management</td>
<td>Near metro stations:- DMRC (Delhi Metro Rail Corporation). If other area other than metro:- MCD (Municipal Corporation of Delhi).</td>
</tr>
<tr>
<td>Vendors Zone and Enhanced Public Realm</td>
<td>Municipal Corporation of Delhi (MCD) and DDA (Delhi Development Authority), Delhi metro rail corporation (DMRC).</td>
</tr>
<tr>
<td>Plantation of Trees</td>
<td>National Green Tribunal and Department of Environment Delhi.</td>
</tr>
<tr>
<td>Legalise IPT and NMT</td>
<td>RTO Delhi, Transport department, Delhi government.</td>
</tr>
<tr>
<td>Local modes</td>
<td>Public bicycle sharing system, Bicycle parking, Designated parking for NMT and IPT by Delhi metro rail corporation (DMRC).</td>
</tr>
</tbody>
</table>

### Conclusion

People often have problem in starting their trip and these difficulties don’t lie in the main line haul transport network but in availability of modal options that a person gets beyond his or her residence to reach the station located at main transport network i.e. the gap for local connectivity. It is important to understand that the feasibility of each of
these modes may vary with landuses, densities and overall intensity of activities and hence requires judicious planning. The proportion of public transport users using bicycle for local connectivity, at present, is very low. Therefore, it is necessary to improve the loopholes of LMC in the selected case study stations.

To improve the conditions of local connectivity, it is necessary to provide planning on the basis of following criteria:-  
1. Upto 500 m walking.
2. Upto 1 km walking and cycling.
3. Upto 1.5 km other feeder modes.

On the basis of these criteria, broad level proposals for all metro stations and station specific proposals for Saket metro station is given for enhancing accessibility of local connectivity which includes improving station area, enhancing pedestrian network, strengthening roads, suggesting feeder routes etc. On the basis of these proposals, local connectivity can be improved in Saket and can be implementing in other metro stations also. It is also necessary to enhance multi-modal integration or integration with other modes i.e. physically, fare and operational integration. These strategies can be used to improve Local Connectivity for efficient Transit Oriented Development especially in the case of Delhi metro.

References

Thesis

Internship / Training Reports

Conferences and Research Papers
2. Chidambara, “Greening the ‘last’ mile to transits: Place making for healthier and sustainable mobility”, Department of Urban Planning, School of Planning and Architecture, New Delhi (2016).

Articles and Manuals
5. Los Angeles County Metropolitan Transportation Authority , “First Local Strategic Plan & Planning
Guidelines, los Angeles, California”.(2014).

Newspaper article (online)
<table>
<thead>
<tr>
<th>Policies / Guidelines</th>
<th>Year</th>
<th>Highlights</th>
<th>Results</th>
<th>Shortcomings</th>
</tr>
</thead>
<tbody>
<tr>
<td>12th Five year plan</td>
<td>2012-17</td>
<td>Does not deal separately with the aspect of LMC but it does point out its significance in the context of integration. Creation of multimodal interchange facilities where commuters can change modes or routes without much time penalty and in safety without coming in conflict with other vehicular modes.</td>
<td>A special budget has been allocated to NMT projects specially.</td>
<td></td>
</tr>
<tr>
<td>National Urban Transport Policy</td>
<td>2006</td>
<td>Focus on improving urban environment by integrating landuse and transport. Focus on public transport priorities non- motorized transport.</td>
<td>Formed baseline for the 12th five year plan on urban transport. Advised transport policy and programs of JNNURM</td>
<td>Taxation for public transport not fair. No defined norms and parameters for LMC i.e., NMT Does not discuss ways of generating finance for public transport. (Tiwari 2011)</td>
</tr>
<tr>
<td>Jawaharlal Nehru National Urban Renewal Mission</td>
<td>2005 - 10</td>
<td>City development plan to be prepared for City development projects. 25 comprehensive mobility plans were drawn and 10 are still in process.</td>
<td>Street improvement project implemented in Pune, Nanded, New Delhi. Only fraction of transport budget utilized for NMT.</td>
<td>Plans do not identify the source of their funding. (Pai 2012). No project identified for LMC specially NMT.</td>
</tr>
<tr>
<td>URDPFI Urban and Regional development plans formulation and Implementation</td>
<td>2014</td>
<td>Provide fast, convenient interchange options and spatial provision for various modes of Intermediate Public Transport (IPT) at Multimodal Transit Station for seamless travel. Provide multiple mode choices for last-mile connectivity at various prices and comfort levels and at a given situation, eliminate the need of Intermediate Public Transport by design and engineering.</td>
<td></td>
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</tr>
<tr>
<td>The new National Urban Transport Policy</td>
<td>2014</td>
<td>First time talks explicitly on “local connectivity”. It broadens the scope of multi-modal integration to include “private modes of transport i.e. walk, cycle, cars and 2-wheelers and para transit modes i.e. tempos, autos, mini bus and cycle rickshaw to the mass rapid transit network” which was previously “limited to integration of buses with Metro rail” (IUTI, 2014).</td>
<td>The policy also recognizes the significance of improving local connectivity to public transport through provision of footpaths and cycle lanes, provision of feeder services, and incorporating design principle to promote safety, accessibility, reliability and affordability, amongst other measures.</td>
<td></td>
</tr>
<tr>
<td>Organization</td>
<td>Year</td>
<td>Document Title</td>
<td>Details</td>
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<tr>
<td>Unified Traffic and transport Infrastructure (Planning and engineering)</td>
<td>2010</td>
<td>Street design guideline manual. Covers all aspects of good street design with suggested road widths and examples.</td>
<td>Adopted in Delhi Aurobindo Marg, ITO, Pragati Maidan</td>
<td></td>
</tr>
<tr>
<td>Indian Road Congress</td>
<td>2014</td>
<td>Standards and guidelines for pedestrian and cycle oriented infrastructure and designs are already suggested but there lies a great scope for improvement.</td>
<td>Street design features discussed in details with suggested widths and examples. Constant up-gradation with design schemes adoption the changes occurring the road is required.</td>
<td></td>
</tr>
</tbody>
</table>

Source: Planning and design for urban neighbourhood based on non-motorised transport case study Delhi, IIT Roorke and remaining portion compiled by author