SUSTAINABLE URBAN NEIGHBOURHOOD WITH EFFECTIVE NON-MOTRISED TRANSPORTATION

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Received: July 02, 2018 Accepted: August 07, 2018

ABSTRACT *Urban population of India is increasing rapidly at an alarming pace of 2.84% (Census, 2011). The vehicular population has also grown tremendously from 9% in 1951-61 to 10% in 2001-2011. On contrary, the road area (network) (4.5% in 1961-71 to 5% in 2001-2011) has not grown in pace with the vehicular population. Till 2012, 159.5% vehicles were registered in India, in which 94 % are private vehicles and taxis; rest 4.5% and 1% was goods vehicles and buses respectively.*

Rising vehicular population has increased the V/C ratio of the roads from 0.3 % to 0.8% in last decades which has adversely impacted the health of the city residents. Thus, it becomes essential to control the fast growing motorized vehicular growth. There is also requirement of set parameters and their categorization which would help to measure the extent and sustainability component of NMT's network of the city. In such scenario, the spatial relationship of NMT becomes an important factor of variance.

Spatially, Urban Neighbourhood is the smallest unit and base model scale of community development for population residing along with commercial, public semi – public and institutional settlements. NMT planning at urban neighbourhood level for short trips (1.6 km to 3 km) need to be considered for the enhancement of transportation modes. This will improve the economic condition of the country by decreasing the dependency on motorized transportation and thus the demand and import of crude oil.

The road space designated for NMT should also increase with the increase in NMT which is not the case now days due to increase in the movement of motorized vehicles. Apart from road space there are several other factors which play a major role in determining the extent of spatial relationship of the NMT. This study is focused in determining the parameters which enable in accessing the spatial context of NMT in India.

Keywords: *Urban neighbourhood planning, Sustainable transportation methods and NMT.*

1. INTRODUCTION:-

Increasing population and urbanization in India tends to increase the registration of the motorized vehicles. Due to the lack to proper traffic audits, proper road infrastructure and encroachments on the major and minor roads including the arterial roads, sub-arterial roads and collector road in the Indian cities. Thus, there is an increase in the rate of accidents of motorized vehicles, congestion and overcrowding of vehicles on the road. As per the census of India 2011, the urban population has increased by 298.8 million in 60 years lying between 78.3 million (in 2365 towns, 1951) to 377.1 million (in 7935 towns, 2011) This rise in urban population has increased the movement of motorized vehicles in cities and towns due to increasing dependency on motorized vehicles. In current scenario, there has been a downfall in the population coverage of NMT in Delhi from 59 % in 1980 to 39% in 2005. Patna is the best city as it has nearly 60% or more population depended on NMT mode of transportation. Only lower income group (LIG) in India depends on the NMT modes in their daily movement.

1.1. CLASSIFICATION OF NMT IN INDIA:

The Non–motorized transport modes in India can be classified as follows:-

Human energy based modes	Animal Powered Modes
Walk (pedestrian)	**Pack Animals**
Bicycles	**Animals Carts**
Cycle rickshaws	**Tongas/Ekkas**
Handcarts	
Boats	

1.2. BENEFIT OF NMT

According to Rahul et.al (2013), If the NMT (Non-motorized transportation) could be increased by 1 % over Motorized Transportation (MT) in India, then definitely it will help the people's by improve their health and save up to 250000 rupees per day. The various benefits of NMT are given below:-

- **Enhancing of the NMT conditions:** - It basically depends on the enhancement, up gradation and advance the comfort and user benefits.
- **Increased the activity of NMT:** - It basically includes the Public Fitness improvement, Health security, Local Security, which have their positive interaction among the people of different neighbourhood includes walking on petty living streets.
- **Automobile Travel is reduced:** – It includes the reduce traffic jams, congestions, level of pollution, conservation of energy & economic development
- **Compact Neighbourhood**: - It basically includes reduction of transport costs, more improvement in accessibility for non-drivers, preservation of open spaces and parks.

1.3. OBJECTIVE OF THE STUDY:
To study and define the parameters for carrying out the Non-motorized and walk able survey for assessing the performance of Indian cities in regards to sustainable mode of transportation.

2.0. LITERATURE REVIEW
2.1. METROPOLITAN AREA
As according to the 74th amendment of the Constitutional Act, 1992 defines that the Metropolitan area in India as, an area having population of 100, 0000 or more, which can be includes one or more districts and inhere of two or more Municipalities or Panchayats or other adjacent areas, stated by the Governor through public notification to be an Metropolitan area. (1). A metropolitan area, describe as a metro area, suburbanite area and dweller belt, which includes the region consisting of a densely populated urban areas and its less-populated surrounding sections and all the sharing industries, infrastructure and the housing. In metropolitan regions, the satellite cities are also to be included as the urban areas and towns.

2.2. TRANSPORT SCENARIO OF INDIA:-
The transport scenario of India is described as:-

- In maximum metropolitan cities in India, there is an 3 times increased in the vehicle in last 23 years due to increasing in urban population and traveling demand of the peoples in India (26).
- In between the 2010 and 2050, the intercity travel demand will be grow or expand by 4.3 times. As according to business-as-usual (BAU), this demand will be met by road-based transport (Dhar et al. 2013).
- The non-pollution vehicles like as CNG and Battery operated vehicles are the more efficient vehicles with low emissions in the metro cities.
- In the Metropolitan city like as Mumbai the accessibility, mobility and travel demand of 80% population is based on public transit system and only the 20% peoples in Mumbai are engaged with two wheeler /NMT vehicles.
- As per the NTDCP Final Report 2017, the total number of MT (Motorized Transportation) has increased by 0.3 million in 1951 to 142 million in 2011 (26). Also, Annual increase rate of motor vehicles is 7.7 % p.a as compared to the increase in population of 3.8% p.a in India (26)
- Registration of motor vehicles has increased by 21.9 % in last decades.
- The total road space availability for Motorized vehicles (MV) has decreased by 0.18 km per vehicle to 0.01 km per vehicles from past few years, (NTDCP Final Report 2017).

2.3. NON-MOTORIZED TRANSPORT AS SUSTAINABLE MODE OF TRANSPORTATION:-
- NMT uses very low cost Infrastructure as compare to Motorized transportation.
- In NMT there is a high user safety from accidents.
- NMT is the Eco friendly or Environment friendly mode of transportation.
- The users of NMT modes do not face very high cost as MT users.
- NMT is the healthy mode for Population or it's good for the health of people.

2.4. URBAN TRANSPORT SYSTEM PROBLEMS:
A. Road congestion: - The road congestion is one of the major problem of Indian urban transport system due to the rapid increase in both population and registration of the motor vehicles Road congestion has become a big problem during peak hours when it mainly takes 4 times of duration than the average time to reach from origin to destination specially in New Delhi and Bangalore. Even in Bangalore many times the NMT (Walking) modes takes less time than the moving motorized vehicles on the roads to reach from origin to destination.

B. Problem of parking:- The non- availability of parking spaces in the Metropolitan areas both on street and off street is one of the biggest problem in India. Also, hawkers and vendors create more hindrances in the traffic by encroaching the parking spaces due to the illegal encroachment of the vendors or hawkers tend to decrease the space for parking of vehicles. Even the road side parking spaces in front of shops, big commercial areas, institutional areas and residential areas are also encroached by the hawkers, which create hindrances in parking of motorized vehicles because motorized vehicles more space for parking according to the size of the vehicle. Then the wrong parking of motorized vehicles on the road side or along the road creates the bottlenecks on the major roads. Available data shows that a high proportion of Indian streets are faced with on-street parking issue (Rye, 2010):

Figure 1: Encroachment of on Street parking by the vendor.

Figure 2: Encroachment on carriage way by Vendors.

Figure 3: Encroachment of on Street Parking s by Vendors.

Figure 4: Encroachment of on street parking bays.

CITIES PROBLEM	
Surat	There is nearly 60% length of the roads are used or blocked with on street parking
Delhi	There is nearly to 14% length of the roads are blocked by on street parking

C. Air pollution: - The real problem of air pollution in Indian cities is assumed as air quality of CPCB's (Central Pollution Control Board) classification.

- In the case of New Delhi, the Motorized vehicular pollution commenced disintegrating from 1990 by the high population growth effect the number of motorized vehicular growth and economic development. There is the rapid growth of motorized vehicles by 87 per cent to 3.6 million between the 1990-2001; the population of the city is increased by purely 14 per cent from 9.5 to 13.8 million this period. This thing also tends to increase the pollution level of the city, which resulted as the high Smog level in Delhi in 2017 winters, which badly effect the health of the peoples of the Delhi.

Figure 5: Problems due to increase in level of Smog in Delhi.
Source: - Pic taken from The Hindu Newspaper.

- Faridabad, Delhi, Jalandhar, Ludhiana comes are include in the category of most polluted cities.
- Metropolitan cities in India as the NMT's share in transportation modal are very low. Only the people in the category of LIG and EWS (Economic weak section) use **the NMT in these cities.**

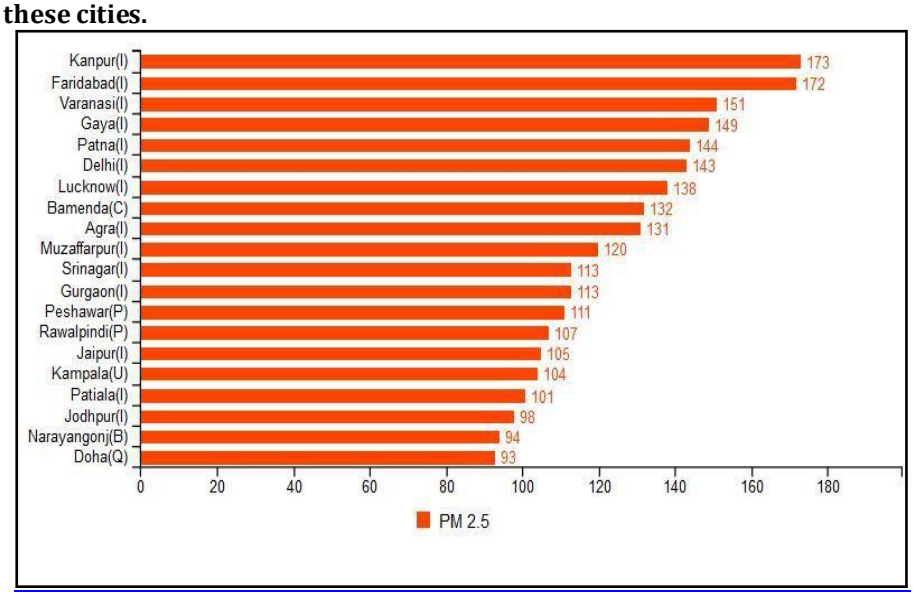

Figure 6:- Most Polluted cities in the India by WHO Report.
Source: The Hindu Newspaper on May 13, 2018 (WHO Report).

2.5. PROMOTING THE NMT AS SUSTAINABLE MODE THROUGH INTELLIGENT TRANSPORT SYSTEM (ITS) AS SUSTAINABLE MODE (DOOR TO DOOR SERVICE):-

• To develop and promote the NMT mode as ITS (Intelligent transportation mode) for cities with objective of achieving sustainability.

Example: The (NMT Mode) cycle rickshaws in dial-a-cab format have been launched in India. The projects aim to provide better access of cycle rickshaws to the residents of Fazilka and Chandigarh by means of direct dial-a-rickshaw facility, to support the livelihood of cycle rickshaw operators and to protect the environment.

2.6. URBAN MOBILITY THROUGH NON-MOTORIZED TRANSPORTATION:-

• NMT for Local Market (for daily needs and Shopping)
• NMT for Local Wok places
• NMT for Various Terminals (Bus/ Railway/Local transportation)

- NMT for Worship places (Especially on Morning and Evening timings)
- NMT for Recreational places (Playgrounds, Gym and Indoor stadiums)
- NMT for Public/ Semi Public areas.
- NMT for Community Centres
- NMT for Schools and Colleges
- NMT for Health places (Clinics and Dispensaries).
- NMT for Health Fitness
- NMT for Vicinity of residential areas from the road connectivity from Main roads.

2.7. URBAN NEIGHBORHOOD:
Urban Neighbourhood (UN) — Urban Neighbourhood is mainly described as residential area with other land uses, which includes the several range of population density and also has connectivity through various nodes and corridors. It includes various growths Centre's, Public/Semi-public areas, commercial area, institutional area, recreational areas and parks with open spaces along with wide range of circulation area. In urban neighbourhood all the areas are approachable at walking distance or approachable with NMT modes easily.

2.8. NEIGHBOURHOOD PLANNING:
It is an attempt to form various physical units of residential areas in which people belonging to a particular rank of life settle or stay. **(RANGWALA S.C., 1985).**

2.9. URBAN NEIBOURHOOD SCALE:
Population Wise: Minimum: 3000 – 5000 (N.L. ENGELHARDT) Maximum: 15000 – 18000 (LE-CORBUSIER)
Area (Size): Min. = 60 hectare or 0.6 km.sq (CLARENCE PERRY, 1900) Max. = 202 hectare or 2.02 km.sq (CLARENCE STEIN, 1923).

2.10. NORMS & STANDARDS FOR URBAN NEIGHBORHOOD:-

Neighborhood Population	Land Use Areas	Area Per Sq. M		
		No.	Per Unit	Total
10,000 Persons	Primary School	1	2000-4000	2000-4000
	Sr. Secondary School	1	6000-8000	6000-8000
	Religious Building	2	400	800
	Electric Sub Station 11 KV	1	80	80
	Banquet Halls	1	800-2000	800-2000
	Local Shopping	1	3000	3000
	Service Market	1	2000	2000
	Informal Market/Rehris	1	1000	1000
	Three Wheeler/Taxi stand	1	400	400
	Neighborhood Park	1	10000	10000
	Neighborhood Play Ground	1	5000-10000	5000-10000
	Underground Water Tank with booster station & OHT	1	2000	2000
	Sewage Pumping Station	1	500	500

	Coaching Centre's and IT Tuition center's	1	500	500
	Dispensary	1	800-1200	800-1200

Source: Delhi Master Plan.

2.11. THE PRINCIPLES OF URBAN NEIGHBOURHOOD:-

1. **Compass:** - The DU (Dwelling Units) are confines from its face by main road.
2. **Covering Strips: -** By necessary to protect the urban neighbourhood from distress of traffic and provide efficient facilities for the development of the parks and open. There are many schemes use by peoples like as developing of the playgrounds, recreational areas and widening of the roads in future called as Petty Green Belts.
3. **Internal Streets**: - Internal streets are basically designs with purpose of security & safety to the neighbourhood level and the small kids and school going children's. The designing of these streets are basically circulated throughout the various units, which is easy accessible to neighbourhood units like as shops, hospitals, community canters and playgrounds etc.
4. **Building and Block layout**: - To encourage relations at neighbourhood level and for social stability purpose. Building and blocks layouts as according to the different income group of the different community of peoples and it should be provided such as Single family houses, double family houses, cottage and flats etc.
5. **Commercial centres/ Market places**: - Each shop should be located at ambit of the unit, preferably at traffic junctions and adjacent to the neighbourhood units.
6. **Community Centre's: -** Community centres are present in each neighbourhood, which will have its Centre with social, cultural and recreational amenities.
7. **Basic Social Facilities/Infrastructure: -** All facilities are required for the family as per their comfort level and convenience, which is to be within the easy accessible reaching areas which basically includes the schools, religious temples, shopping complexes and community centres, which are basically located within the distance of 1km to 1.6 km in the central place to form a nucleus for the development of social life of the neighbourhood.

2.12. CHARACTERISTICS OF PLANNED URBAN NEIGHBORHOOD (41):-

- Higher density of residential development.
- Have Compact urban places.
- Walk able distance in neighbourhoods.
- Easy accessible to public transport/ accessible public transit system.
- Easy accessible and more convenient to various employment community and other facilities like as health.
- Well-connected to playgrounds, open spaces and recreation centres.
- High quality of urban designs. (Source: www.moretonbay.qld.gov.au)

2.13. PROBLEMS IN THE URBAN NEIGHBORHOOD MOBILITY OF THE NMT:-

• Street vendors or hawkers (Haphazard growth of the Street Vendors/Informal Sector on the place of pavements, footpaths and parking spaces etc. in the urban areas)
• Surface conditions of the walk able paths or pedestrian paths are not very good condition.
• Poor railing and landing place facilities for long steps.
• Big problem of on Street Parking on major roads as well as minor roads.
• Lack of pedestrianization infrastructure on the streets.
• Not very good conditions of road furniture and road side infrastructure.
• Very poor pedestrian and shaded marking lanes for NMT.
• Badly designed Crossings, which didn't have any priority to NMT on Junctions.
• Poor marking of safe walk able or complete pedestrian movement Streets in the urban neighbourhood level and terrain are also very compatible.

2.14. PREFERRED MODES IN URBAN NEIGHBORHOOD.

Accessibility and mobility is highly dependent on different factors like as street pattern, urban residential areas connectivity with community level facilities like as schools, shopping areas etc. through minor roads

and a part of them due to socioeconomic durable, variables and urban form that could create conditions to facilitate and inspire different mobility in the Neighbourhood level.
Mainly the neighbourhoods are based on the support of modes other than motorized vehicular modes and movements of non- motorized or public motorized as appropriate mobility solutions and meet resident's expectations along with the reduce the need for high level of motor vehicle ownership; whereas the more dependency on private motorized vehicles increases congestion and is root cause of increases the fuel consumption, expenditure on energy and environmental pollution badly (30).

2.15. SUSTAINABLE MOBILITY AT URBAN NEIGHBOURHOOD LEVEL:-

The sustainable urban mobility aims to inspire the movement of NMT that reduces the dependency of population on automobile and induce non-motorized, non-pollution and public transit system (30).

• In the Sustainable urban neighbourhood, it basically adapts the safe approach and some improvements imperative of individuals, communities and other population for the virtue within and between ensuing generations.

• It is understandable, achieves sufficiently and precisely, offers a choice of transport mode other than motorised vehicular transportation and supports a fluctuating economic based direction, as well as adequate improvement on regional basis which is highly dependable on the aspects of economics.

2.16. MOVEMENTS IN URBAN NEIGHBORHOOD:-

The basic types of urban neighbourhood movements are describe as: (34)

- **Pendulum movements**: - This is important action or movement in the urban neighbourhood includes the movement or mobility from residence to work or residence to institutes. They are extremely intermittent since they are likely and repeat on a continue basis, most of the time a daily affirmation, thus the term pendulum.
- **Professional movements**. These actions are basically associated to accomplished, work-based, activities such as meetings and consumer services, basically taking place during work hours.
- **Personal movements**. These are casual actions combine to the location of commercial activities like as shopping areas and recreation.
- **Recreational movements**. These are the specialised actions in the urban neighbourhood level, which are basically depends on health purposes in the peak timings like as in the morning time or in the evening time like as mobility of community of peoples in the parks, open spaces, recreational grounds and stadiums etc.
- **Distribution movements**. These are mainly depends on the removal of freight movement to satisfy utilization and performance as required. They are the mostly connected to transport terminals, retail channel and distribution Centre's. However, the growths of online activities involve more transit actions being carried out to residential areas (34).

2.17. MOBILITY PATTERN IN THE URBAN NEIGHBORHOOD (30):-

Many Authors are talk about the Mobility Pattern/movement behaviour in the Urban Neighbourhood by using different types of factors, including density (Cervero, 1996), remarkable street connectivity (Boarnet and Crane, 2001). The Factors are described as follows (30):-

- **In Reference to Density:-**
  This factor establishes an analogous dependency from low density of societies in correlation to high density of societies on private motorized vehicles in which they basically found high population densities broaden the stretch of opportunities for the advancement and improvement of the local personal contacts, movements and services that can be preserved without resort to motorized travel and average distances are reduced between residents and work places, reducing the travel needs and reduce the travel distances.

- **In Reference to land use pattern:-**
  When the mobility is in between the separate land use and mixed land use, then it mainly affect the travel behaviour regarding different choices of modes, distance of the trip and time of the trip and prevalence of the trip. The Land use pattern of any area mainly put their impact on the relationship of residential land use and commercial land use area; it mainly effects the separation between residential and other socio-economic centres at neighbourhood level by the travel demand through various modes.

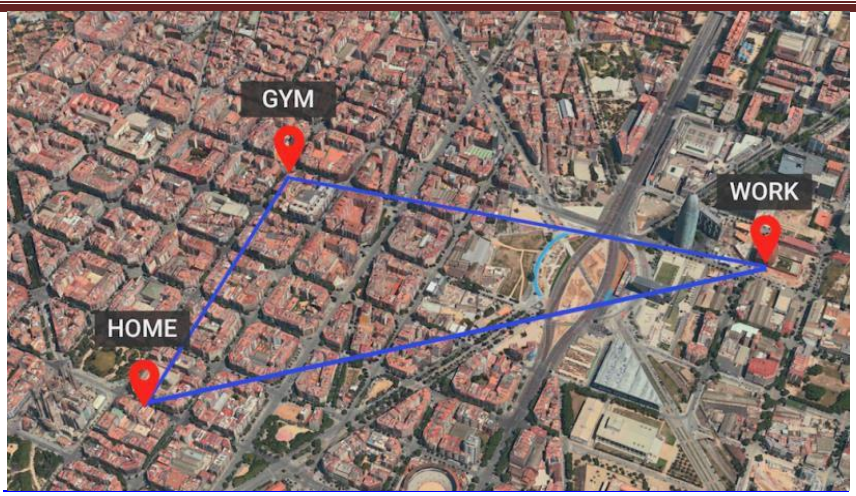

Figure 7:- Example of Mobility pattern of Urban Neighborhood in different Land Uses (30).
*Source:-**The Geography of Transport Systems, FOURTH EDITION, Jean-Paul Rodrigue (2017), New York: Routledge, 440 pages. ISBN 978-1138669574.***

Some peoples like to choose walkability or cycling as their travel vehicle while moving in the urban neighbourhood as compare to the MT modes which effect the time of the trip, while moving on different patterns. Mainly the frequencies of the trips do not affect more the trip distances in urban neighbourhood land use patterns. The walkability in the urban neighbourhood is depend on the different land use pattern like as the major streets near to the main commercial areas, institutional areas and CBD areas have high walkability areas and the major or minor streets near the residential areas are less walkability areas. So different type of road infrastructure is required for different types of pedestrian paths according to different land uses (according to the different walkability in different land uses).

Regarding Socio-economic Level:-
This factors depends on the socio-economic patterns could have their highly important impacts on urban neighbourhood movement behaviour of peoples and it drive their behaviour among various income groups like as HIG, MIG and LIG. The income status is highly connected with certain driven patterns. As taking the example of high income residents, they mostly depend on their own motorized vehicles and ignore the public transit system; it mainly depends on long distance trips along with high frequency with private motorized vehicles (Hanson, 1982).

2.18. MOBILITY GAPS IN URBAN AREAS:-
Mainly the maximum cities have 2 spaces for mobility. First one is the transit-oriented and located into central areas, and the second one is Vehicular traffic oriented and present in periphery areas.
The gaps in the mobility effect on the employment also. A person, who don't have any car or motorized vehicle can access to only the limited number of employment locations, where an individual can travel through public transportation by daily routine. These types of locations are mainly found in the central part of the urban areas, which are more public transit-oriented. That's why the maximum labour market is present in these central areas but due to the increase in sub-urbanization areas on the periphery side of the city, the employment opportunities are also available there easily. An individual along with their car can access more wide and outer area for their job opportunities. So accessibility is being the main factor in this. (34). There is also the strong relationship between the land use pattern and transportation like as follows:-
Compact Development – NMT (Non-Motorized Transportation)
Sprawls Development - MT (Motorized transportation).

2.19. THE LAND USE – MOBILITY PATTERN INTERACTION:-
The interconnection between different pattern land use and mobility on daily basis has been of growing interest among researchers. (R. Ewing and R. Cervero (2001) .
The researchers mainly focus on these following 5 elements:-

- **Density and Quantity:**

It is considered as activity level (Population or/and Employment) per unit area.

- **Diversity and Assortment:**

It is thoughtful as the action and significance or concern of different types of land uses.

• Street Design or design of the neighbourhood streets:
The designs of local streets in the urban neighbourhood are referred in it.
• Destination should be accessible
To accessible trips attractions.
• To transit the distance:
It is a quantify the convenience of Public transport.

2.20. CONCLUSION:-
By the encouraging the non-polluting mobility in the urban areas as sustainable mobility by which the movement behaviour of peoples through motorized vehicle are reduces and increase in the mobility by Non-motorized vehicles. Through the below mentioned parameters are plays an important role to analyse and designing the urban mobility systems that are sustainable on social, economic, and ecological levels in the metropolitan cities. The main aim for this development of NMT is to reduce the over consumption of transportation energy, which tends to increase social interaction of peoples specially while moving in neighbourhood level and also tends to increase the economic subsidiary effects of side path through movement.

PARAMETERS FOR NMT	
For the other NMT Survey (exclude walkability):	**For the Walkability Survey**
➢ Conflict with other modes	➢ Walking Path Modal Conflicts.
➢ Availability of Cycle tracks	➢ Availability of walking Paths.
➢ Priority at Junctions	➢ Availability of road crossing
➢ Air pollution exposure	➢ Grade crossing safety
➢ Motorized behavior	➢ Motorist behavior
➢ Lighting	➢ Amenities
➢ Quality of riding surface	➢ Disability infrastructure
➢ Crossing Point	➢ Obstructions
➢ Shaded lanes	➢ Safety from Crime
➢ Connectivity to the street networks	➢ Comfort & attractiveness
➢ Presence of Service Shops	➢ Distance between destination
➢ Traffic calming measures	
➢ Security and Safety	
➢ Distance between destination	
➢ Availability of Parking	
➢ Weather	
➢ Service Shops	
➢ Street Furniture	
➢ Land use	

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