**Greening the ‘last’ mile to transits: Place making for healthier and sustainable mobility**

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**Abstract**

Sustainable mobility concerns have seen cities introducing mass transit systems, but travel choice factors such as accessibility, convenience, comfort, and safety can not be addressed through a transit system alone. The lack of suitable last mile options discourages private mode users to shift to public transport. For a larger mass, cycling and walking are the only solutions for negotiating the last mile. Unsafe, uncomfortable last mile conditions compel transit commuters to use private modes for last mile connectivity, thereby generating massive parking demand at metro stations. The paper discusses the significance of creating apposite spaces and environment for pedestrians and other non-motorised transport (NMT) as ‘green mobility’ solutions for covering the last mile to transit systems, with a case study of an Indian city Delhi. It discusses user choices and behavior with respect to the quality of last mile at six metro (transit) stations in the city. The paper also highlights demand-generated green mobility solutions that have come up in the city and that need to be encouraged through integration in planning and policy making for transit systems. The study concludes that all transit system planning must mandatorily include integration with other modes, adequate spaces, and safe and smooth transfer for all modes. It also recommends planning for enhanced walking and cycling environment in a larger context that includes the catchment area around metro stations rather than station-centric planning.

**Key words**

last mile connectivity, green urban mobility, non-motorised transport, sustainable mobility

**1.0 INTRODUCTION**

In today’s globalized scenario, cities are becoming increasingly competitive. The churning of economic, social and cultural activities is taking place at enormous scales. The need to connect, both in the physical and the virtual spaces can not be negated. Travel, thus takes a centrestage in every urban dweller’s life; however, it comes with its set of negative externalities in the form of congestion and jammed conditions on roads, accidents, green house gas emissions and air pollution and psychological and other health hazards. Cities all across the world are today trying to reduce the number of personal automobile trips and promote public transport. This is however, easier said than done. A variety of factors affect travel choices between public vis-à-vis private transport; and cities are adopting various strategies to divert choices towards the latter. Increasing number of cities, especially in the emerging economies have introduced mass transit systems, but travel choice factors such as accessibility, convenience, comfort, safety can not be addressed through a state-of-the-art transit system alone. Mass transit systems are limited by their lower accessibility, in terms of direct access from trip ends. On the other hand, private modes offer a variety of advantages such as demand mobility, comfort, status, speed, and convenience (Rodrigue, 2013). Stopher et al. (1974) suggested that the attractiveness of public transport can be decomposed into four generic elements: safety, cost, time, comfort and convenience.

Unfortunately, most transit planning focus on improvement in these elements of the transit system per se and not of the overall transit journey which includes the first and the last mile connectivity (LMC). A trip made on transit systems usually requires the commuter to utilize more than one mode of transport. It is now somewhat well researched that the out-of-transit (or the first/ last mile) experience can play an influencing role in travel choice. Researchers have found the connecting ends to be its weakest link and that they can significantly influence the overall appeal of transit systems given their substantial contribution in terms of travel time and travel discomfort (Krygsman, et al., 2004 and Rietveld, 2000 in Tay, 2012). The attractiveness of transit as a mode therefore depends not just on the quality and attributes of the main mode but also on the quality and attributes of the LMC.

The origin of the term LMC can be traced to telecommunications and technology industries to describe the technologies and processes used to connect the end customer to a communications network. It is the final leg of delivering connectivity from a communications provider to a customer. Although the term reads `mile’, the actual distance of this leg may be less or considerably more than a mile, especially in urban fringe and sprawl. In the context of urban transport, the term finds relevance in transit systems where it is referred to as both the initial and final leg of delivering connectivity - from origin to transit nodes and from transit nodes to destination. The term is severally referred to as ‘last mile’, ‘first mile’ or ‘first and last mile’ and has generated considerable interest in recent years over how it influences public transit usage.

In terms of strategies adopted for enhancing the LMC, we see that there has been a gradual, albeit slow paradigm shift from station-centric to area-centric. Most of the earlier studies and city-level efforts focused on provision of feeder services, integration of modes, provision of real time and integrated passenger information and ticketing, parking facilities and provision/ improvement of facilities at transit hubs. While not downplaying the significance of these strategies for transit system quality improvement, these strategies within themselves are not sufficient to cater to the wider needs of the transit user in a wholesome manner. Most transit trips require some degree of walking and this degree of walking can be increased with enhanced walking conditions in not merely the immediate vicinity but at a larger area/ neighbourhood level. More recent strategies at addressing the last mile, recognizing this significance have thus widened their scope to improve walking and cycling conditions at the area level, surrounding transit hubs. One can learn from Singapore policy on transport connectivity that lays focus on improvement of services not just at the hubs but enhancing accessibility of these hubs from the areas surrounding it, thereby improving the last mile experience. The city has also successfully translated policy to planning by not only making all stations barrier-free but through creating at least 2 barrier-free access routes for more than 80% of the hubs. Similarly, in the PATH planning guidelines for Los Angeles there is due stress given to improvement in the quality of active transportation (comprised of sidewalks, bike lanes, street crossings, signals, signs, curb returns, lighting, furnishings and landscaped elements) and landuse integration.

There is a body of literature establishing link between surrounding built environment and transit ridership (Sung, 2014; Marshall and Grady, 2005; Cervero, 1996). The paper contends that urban streets are a component of the built form and in absence of adequate walking-friendly environment, transit users tend to use unsustainable modes for access/dispersal to/from transit stations, whenever they can afford it. Some research point out that the type of mode used depends on the distance of the origin point to the transit station (Loutzenheiser, 1997; Parsons et al., 1996), yet the same studies and other research (Ozbil, A. and Peponis, J., 2012; Jiang, et.al., 2011**;** Rodriguez and Joo, 2004; Cervero, 2002; Cervero and Kockelman, 1997; Ewing et al. 1994) also indicate that the use of NMT (specially walking) for last mile connectivity can greatly be influenced and their catchments enhanced by other factors such as density, landuse, street and network design and layout and overall environment. The paper brings to the fore the significance of appropriate placemaking for ‘green mobility’ i.e., for pedestrians, cyclists and other non-motorised transport (NMT) which will not only enhance transit ridership but also encourage healthier and sustainable ways to access the transit and promote equitable use of road space.

**2.0 INDIAN SCENARIO**

The vehicular growth in Indian cities is increasing at a tremendous speed. It is rather alarming to note that during the period 1961 to 2011, while the number of cities in India increased three fold (from 2,363 in to 7,935) and the population increased 5 times (from 79 million to 377 million), the vehicular population marked a whopping increase of approximately 200 times (from 0.7 million to 142 million) (CSE, 2013). Of this, larger cities including metro and mega cities constitute the maximum share, with Delhi taking a clear lead.

A reflection on whether the infrastructure is commensurate with this surging vehicular growth reveals an interesting dichotomy. On one hand, the road space as percentage of total land area in Delhi is 21% (Sahai and Bishop, 2010), much higher compared to cities like Tokyo (13%), Hong Kong (12%) and Bangkok (11%); as such, continued and aggressive expansion of road network is likely to be highly unsustainable. On the other hand, the road space availability has halved from 12 kms/1000vehicles in 1990-91 to about 6 kms/1000 vehicles in 2005-06, leading to heavy congestion on most city roads and increasing levels of vehicular pollution. This is a resultant of shifting trend towards private motorised modes of travel. On some major arterial roads, cars occupy as much as 70% of the road space carrying merely 20% of the total trips. The modal share of public transport (including bus and metro trips) in the city has gone down from 60% to 45.5% between the period 2000-01 and 2007-08 (RITES, 2008), despite introduction of BRT corridors and an expanding network of metro rail.

A large percentage of trips in Indian cities are made by non-motorised modes. A 2008 study on 30 Indian cities found that “in cities with more than 8 million population: 22% walked all the way, 8% used cycles and 44% used public transport. This adds up to 74% of people who rely on non-motorised transport for at least part of the commute” (WWF). Although walking is ubiquitous and intrinsically embedded in Indian urban mobility pattern, the apathetic attitude towards provision of pedestrian facilities does not encourage users to readily go for this option, unless when compelled to do so. A World Bank report (2008) remarks, “the urban poor make up a city’s ‘captive walkers,’ but since this group has the least resources, it usually has the smallest political voice”. Despite NMT users being the highest percentage of victims in road accidents, (44.5% pedestrians and 6.1% cyclists) (MORTH, 2012 in CSE, 2014), the urgency with which road safety need to be treated with is found wanting. The same report also highlights that pedestrian and cyclist accidents and fatalities around public transport nodes, markets, etc. in Delhi have been on the rise by 1.3 to 4 times.

**2.1 Policy manifestation into planning and implementation**

Till recently, the aspect of last mile connectivity for transit systems did not find mention in transport policies though they promoted public transit systems, multi-modal integration and to an extent, NMT. New policies, however, have come to recognize the significance of both LMC and NMT. The Working Group on Urban transport for the 12th FYP points out its significance in the context of integration of public transit with other modes although, strategies at best, are touched at the surface level. The report also recognizes the role of “cycle rickshaw as an intermediate public mode of transport and best suited to provide the last mile connectivity in an integrated citywide multimodal public transport network”. The new National Urban Transport Policy (NUTP) for the first time explicitly covers “last mile 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). The policy also recognizes the significance of improving last mile 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.

However, the realization of policy to planning and its manifestation on ground is yet at a very nascent stage in most Indian cities including Delhi. Most cities take up transit system and NMT planning in isolation to each other. It is also true that while cities have been enthusiastic in introducing transit systems, there has been rather lackadaisical approach towards NMT planning and its integration with transit systems. There is very little work done in the field; and little of what has been done, has focused on mere provisioning of low capacity feeder bus services, without understanding user behavior and requirements with respect to varying conditions. As pointed out earlier, a high percentage of public transport users are also pedestrians, it is essential that at least all streets leading to transit stations are made NMT-friendly. This sensitivity in planning and even more at ground-level implementation is rather lacking, which is evident from the money spent on provision of NMT infrastructure. Despite the city transport budgets almost doubling between 2002-07, 80% of the money was spent on widening roads, sometimes at the cost of sidewalks, with hardly any been spent on pedestrian facilities (TNN, 2009).

**3.0 DELHI METRO TRANSIT USAGE**

Since its first operation in December, 2002, the Delhi Metro network has expanded to 193 operational kilometres with 146 stations. The total length, number of stations developed for various lines, and the average daily ridership for each line are indicated in Table 3.1.

**Table 3.1 Line-wise characteristics of Delhi Metro**

|  |  |  |  |
| --- | --- | --- | --- |
| **Line** | **No. of** **Stations** | **Length****(in km)** | **Avg. Daily** **Ridership** |
| Yellow | 34 | 44.65 | **9,62,144** |
| Blue | 51 | 58.67 | **7,30,983** |
| Red | 21 | 25.09 | **8,18,709** |
| Green | 16 | 18.46 | **73,542** |
| Violet | 18 | 23.24 | **1,53,191** |
| Orange | 6 | 22.7 |  |
| **Total** | **146** | **192.81** | **27,38,569** |

*Source: delhimetrorail.com, 2015*

As indicated in Fig.3.1, the average daily ridership of metro has risen from 1.24 lakhs in 2004-05 to 21.9 lakhs in 2013-14. Yet, the metro ridership achieved for the year 2011 fell deficit by 1.5 lakh of that estimated for this year. So, while the city clearly identifies transit improvement for its long-term goal of sustainability, it is still grappling with ways to increase its transit ridership.



*Source: DMRC, Annual Report, 2014*

**Fig.3.1 Average Daily Ridership in Delhi Metro (2004-05 to 2013-14)**

The Metro in Delhi is further expanding and is projected to have a much larger trip share than its existing patronage. The transport demand forecast and development of public transport network study prepared by RITES in 2010 recommends the total Metro length within Delhi to be 330 km by 2021 with an estimated modal share of 20.1%. Achieving this modal share from the present miniscule 4% would be overambitious and far-fetched, unless the city takes proactive measures to make the metro attractive enough to shift private mode users towards mass transit patronage. Given the fact that the transit system in itself is built with the state-of-art technology, mere expansion of network, services and overcoming technical glitches at the transit level may not be sufficient; the answer has to be probed elsewhere, in a larger perspective.

**3.1 Last Mile Connectivity Options for Delhi Metro**

Out of the total metro stations only 23 stations have feeder shuttle services. Apart from feeder bus services, there exist a variety of para-transit modes (viz., 3-wheeler auto-rickshaws, a variety of shared auto-rickshaws, battery operated e-rickshaws and cycle-rickshaws), which can be efficiently utilized for providing last mile connectivity. While all of these modes are currently providing LMC, these are totally demand-driven and unorganized and there are no planned efforts to integrate them with the transit system. Regulations even prohibit certain modes such as cycle-rickshaws and e-rickshaws (which are zero carbon and higher accessibility) from operating in certain parts of the city. Since they are not included in the station area planning, there are no designated parking spaces for them, as a result of which they create nuisance and chaos around metro stations, and operate under unsafe conditions. There are also issues related to the regularization of these modes. Bike hire facilities have been made available at merely 4-5 locations without carrying out a station-wide study of the cycling conditions and infrastructure in the vicinity of the station, their potential and feasibility.

**4.0 CASE STUDY STATIONS AND THEIR SURROUNDING AREA CHARACTERISTICS**

The paper presents the findings of a study conducted at six metro stations of Delhi. The selected stations are located on different lines of the metro network and parameters such as station typology (interchange, mid-block and terminal), ridership, density, type of landuse in the surrounding vicinity were considered for selecting the stations. The paper does not attempt to establish the relationship of transit ridership with last mile connectivity, as it would require a higher sample size of stations having similar characteristics and varying LMC environment. However, it tries to analyse user behavior with varying station and LMC characteristics and also assesses tries to assess the sustainability of the last mile environment. A sample of 30 commuters was taken at each station and surveys were limited to capture commuters alighting the metro station. Table 4.1 indicates the station characteristics in terms of ridership and typology and its surrounding area key characteristics in terms of density, landuses and availability of modes for LMC.

**Table 4.1 Station Area Characteristics**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Station Name**  | **Daily****Ridership**  | **Typology**  | **Adjacent area characteristics** | **Last mile** **modes available** |
| **landuse** | **density** **(in PPH)\*** |
| Rajiv Chowk | 64,415 | Interchange | commercial, PSP | 200 | Auto-rickshaw |
| Chandni Chowk | 62,743 | Mid block | commercial, mixed use | 700 | Cycle rickshaw |
| Noida City Centre | 28,455 | Terminal | residential | 250 | Cycle rickshaw, auto-rickshaw, shared auto-rickshaw (Vikram), bus |
| Chhatarpur | 24,331 | Mid block | residential, PSP, informal commercial | 350 | Auto-rickshaw, shared auto-rickshaw (gramin seva), feeder shuttle, bus |
| Vishwavidyalay | 23,182 | Mid block | residential, commercial, institutional | 400 | Cycle rickshaw, auto-rickshaw, e-rickshaw, bicycle on rent, feeder shuttle, bus |
| Akshardham | 14,589 | Mid block | PSP, residential | 350 | Cycle-rickshaw, bicycle on rent, auto-rickshaw, feeder shuttle, bus |

*Source: DMRC and Primary Survey, 2015.*

*\* the densities in persons per hectare (PPH) are approximate and generalized for the entire vicinity; it does not reflect the mix of high and sparse density pockets separately that may be present around the same station*.

The first two stations have similar ridership and both of these are located in areas that are the busiest activity centres of the city. Rajiv Chowk is the busiest station of Delhi and falls in the CBD of the city with a planned commercial and public/semi-public (PSP) land use in its vicinity. Chandni Chowk station falls in a very dense (approximately 700 PPH) and congested part of the old city having primarily commercial and mixed land uses. The area is an intense activity zone with its dense network of narrow streets and by-lanes, and a rich variety of formal and informal retail and wholesale commercial activities.

The next two stations are located at the outskirts of the cities. Noida City Centre station is a terminal station, and falls in the National Capital Region (NCR) of Delhi. A lot of new residential development is in the vicinity of the station. Commercial development in the city centre has also commenced which is likely to increase the ridership manifolds. Chhatarpur station, although a mid-block station on the Delhi-Gurgaon line, is located at the periphery of Delhi.

The last two stations are both mid-block with lower ridership but are located in quite different contexts and both have a ‘bicycle on rent’ facility. At Vishvavidyalay, which has Delhi University (institutional), and dense residential and mixed uses in its vicinity, the facility is very popular, whereas at Akshardham station which has a huge temple with sparse development on one side and dense low-income residential on the other side, the facility has no takers.

**5.0 LAST MILE TRIP CHARACTERISTICS AND QUALITY**

The last mile trip characteristics parameters identified through various literature (Tay, 2012; Nelson/Nygaard, 2009; Giovani, Rietveldt, 2008; Iseki, Taylor, Miller, 2006) and used in this study are the number of options (modes) available and their frequency (or waiting times), distance, cost and time incurred, and other qualitative aspects such as safety, comfort, convenience and availability of infrastructure.

**5.1 Last Mile Trip Modes**

The use of NMT for covering the first and last mile, as indicated in Fig 5.1, is more than 50% for all stations with the exception of Noida and Chhatarpur. Better walkability conditions combined with shorter last mile trip lengths and non-availability of other NMT modes gives Rajiv Chowk the highest (87%) share of walk trips.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Rajiv Chowk** |  **Chandni Chowk** | **Noida City Centre** | **Chhatarpur** | **Vishwavidyalay**  |  **Akshardham** |

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**Fig 5.1 Last Mile modes opted by commuters at various stations**

At Vishwavidyalay, where there is ‘bicycle on rent’ facility available, a significant percentage (13%) of commuters are using this mode for their last mile trip. This indicates that availability of a facility does impact user choices. However, contextual factors such as adjoining landuse and user profile also determine the usage of a facility. The presence of a significant proportion of university-going and young age-group commuters at this station account for the cycle’s popularity. In case of Akshardham, which has a similar and better quality ‘bicycle on rent’ facility it has no takers, as the area is largely visited by tourists (generally families) for recreational and religious purposes, who prefer cycle-rickshaws to cycling.

**5.2 Average Trip Length**

Table 5.1 gives the average trip lengths of the different sections of the trip including the transit main haul, the first and the last mile and for the entire trip for the different stations. The first and the last mile together constitute approximately 13–23 per cent of the entire journey distance.

**Table 5.1 Average Trip Length**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Station Name** | **Main Haul** | **First mile** | **Last mile** | **First & Last mile** | **Total trip** |
| in kms | in %age | in kms | in %age | in kms | in %age | in kms | in %age | in kms |
| Rajiv Chowk | 12.6 | 79.8 | 2.2 | 13.9 | 1.0 | 6.3 | 3.2 | 20.2 | 15.8 |
| Chandni Chowk | 10.6 | 81.2 | 1.3 | 9.8 | 1.2 | 9 | 2.5 | 18.8 | 13.1 |
| Noida City Centre | 18.4 | 77.3 | 1.2 | 5 | 4.2 | 17.7 | 5.4 | 22.7 | 23.8 |
| Chhatarpur | 20.8 | 80.3 | 2.1 | 8.1 | 3 | 11.6 | 5.1 | 19.7 | 25.9 |
| Vishwavidyalay | 21.3 | 80.1 | 2.7 | 8.1 | 2.6 | 9.7 | 5.3 | 17.8 | 26.6 |
| Akshardham | 17.3 | 86.5 | 2 | 10 | 0.7 | 3.5 | 2.7 | 13.5 | 20.0 |

*Source: Primary Survey, 2015*

The average trip length for the first and last mile, although relatively lesser for stations located in the centre of the city (2.5km for Chandni Chowk and 3.2 km for Rajiv Chowk), it yet constitutes a significant percentage of the total journey (18.8% and 20.2% respectively). It is also interesting to note that commuters try to keep at least one end of the journey shorter, preferably less than 2 kms, which is an easily negotiable distance for NMT.



**Fig 5.2 Average Trip Lengths (in kms)**

It can be seen from Fig 5.2 that the last mile distance is higher for stations located in outlying areas (Noida city centre, Chhatarpur), both in terms of absolute numbers (4.2 km and 3 km respectively) and as a proportion of the total trip length (17.7% and 11.6% respectively). Yet, in these two stations having similar surrounding contexts, while the share of walk trips is similar the dependence on motorised modes for LMC is higher in case of Chhatarpur, because of lack of NMT options. Thus it indicates that provision of suitable options does shift the fulcrum towards more sustainable modes for covering the last mile.

**5.3 Trip Cost and Time**

The time and cost incurred in the last mile are important reflections of the last mile connectivity. Fig 5.3 (a)&(b) indicate the proportion of cost and time spent in the first and last mile to the total journey. The time for each trip segment is inclusive of the waiting time incurred in that segment. It can be seen from the figure that in terms of absolute numbers, the cost and time spent in the last mile is maximum for stations located in outer areas, i.e., Noida City Centre and Chhatarpur. This accrues from the larger trip lengths in these areas. However, for all stations combined, the average cost and time spent in the first and last mile is almost 50% of the total journey (49.7% and 47.7% respectively), indicating a poor quality of the last mile.



**Fig. 5.3(a) First/Last Mile Travel Cost Fig. 5.3(b) First/Last Mile Travel Time**

It can also be inferred from the figure that commuters try to balance the cost and time by keeping it low for one leg of the journey when the other leg gets considerably high, as is very clear in the case of Noida and Rajiv Chowk. This means that they must walk at least one leg of the journey, which further underpins the importance of providing adequate NMT facility and infrastructure.

**5.4 Quality of Last Mile ‘Green Mobility’ Options**

The quality of the last mile to a great extent influences transit ridership and the choices opted by users. Nelson\Nygaard (2009) talk of first mile/ last mile barriers for commuters who "could potentially take transit but whose starting point or final destination cannot be conveniently accessed from the nearest transit stop/station due to distance, terrain (hills, street patterns), or real or perceived safety issues (traffic, crime)". As mentioned in the introductory section, poor walking and cycling infrastructure and conditions are significant deterrents to use of transit services.The study analyses the quality in terms of service connection (frequency, reliability), comfort, accessibility (including walking/ cycling environment), safety (in terms of crime and traffic), attractiveness, and amenities. These aspects were considered while assessing the overall quality of the last mile at each station. The paper presents the findings of the last mile environment with respect to ‘green mobility’ that include walking, cycling and non-motorised IPT modes.

At all selected stations, there width of footpath near stations was found to be adequate, except for Chandni Chowk. At Rajiv Chowk, while the pedestrian infrastructure is relatively better compared to other stations, it is far from satisfactory. The condition of sidewalks is poor. Pedestrians have to negotiate vehicular traffic to cross roads. However, the crossing is not critically dangerous because of relatively low vehicular speeds and well-located tabletop at-grade crossings. Undesignated spaces for auto-rickshaws restrict the free movement of pedestrians. While there is a bicycle parking facility, there is no facility for ‘bicycle on rent’. Notwithstanding the ordinary infrastructure, a huge proportion of transit users walk the last mile (87%), since the overall safe feeling in this area is good. The safe feeling by commuters is on account of several factors such as the high intensity of activities round-the-day, ‘eye on the street’, presence of informal sector, etc.

The manifestation of streets as public spaces can be vividly experienced on the streets surrounding Chandni Chowk station. These streets are the hubs of diverse activities. Although there are no sidewalks and crossings available, safety from the point of view of traffic is rated as good as the entire street is pedestrian dominated with minimal vehicular traffic. Almost the entire last mile is covered by non-motorised modes (90%). The overall safe feeling of the area is however ranked as poor. This is on account of encroachment on road, cycle-rickshaws parked in a chaotic manner, and over-crowdedness, making it difficult for pedestrians to move freely and also creating conditions conducive to petty crimes such as pickpocketing. The surface condition of the road is poor and extremely unfriendly for people with special needs and there is scope for improvement of sidewalks in the surrounding areas. Bicycle on rent facility is not available although there is opportunity, given the low-income category and heavy tourist ridership.

 Noida City Centre is rated the worst when it comes to provision of NMT infrastructure. It gets some points on account of the multitude of options available for covering the last mile. Another good feature here is designated place for cycle rickshaws. However, commuters have to negotiate through unsafe vehicular traffic streams to access the cycle-rickshaws. The sidewalks have high risers that are not pedestrian friendly and not at all designed in consideration with universal accessibility. Being located right near an intersection of an arterial and a sub-arterial, there is heavy pedestrian crossing negotiating through heavy vehicular movement. In absence of designated stands, auto-rickshaws, shared auto-rickshaws, chartered and other bus services, e-rickshaws, all compete for the available road space, thereby creating traffic congestion and accident hazards for commuters. All of these, combined with level of illumination, low level of street activities in the surrounding areas, presence of a bus depot at another end of the crossing, give the area an overall unsafe rating.

At Chhatarpur, while the condition of pedestrian infrastructure within the station premise is satisfactory: the sidewalks and crossings are good and there are tactile pavement and escalators; the same cannot be said of its surrounding vicinity. The overall safe feeling of this area is ranked poor on account of sparse development and low street activity. Lack of NMT modes, poor walking and cycling conditions in the vicinity and unsafe feeling result in heavy dependence on unsustainable motorized modes for last mile connectivity.

The Vishvavidyalay station has a good quality of NMT facilities. The NMT options available are higher. The walking and cycling conditions are comparatively good and the overall safe feeling is rated good. However, there is scope for improvement in terms of additional and better quality provisions for “bicycle on rent” as the present supply runs short of the huge demand.

**6.0 Conclusion**

The study finds that high-density, mixed landuse, dense street networks, intense activities, are all conditions that support walking. This is corroborated by previous research (Ozbil and Peponis, 2012) that found mixed-use neighborhoods around stations and denser street networks to be associated with higher proportion of walking shares among station patrons. These conditions have an inherent ‘safe feeling’ because of which transit commuters are ready to walk even when the supporting infrastructure is lacking or poor. However, in cases when the intensity of activities tends towards over-crowdedness and chaos, it can reverse the ‘safe feeling’ for commuters, as is seen in the case of Chandni Chowk station. These can be overcome through systematic and planned organisation and management of, and well-designated spaces for activities.

The study also concludes that it is not sufficient to have adequate space but an ensured ‘safe place’ on the right of way to favour higher patronage of non-motorised transport. Commuters are more willing to walk in overcrowded conditions than in ‘isolated’ conditions and/or when they have to negotiate through heavy vehicular traffic. The finding underscores the need for compact, mixed-use neighbourhood planning for future development. While it may be difficult to create such conditions in already developed pockets, ensuring safety and security of transit and other NMT commuters is possible through making streets vibrant, reorganisation of the right of way and designating spaces for NMT usage.

The study points out that at almost all the stations, barring Chhatarpur, there is significant proportion of NMT usage observed to cover the last mile. Although for shorter last mile trip lengths, there is greater tendency amongst commuters to opt for NMT; in absence of walking-friendly environment or other NMT modes, higher percentage of polluting and unsustainable modes are used even for shorter distances. The propensity to resort to private motorized modes for LMC also increases with lack of or sub-standard para-transit and NMT options. These are pointers for cities to adopt ‘green’ strategies on streets leading to transit hubs through better placemaking for healthier, sustainable and people-friendly modes of transport.

More than 10 years since its first operation, Delhi metro agency is yet to prepare a plan, which addresses LMC issues in a wholistic manner. Ad-hoc efforts in the form of starting feeder routes, which cover a miniscule percentage of total stations (less than 15%) and public bike sharing at 3-4 stations, do not indicate of the seriousness that the issue requires. The callousness of transport agencies towards lack of provision or demarcation of spaces for environmentally sustainable modes at stations, while ensuring large private vehicle parking spaces wherever possible also speaks volumes of the attitude towards NMT users. NMT have a clear edge over other motorized modes, especially for short distance trips as they have zero carbon emission, and greater flexibility and accessibility. Despite the heavy patronage, there is little attention given to creating a reasonably good environment for NMT. The key challenge is in building safe and comfortable NMT friendly environment in the larger context, given that most of Delhi roads lack even the basic pedestrian infrastructure, that is, sidewalks. Another challenge is to create sensitivity amongst planners and transit planning agencies towards the role that LMC can play in increasing the overall transit ridership and thereby profitability.

Provisioning of NMT infrastructure also makes economic sense. An ADB (2010) report observes that using the same money as required for constructing 1 km of metro, one can construct 18 km of BRTS, 235 km of bikeways, 350 km of footpaths. However, it is also not sufficient to merely create sidewalks and cycle lanes. The walking and cycling conditions will determine how well these facilities are put to use. Cities like Singapore, Guangzhou have created extensive networks of sheltered or landscaped walkways connecting the transit hubs. This is of utmost significance for Indian cities, given the harsh climatic conditions. It is equally important to give commuters choices of modes. The study also indicates that standard prescriptive solutions cannot be implemented across all stations; contextual planning is important. While certain NMT options may be extremely suitable for a particular situation, the same may be meaningless in other circumstances. Local context specific planning guideline for LMC is required. Environment-friendly and people-friendly modes such as cycle-rickshaw, battery operated rickshaws (which are already plying in certain parts of the city) can play a great role in enhancing LMC in Delhi and many other Indian cities.

Last but not the least, if cities like Delhi want to reverse their downward trend of public transport modal share, their transport priority needs to reverse: ‘green’ the ‘last’ mile first and then expand the transit network; for, it is also somewhat documented that the commuter may be willing to stretch the last mile to ‘over a mile’ in greener conditions.

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