Urban transport sustainability assessment for the Use of motorized vehicles in road transport India

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Abstract. Urban population growth in India observes continuous increase since 1901 with 34.03 % in 2018 allowing swelling of urban limits as per the Ministry of Housing and Urban Affairs. Considering urban growth the Ministry of Transport has been active for developing urban roads increasing road length to 58, 97, 671 km in 2017. Consequent to urban growth and developed roads is observed the raise in vehicle ownership adding on to motorized vehicles adapting modal shifts leading to amassed use of speed moving motorized vehicle/s. The total number of motorized vehicles in 2017 is 253,311 thousands. A research study marks the rate of increase in motorized vehicles as 11.69% against the 1.84% growth of the population in India. These Motorized vehicles are the major pollution contributor, producing significant amounts of nitrogen oxides, carbon monoxide, and other pollution leading to significant number sharing about 2/3rd of air pollution-related deaths in India. The road side landscape can help in reducing the effect of pollution due to these vehicles if planted appropriately. The use of multimodal integrated transportation is one of the solution to integrate the public transport allowing private transport network with provisions for non-motorized transport. This paper aims to urban transport sustainability assessment for the use of motorized vehicles in road transport India. The objectives of this paper include the study of increasing rate of motorized vehicles as against the urban growth and accidents due to air pollution from these vehicles, and the probable solutions for the reduction of accidents in India with emphasis on study from Maharashtra. Maharashtra being at the top in the vehicle ownership in India it is selected for the case study along with the assessment study on multi-modal transport solution at Nagpur.

Keywords: Urban Population Growth, Motorized vehicles, Non-Motorized Transport, Road Accidents, Urban Transport, Air Pollution, Transport Sustainability

1. Introduction

Worldwide, mobility is regarded as an important basic living requirement. Increasing personal mobility offers access to both essential services and leisure activities. At the same time, versatility is part of and extends the option of a modern lifestyle.

Urbanization is a common phenomenon observed in major countries of the world as a consequence of the uplift. As per the UN world population statistics 2018, 4.13 billion of the worlds population sharing about 55% is living in urban areas and it is projected to reach 6.68 billions by 2050. [1]
1.1 World’ Scenario
The US ranks first for having the highest number of road injuries, as per the WHO Global Road Safety Report 2018. In the 199 countries published in World Road Statistics, India ranks 3rd in road accidents and 1st in the number of road accident fatalities, led by China and the US in 2018. India accounts for nearly 11 percent of the world's accident-related deaths, with a high percentage of road accidental deaths in low-income countries of up to 27 percent and a low percentage in high-income countries of 9.3 %.[2]

Figure 1. Share of the road accidental deaths by Low and High Income countries [2].

Table 1. Top 12 countries based on road accidents data in 2018 along with the fatalities and injuries due to road accidents. [3]

| Country               | Accidents Number | Rank | Persons Killed Number | Rank | Persons Injured Number | World Rank |
|-----------------------|------------------|------|-----------------------|------|------------------------|------------|
| U.S.                  | 22,11,439        | 1    | 37,461                | 3    | 31,44,000              | 1          |
| Japan                 | 4,99,232         | 2    | 4,698                 | 21   | 6,14,155               | 2          |
| India                 | 4,80,652         | 3    | 1,50,785              | 1    | 4,94,624               | 3          |
| Germany               | 3,08,145         | 4    | 3,206                 | 34   | 3,96,666               | 6          |
| Chinese Taipei        | 3,05,556         | 5    | 1,604                 | 57   | 4,03,906               | 5          |
| Korea Republic        | 2,93,305         | 6    | 15,998                | 7    | 3,63,531               | 7          |
| Iran                  | 2,20,917         | 7    | 431                   | 429  | 3,31,720               | 8          |
| China                 | 2,12,846         | 8    | 63,093                | 2    | 2,26,430               | 11         |
| Turkey                | 1,85,128         | 9    | 7,300                 | 33   | 3,03,812               | 9          |
| Italy                 | 1,75,791         | 10   | 3,283                 | 33   | 2,49,175               | 10         |
| Russian Federation    | 1,73,694         | 11   | 20,308                | 6    | 2,21,140               | 12         |
| United Kingdom        | 1,36, 621        | 12   | 1,792                 | 55   | 1,60,315               | 13         |
Figure 2. The Road Accidents data for top 12 countries in the world as per world road statistics WRS 2018 India rank 3rd. [2]

1.2 India: Urbanization, transport developments and Road Accidents:

India is a developing country with the growing urban population and developing socio-physio-economy. The urban population growth pattern of India marks the increase of 10.84% in 1901 to 34.03% in 2018. It shows the significant growth rate increase during the decades 1941-51, 1971-81 and 2001-11 with 3.43%, 3.33% and 3.38% respectively. [4] [5] The urban population growth includes share of migration and internal natural growth. [6] With the fact of urbanization trend the department of road transport under Ministry of Road Transport and Highways (MoRTH) has planned for increasing the road length. Accordingly, the total road length in India is amended from 1189 thousands km in the year 1970 to 5898 thousands km in 2017. [7] With the developed roads and urbanization the use of motorized vehicles is also increasing. Urbanization as well as the development of roads have added the registered motorized vehicles with increase in number from 1,401 000’s in 1970 to 2,53,311 000’s in 2017. [8]

Figure 3. Growth of Urban Population in India shown in percentage since 1901-2018 [4] [5]
Figure 4. Increase in Road length in 000’ km and Number of road accidents in 000’s. [8]

With the socio-economic development, the vehicles density measured in number of vehicles on road per kilometer length has increased from 1.18 to 42.95 from 1970 to 2017. The increasing vehicles density on road has added the clashes thereby increasing number of accidents from 114 thousands to 467 thousands during 1970 to 2017. (Transport data 2020). (www.cecdata.com by The ministry of road transport). It indicates the increase in road length, increase in urbanization, addition in vehicle ownership have led to traffic density rise and clashes resulting in road accidents.

**Table 2.** Data on Road length, Motorized Vehicles and Road Accidents since 1970 to 2018 [8]

| Year | Road Length in ‘000s. | Registration of Motorized Vehicles in ‘000s. | Vehicle Density on road per km length of road in ‘000s. | Road Accidents in ‘000s. | Fatalities due to road accidents in ‘000s. | Persons injured in road accidents in ‘000s. |
|------|----------------------|-----------------------------------------------|-----------------------------------------------------|--------------------------|-----------------------------------------------|-----------------------------------------------|
| 1970 | 1189                 | 1,401                                         | 1.18                                                | 114                      | 15                                            | 70                                            |
| 1980 | 1492                 | 4,521                                         | 3.03                                                | 153                      | 24                                            | 109                                           |
| 1990 | 1984                 | 19,152                                        | 9.65                                                | 283                      | 54                                            | 244                                           |
| 2000 | 3316                 | 48,857                                        | 14.73                                               | 391                      | 79                                            | 399                                           |
| 2010 | 4582                 | 1,27,746                                      | 27.88                                               | 500                      | 135                                           | 528                                           |
| 2015 | 5412                 | 2,10,023                                      | 38.38                                               | 501                      | 146                                           | 500                                           |
| 2016 | 5603                 | 2,30,031                                      | 41.05                                               | 481                      | 151                                           | 495                                           |
| 2017 | 5898                 | 2,53,311                                      | 42.95                                               | 465                      | 148                                           | 471                                           |
| 2018 | NA                   | NA                                            | NA                                                  | 467                      | 151                                           | 469                                           |

2. Analysis of Road accidents

In India, a total of 4,67,044 road accidents were recorded in 2018 by the States and Union Territories (UTs), claiming 1,51,417 lives and causing 4,69,418 people to be injured. The number of deaths increased by 0.46 percent in 2018, the number of people injured increased by 2.4 percent and injuries decreased by 0.33 percent compared to the previous year, i.e. 2017, in percentage terms. The severity of road accidents, calculated by the number of people killed per 100 accidents, increased in 2018 by 0.6 percentage points.
over the previous year, i.e. 2017. In the order of its ranks, Madhya Pradesh, Uttar Pradesh and Maharashtra are the top three states respectively.

2.1 Share of Road Accidents related to NMT:

The Share of road Categories in Road accidents, number of persons killed and injured during 2008-18 have been studied from the report and the analysis is drawn with the % share on NHs, SHs and other roads for the road accidents, Fatalities due to road accidents and the persons injured.

Figure 5: Map of India showing state wise distribution of Road Accidents during 2018. [8] Uttar Pradesh, Madhya Pradesh, Maharashtra Karnataka, Kerala and Tamilnadu are under the category with maximum road accidents.

Figure 6: Map of India showing state wise distribution of Persons Killed in Road Accidents during 2018. [8] Uttar Pradesh is at the top and it is followed by Rajasthan, Madhya Pradesh, Maharashtra, Karnataka and Tamilnagu standing at the second position based on persons killed in 2018.
### Table 3. Category wise total road length, accidents, persons killed and injuries in 2018 (compiled from the Transport, 2018).

| Category of Roads       | Length as on 31.03.2017 | Accidents | Persons killed | Persons Injured |
|-------------------------|--------------------------|-----------|----------------|----------------|
|                         | Kms          | %         | Number       | %           | Number       | %     | Number       | %     |
| National Highway (NH)   | 1,14,158     | 1.94      | 1,40,843     | 30.16       | 54,046       | 35.69 | 1,40,622     | 29.96 |
| State Highway (SH)      | 1,75,036     | 2.97      | 1,17,570     | 25.17       | 40,580       | 26.80 | 1,21,579     | 25.90 |
| Other Roads (OR)        | 56,08,477    | 95.10     | 2,08,631     | 44.67       | 56,791       | 37.51 | 2,07,217     | 44.14 |
| Roads Total             | 58,97,671    | 100       | 4,67,044     | 100         | 1,51,417     | 100   | 4,69,418     | 100   |

### Table 4. Percentage share of road categories in Road Accidents, Fatalities and Injuries on Highways and Roads in 2011 and 2018 [8]

| % in 2011 on NHs | % of Accidents | % of Fatalities due to accidents | % of Injuries due to road accidents |
|------------------|----------------|----------------------------------|-----------------------------------|
|                  | % of Road Accidents | % of Fatalities | % of Injuries |
| NHs              | 30.1            | 37.1                             | 30.5                              |
| SHs              | 24.6            | 27.4                             | 26.1                              |
| Ors              | 45.3            | 36.5                             | 43.4                              |
| % in 2018 on NHs | 30.1            | 35.7                             | 30                                |
| % in 2018 on SHs | 25.2            | 26.8                             | 25.9                              |
| % in 2018 on Ors | 44.7            | 37.5                             | 44.1                              |
Figure 7. Comparison of Percentage share of road accidents, fatalities due to road accidents and the injuries due to road accidents on National Highways, State Highways and Other roads [8]

Table 5. Percentage share of road accidents, fatalities due to road accidents and the injuries due to road accidents on National Highways, State Highways and Other roads [8]

| Year | Share percentage of Road accidents on National Highways | Share percentage of Road accidents on State Highways | Share percentage of Road accidents on Other Roads |
|------|---------------------------------------------------------|-----------------------------------------------------|--------------------------------------------------|
| 2008 | 28.5%                                                   | 25.6%                                               | 45.9%                                            |
| 2010 | 30%                                                     | 24.5%                                               | 45.5%                                            |
| 2012 | 29.1%                                                   | 24.2%                                               | 46.7%                                            |
| 2014 | 28.2%                                                   | 25.2%                                               | 46.6%                                            |
| 2016 | 29.6%                                                   | 25.3%                                               | 45.1%                                            |
| 2018 | 30.1%                                                   | 25.2%                                               | 44.7%                                            |

Figure 8. Percentage share of accidents by category of roads [8]
Table 6. Accidents, Fatalities and Injuries based on the collision type [8]

| Collision type       | No of accidents | Persons Killed | Persons Injured |
|----------------------|-----------------|----------------|-----------------|
| Vehicle to Veh.      | 2,33,281        | 74,766         | 2,36,910        |
| Vehicle to Pedestrian| 10,914          | 10,161         | 64,997          |
| Vehicle to NMV       | 44,708          | 5,728          | 19,273          |
| Vehicle to Animal    | 3,682           | 2,267          | 4,097           |
| Others               | 2,96,667        | 31,675         | 1,22,590        |
| Total                | 4,67,644        | 3,51,417       | 4,09,418        |

*Note: figures in parenthesis is the percentage share in total

The accidents share on National highways is increasing whereas on state highways it is constant and percentage share of accidents on other roads is reducing gradually.

When calculated the clashes between the vehicle to NMV, pedestrians and animals, it adds to 22.93% of the total road accidents, 22.24% is the fatality and 19.17% persons are injured. It marks that 1/5th is the risk in using NMT while on road which is continued regularly as seen from the table below 2017-18 the percentage change in persons killed is 20% total for NMT & related traffic.

Table 7. shows the decadal growth is seen in the persons killed due to clashes and accidents. [8]

| Road-user category          | Persons killed 2017 | Persons killed 2018 | %age change |
|----------------------------|----------------------|----------------------|-------------|
| Pedestrian                 | 20,457               | 22,636               | 10.75       |
| share in Total             | 13.8                 | 13.0                 |             |
| Bicycles                   | 3,559                | 3,173                | 3.20        |
| share in Total             | 2.4                  | 2.4                  |             |
| Two-wheelers*              | 48,746               | 55,336               | 13.52       |
| share in Total             | 33.0                 | 36.5                 |             |
| Auto-Rickshaws             | 7,167                | 6,629                | -9.51       |
| share in Total             | 4.8                  | 4.4                  |             |
| Cars, Taxis, Vans & TMV's  | 36,869               | 25,115               | -35.5       |
| share in Total             | 18.2                 | 16.6                 |             |
| Tractors & others          | 17,158               | 15,180               | +11.70      |
| share in Total             | 11.6                 | 10.0                 |             |
| Buses                      | 9,069                | 8,164                | -9.98       |
| share in Total             | 6.1                  | 5.4                  |             |
| Other Motor Vehicles       | 11,410               | 11,109               | -2.64       |
| (including e-rickshaw)     | 7.7                  | 7.3                  |             |
| Others (Animals drawn vehicle, cycle rickshaws, hand carts, & other persons) | 3,478 | 3,585 | 3.07 |
| share in Total             | 2.4                  | 2.4                  |             |
| Total                      | 1,47,913             | 1,51,417             | 2.37        |

*Two-wheelers include motor cycles, scooters, mopeds

2.2. Oil consumption and Pollution due to motorized vehicles:

As estimated by the Center for Science & Environment, New Delhi and India’s overall transport sector emit about 15% of CO2 emissions, while the country’s total oil consumption accounts for 57% of CO2. And CO2 emissions from transport are that at the fast est rate, at more than 6 percent per year, of all oil-consuming industries. [9][10] Energy statistics 2018 for India states the growth rate of oil and gas required for motorized transportation is very low to negative value. [11] It alarms us for the alternate energy source for transportation. World Research studies mark the need for energy savings through transport modes for the clean environment. [12] One of the research analysis reveals the merits and demerits of fuel cell vehicles against fuel cell vehicle. [13]
2.3. Landscaping to reduce issues related to traffic:

Landscaping is the solution along road sides and at the dividers to reduce the pollution effects.[14] In hot climates, trees do have a cooling effect. The roadside plantation acts as a buffer for noise. Sunken roads may be built for this reason, as the psychological effect of noise often decreases as the noise source disappears. As vegetation absorbs noise, mounds can be planted with trees. Trees with thick and dense foliage (evergreens) should be chosen for this reason. Dust collects on leaves and other particulate matter, which reduces air pollution. Smoke is absorbed by the leaves through their pores which further helps in purifying the air. [15] [8] [16]

3. Analysis of Road Accidents in India:

As per the research study [17] and survey there is observed a significant relation between the Per capita income and increase in the number of vehicles. Urbanization increases with the increase in per capita income and further adding on vehicular ownership. Increasing vehicle density on roads is inviting for the accidents leading to unwilling deaths of the users due to various road traffic challenges and issues. [18] [19]

Figure 9. Compound Annual Growth Rate of Production of Energy in India by Primary Sources from 2009-10 to 2018-19 [11]

Figure 10. Growth rate of vehicles and the Road Length in India [20] [21] [22]
Figure 11. Relation of PCI & Vehicle growth compiled from MoRTH and RBI data. [17] [23]

Figure 12. Relation of vehicles ownership with per capita income and increase in urban population compiled from MORTH & World Bank Data. [17] It marks the number of per capita vehicles increases with the increase in the income level.

4. Road Accidents Study of Maharashtra and Nagpur

4.1 Study of Road Accidents in Maharashtra:

Maharashtra is the Indian state with the increasing number of newly registered motorized vehicles. [22] It marks the reduction in road accidents since 2014-2018 and ranking at 6th in the road accidents in India [8] which used to be at the 2nd and 4th rank earlier. Maharashtra observed the increase in number of persons killed in road accidents by 997 from 2017 to 2018. The number of fatalities is 13,261 in 2018. It marks the 2nd position in number of persons killed in road accidents during 2018 as against being 3rd during 2017.
Table 8. Increase in Road accidents fatalities in various states from 2017 to 2018 with the state wise rank. [8] [7]

| Sl. No. | State/UTs       | State/UTWise Total Number of Persons Killed in Road Accidents during 2017 | Increase in 18 over 17 | % Increase in 18 over 17 | Rank of State/UTs in Total Number of Persons killed in road accidents |
|---------|-----------------|-------------------------------------------------------------------------|-----------------------|--------------------------|---------------------------------------------------------------------|
| 1       | Uttar Pradesh   | 20,124                                                                  | 2,132                 | 106                      | 1                                                                   |
| 2       | Madhya Pradesh  | 12,264                                                                  | 13,263                | 897                      | 2                                                                   |
| 3       | Tamil Nadu      | 16,157                                                                  | 12,216                | -394                      | 2                                                                   |
| 4       | Karnataka       | 10,689                                                                  | 10,986                | 36                       | 4                                                                   |
| 5       | Maharashtra     | 10,177                                                                  | 10,706                | 528                      | 6                                                                   |
| 6       | Rajasthan       | 10,444                                                                  | 10,320                | -124                     | 5                                                                   |

4.2 Analytical Study of Road accidents and Mobility Proposal for Nagpur city:
In Maharashtra state, Nagpur is the third largest urban agglomeration. It is the second capital of Maharashtra with its winter assembly hub, having an Indian zero mile. As per the 2011 Census, 6 percent of the state’s total urban population and 52 percent of the total district population live within the limits of the Nagpur Municipal Corporation (NMC). The population of the Nagpur Metropolitan Area (NMA) consists of 24.1 Lakh and 6.6 Lakh NMC areas from other areas, including Kamptee, Kalmeshwar, Hingna and surrounding villages.

Figure 13. Location Map of Nagpur showing Highways (Asian Highways, National Highways and State Highways) [23]

Figure 14. Comprehensive Mobility plan for Nagpur [23]
The population distribution in NMA has a highly unequal density ranging from 700 to 850 people per hectare in the middle and low along national highways to around 10 to 150 people per hectare in peripheral areas as per census 1991 figures. The city of Nagpur has roads in the study area spread over 2201.19 km. The length of the roads within the municipal boundaries is 1,907 km of which 1,150 km of roads are under the control of the NMC with 500 km of main roads, which means that the city has a density of roads as 6.66 kms per sq. km of surface area.

The city of Nagpur has a separate radial pattern and has two ring roads. Two national highways (NH44 and NH53) establish the road network in Nagpur, four state highways (SH246, 248, 255, 260 and MSH 9) and other internal roads in the north-south and east-west direction, along with radial patterns formulated by two ring roads. It is a major intersection between the national highways of India and the Asian Highways (AH4 3 and AH46). An Integrated Road Development Plan (IRDP) has been initiated by the Nagpur Municipal Corporation (NMC) to improve the transportation system within the city limits. [24] The total 14,75,217 number of vehicles are registered in Nagpur city till 2017. It shows addition of 78,413 new vehicles in 2017-18. The average trip length in Nagpur is 7.6 kms (including walking trips) and 8.2 kms (excluding walk trips). The average trip length for NMT modes such as walking, riding and cycling rickshaws is 2 km, 3.3 km and 2.5 km respectively. The study of journey lengths in various modes reports that the average train journey length is 23 km, while the average train journey length is 10.8 km and 8.6 km respectively for cars and 2 wheelers. In Nagpur city, the average trip rate was estimated at 1.26, while for total daily trips in 2017-18, the motorized trip rate was observed at 0.95, which is around 5120650. It notes that 15.54% of total trips are NMT base trips with 9.53%, 6.01% and 0.36% trips, including walking, cycling and rickshaw, with the rest being motorized basetrips, respectively. (CMP report 2018) The average trip length (ATL) for car was observed as 6.87 km, for two wheelers 5.50 km and for auto 4.52 km and for public transport mode 9.40 km.

Under Mode Share, it can be noted that the 2-wheeler share is the highest at 42.6%, followed by 19.8% auto rickshaws and 15.6 percent bus. Whereas cars have a 5.7% share in the lowest mode. For two wheelers, the motorized proportion was 65%, followed by cars with 13% and cars with 12%. 10% of total motorized passenger trips were found to be the Public Transport share.

![Figure 15. Travel mode wise Trip Length in km for Nagpur [23]](image-url)
As per the Times of India data in 2019 September Nagpur has witnessed 1,007 road accidents including 250 dead and 1,042 persons injured. It shows decline in road accidents by almost 110, as against 1,117 in 2018. Nagpur city traffic police data says the Road accidents in Nagpur have declined by 9.84% in 2019 but saw a 4.8% rise in fatalities. Accidents total in Nagpur city in 2017 and 2018 gives it a ranking at 26 and 28 whereas Fatalities ranking is 30, 33 and injuries ranking is at 22 and 23. (Nagpur police data)
Most of the accidents occur at the intersections along the main roads within the areas close to the city centre and with high population densities, it is noted from the research study survey by Nagpur local authority. It was also found that most of the collisions involved motor vehicles for pedestrians and cyclists. On the basis of extensive accident data obtained from the Nagpur Traffic Police Department, 35 accident black spots have been reported (refer Figure 18).

![Figure 17. Number Road Accidents, fatalities and related injuries of Nagpur during 2017 and 2018. [23]](image)

![Figure 18: Black spots (32) of major accidents in Nagpur (Traffic Police data 2018) [23]](image)
4.3 Sustainable Transport Attempts in Nagpur:

Level of Service evaluation for transport in the city of Nagpur based on URDPFI guidelines shows low levels of services.

Table 9. Level of Transport Service in Nagpur [23]

| Level of Service (LOS) Scores for Nagpur | Score | LOS   |
|----------------------------------------|-------|-------|
| Pedestrianization: Overall LOS Score    | 8     |       |
| 1. Pedestrian Infrastructure facility  | 1     | 0%    |
| 2. Street Lighting                      | 3     | 4-6   |
| 3. Foot Path Covered                    | 3     |       |

| NMT Facilities: Overall LOS Score       | 12    | 43%   |
| 1. % Network covered                    | 4     | <15%  |
| 2. Parking Encroachment on MT roads     | 4     | <30%  |
| 3. NMT parking facilities at interchanges (%) | 4     | <25%  |

| Intelligent Transport System: Overall  | Score | LOS   |
|--------------------------------------|-------|-------|
| 1. Availability of traffic surveillance | 4     | <25%  |
| 2. GPS/GPRS                           | 4     | <25%  |
| 3. Signal synchronization%             | 4     | <25%  |
| 4. Integrated ticketing System %      | 4     | <25%  |

With this basis the Nagpur city has perceived the attempts towards urban transport sustainability. Under the Proposals for the Nagpur city, it has perceived the proposals for Pedestrian and Cycle tracks etc. along with the proposals for Urban Mass transit corridors, metro network and Bus Transit network proposals over the existing ones promoting NMT uses thereby reducing Motorized vehicle use. [27]

It has also taken up addition of e-rickshaw [26] and e-buses and related infrastructure. Further implementation of intelligent transportation systems at signalized locations and at important (accident prone) locations is also observed. (Refer figure no. 19-22)

![Figure 19: Proposal for Pedestrians lane along the existing roads in Nagpur](image-url)
Thus Multimodal public transport with the feeder level public private transport planning along with the non-motorized transport network will definitely help in reducing the
private motorized vehicular traffic and the issues related to it viz. congestion, pollution and accidents further allowing employment opportunities to the poorer. This will make it possible to achieve the accessibility to work trips in short time possible ie. 50% and 100% target in walkability & cyclability respectively. [28][27]

5. Conclusion

i. Urbanization is a continuous process encouraging socio-physio-economic growth of population and modal shift to motorized vehicle particularly owning car is its outcome increasing congestion, pollution and accidents on roads.

ii. Reducing motorized vehicular trips and promoting use of Non Motorized Transport for the short trips (upto 5 kms) is a sustainable solution over increasing vehicles density and road accidents. This reduces the clashes between NMT & MVs and help promote social sustainability.

iii. In case of the longer trips promoting multimodal integrated public transport gives solution for the faster connectivity of distant areas for all traffic users at affordable rates especially for regular trips. Here pedestrianization is compulsory mode and the NMT is being casually used to reach at intermediate travel point. This reduces the use of private motorized vehicles. It leads to socio-economic sustainability.

iv. E vehicles is an alternative is also seen as an alternative for reducing environmental issues.

v. The Intelligent Transport system help detecting the problems and resolving it.

vi. The plantation along road side act as buffer and help reducing the effect of environmental pollution due to motorized vehicles if planned appropriately.

vii. For all the above mentioned points an upkeep and maintainance of NMT route becomes our responsibility as a citizen and local authority for achieving socially, economically and environmentally sustainable solution.

viii. Thus reducing unnecessary use of motorized vehicles and use of NMT integrated with Public transport for rapid transit reducing MV use can be seen as the sustainable transportation solution for the urban centres.

6. Recommendations

- Urban transport sustainability can be achieved by integration of Non Motorized Transport with public transport system reducing use of private Motorized vehicles. Infrastructure provisioning & promoting NMT use for short/intermediate trips can reduce urban transport issues viz. congestion, air pollution, accidents and cost of travel etc.
- Therefore author would like to recommend for rapid transit developments supported by the mandatory provisions of infrastructure for NMT users on all roads in urban areas avoiding unnecessary use of motorized vehicles to have sustainable transport leading to sustainable city.

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