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ANALYSIS OF SOCIAL & ENVIRONMENTAL IMPACT OF MUMBAI MASS RAPID TRANSIT SYSTEM (MRTS) IN MUMBAI METROPOLITAN REGION (MMR)

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Abstract - *Mumbai Metropolitan Region is one of the biggest Metropolitan Areas of India which consist of Mumbai and its nearby Towns covering 9 Municipal Corporation and 15 small Municipal Councils. MMR is having presently vast network of Suburban Train System (Local train) as one of the Main Mode of Transport. Currently, in last decade lot of efforts have undergone to create new mode of public transport i.e. Metro (Mass Rapid Transit System) with stations at every 1.0 km. A plan of 337 km of Metro network is under various stages of Implementation in MMR Region. This research study deals with analyzing the impact of such a huge MRTS Network on Environmental and Social Parameters of the Region and also it is studied that whether such a huge investment will be helpful in creating a Environmental Friendly Public Transport. Further, a statistical analysis has been done to examine the quantum of shift of Mode of transport of Mumbai Residents from existing modes of Transport to Metro and its impact on Traffic Scenario of Entire MMR. This research project will create a standard platform and tool to identify the quantum of MRTS network to be required for each city based on existing infrastructure and probable growth scope of the city anywhere in India. It will help stakeholders to take decisions and plan for financials to develop the infrastructure in the City.*

***Key Words*: MMR, MRTS, Four Stage TDM, Traffic Impact, Environmental Impact, SMNT**

1. INTRODUCTION

1.1 General

In the last few decades, World has faced tremendous growth in the Urbanization from Megacities to Tier-III cities due to which there is a sharp increase in the registration of personal vehicles. The same has been observed in Indian Cities and people perspective have been to shift to personal mode of transport for daily works. This is resulting into huge impact on Environment and also Social Aspects. It is worldwide noted that rate of natural calamities have increased and similarly rate of accidental deaths have shown sudden rise.

Considering the same many developed countries in past few decades have already approached to take efforts to increase the existing public transport network, develop new modes of public transport and improve the travel experience in public mode of transport. It has resulted into shift of commuters from private mode to public mode of transport. Similar approach was adopted in Delhi, India and presently 350 km of Metro is under operation, 65 km under implementation and 64 km under planning stage. In a city with no rail mode of public transport has shown unexpected shift from road based mode to rail based mode. However, Mumbai Metropolitan Region stands different as compared to Delhi or any other Metropolitan city in India.

Mumbai Metropolitan Region (MMR) had a History of Huge Public Transport Network since 1853 which is known as Mumbai Suburban Rail (Local), it's laid across 390 km and operates 2342 train services along 150 stations. It carries daily 76 lakhs trips with a density of 14-16 persons/sq.mt. It is one of the main mode of public transport with 65% followed by Bus Mode. However, it is found that Mode share has reduced from 75 % to 65% in last 15 years and the reason behind it is inadequate capacity of system and increase in Cars registration. Thus, MMR is in need of a new mode of Public Transport as Suburban System is at-grade and cannot be extended further considering funnel shaped topography of City. Accordingly, MMRDA had prepared Comprehensive Transportation Study in 2005-08 in which Metro Rail System was recommended for entire MMR, following which first corridor i.e. Mumbai Metro Line-1 (Versova-Andheri-Ghatkopar) was implemented and operations were commenced from 2014. The said corridor is 11.4 km long and has daily ridership of 4.5 lakhs Pre-Covid scenario. Further, in successive years, city has seen implementation of multiple metro corridors across entire MMR and it is found that there is a plan of 337 km of Metro Network to be implemented in MMR. Considering 330 km of Suburban Network in existence and huge road network, this plan of 337 km of Mass Rapid Transit System in MMR has created a question of its need.

In this research work, it will be analyzed that what will be the need of such a huge MRTS network, its impact on Traffic, Environmental and Social parameters. Transport Travel Demand Model will be used for different horizon years like 2026, 2031 & 2041 to identify the travel pattern based on metro implemented and shift of mode of transport will be worked out to see reduction in road traffic. Further, being stations at one km, metro commuters will prefer walking and Non-Motorized transport for first/last mode of commuting to stations which will further reduce road traffic. The results of 4 Stage Modeling will be used and correlated to current emissions and net reduction in emissions will be worked out which will give Improvement in Environmental Aspect. However, there is a probability of model giving results which says people do not shift to public transport and MRTS may not be required. The detailed study of this will give us a platform/tool which can be used in different cities to define need of MRTS in each city respectively.

1.2 Problem Identification

- All the metropolitan cities are congested and roads are insufficient to cater the demand.
- Public Transport Share is reducing in the cities with existing Public Transport.
- Travel Experience, Comfort and safety is on risk in Existing Public Transport.
- No Clearly defined tool is available to decide the quantum of Public Transport required for the city.
- Ongoing MRTS Projects impact on Travel Scenario, Environment and Social Aspects of Cities is difficult to be estimated.
- No Firm parameters are there to decide need of public transport for the particular city.

1.3 Objectives of Study are:

- To do detailed study of the existing and upcoming Public Transport Infrastructure for developed cities.
- To define the need of Public Transport Infrastructure for Indian Cities.
- To analyze the Environmental Impact of Mass Rapid Transit System under implementation Stage in Mumbai Metropolitan Region.
- To analyze the Transport & Traffic Impact of Mass Rapid Transit System under implementation Stage in Mumbai Metropolitan Region.
- To analyze the Social Impact of Mass Rapid Transit System under implementation Stage in Mumbai Metropolitan Region.
- To create a platform/tool to define the quantum of public transport requirement for each city.

2. RESEARCH METHODOLOGY

2.1 Background

The said research work is a combination of Transportation Aspect and Environmental Aspect of a Metropolitan Region and outcomes of the same can be used to analyze the need of Transportation Infrastructure Developments in similar regions across globe and level-2 cities in the Country. Further, this study will help to answer the questions raised for the need of Investments in Public Transport and can justify its serviceability in long term period. The Methodology is divided into two parts, a. Travel Demand Analysis and b. Socio-Environmental Impact Analysis.

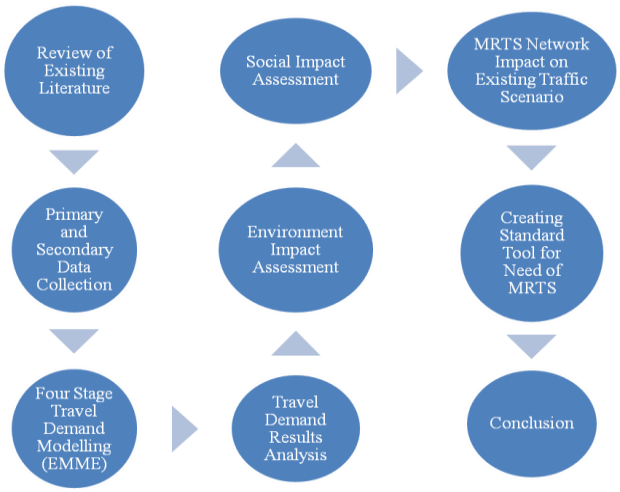

Fig -1: Methodology of Study

2.2 Travel Demand Analysis:

Travel Demand Models have the ability to estimate the future travel demand and transportation deficiencies for the horizon year and multiple intermediate years. The travel demand models are used for the estimation of passenger travel demand and assessment of transport network requirement for various horizon years. An iterative process is applied in the form of EMME macros by including trip generation, trip distribution, mode-choice and assignment stages of the travel demand model. The Output of Travel Demand Analysis in respect to the subject study is expected to be as follows:

a. The spatial allocation of future trips, especially the origin and the destination

b. The estimation of a future modal split among the competing transport means

c. Estimating the traffic volumes on the road network, and of passenger traffic on the public transport network

d. Estimation of travel times, speed of transport modes etc.

e. Responding to traffic demand management measures

In the said study, with a special request to MMRDA, Comprehensive Transportation Study for MMR Model was used which was developed recently for base year 2017 with Horizon Years 2021, 2026, 2031 & 2041. The said model was developed on EMME Software which is being used in the study partially and the outputs of the model are being used to analyze the impact of MRTS. The detailed Travel Demand Analysis Methodology is as follows:

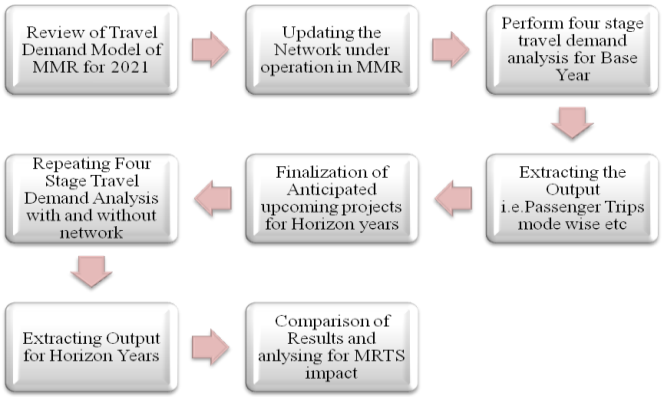

Fig -2: Methodology Chart for Travel Demand Analysis

2.3 Social and Environmental Impact Analysis:

The Output of travel demand analysis is tabulated in detail mode wise and which is converted into PCU (Passenger Car Unit) for with MRTS and without MRTS condition. The difference in the same is considered as reduction in vehicle trips in MMR which is considered for Social and Environmental Impact Analysis. The Environmental Impact Analysis is done as reduction in emissions of Co, CO2, NOx, SO2, Particulates etc. which is converted to savings in Number of Trees in MMR.

Similarly, Social Impact Analysis is done based on the reduction in Travel Time and Congestion with and without MRTS Condition. The said savings are converted to increased comfort, Economical benefits based on per hour Value of Time of MMR residents and indirectly to the Economy of the region.

2.4 MRTS Network Impact on Existing Traffic Scenario

In addition to the above, major impacts of MRTS Network on Traffic Scenario of MMR is also being tabulated in this study. The details such as increase in MRTS Trips per day, reduction in road based trips, change in Average Trip Length Mode wise, reduction in Travel Time, Running Speed and ultimately to percentage of congestion.

3. DATA COLLECTION AND ANALYSIS

3.1 General

To analyze the Social and Environmental Impact of MRTS, there was a need of major data collection i.e. primary and secondary. Considering the quantum of the work, majorly secondary data has been used to get maximum correctness of the impact results. However, some primary data collection has been done for ground truthing of the secondary data. The data has been collected from various sources such as MMRDA website, CIDCO website, MRVC etc. The data collected is used for the four stage travel demand modeling and the results of the same are used to analyze socio and economic impact.

The list of data collected is as follows:

1. Mumbai Rapid Transit System in MMR : Proposed and in operation
2. Navi Mumbai Metro: CIDCO
3. Existing Suburban Rail Network: Proposed and in operation
4. Population and Employment of MMR: Present and Future
5. Land Use Data: Regional Plan
6. Traffic Survey and Household Surveys
7. Road Network: Existing and Proposed

3.2 Mumbai Rapid Transit System in MMR:

MMRDA is a planning & implementing agency for vital regional importance projects in Mumbai Metropolitan Region, Maharashtra. The agency deals with the preparation of Regional Plan, Comprehensive Transport plan and is a Special planning Authority for Commercial Complexes like Bandra-Kurla Complex and Wadala etc. MMRDA had prepared Comprehensive Transportation Study for MMR in 2005 in assistance with World Bank (1- CTS-2005). Based on the recommendation in CTS study, MMRDA had taken up preparation of Mumbai Metro Master Plan through M/s. DMRC. The Master plan recommended 337 kms of Metro for Mumbai City. As per this plan, MMRDA had taken up the implementation of Mumbai Metro Line-1 (Versova – Andheri -Ghatkopar) in PPP mode in 2008.

Fig -3: Stations of Metro Line-1

Further, based on experience of Metro Line-1, MMRDA emerged confidently to take up implementation of other metro corridors proposed in Mumbai Master Plan and the details of the same are as follows:

Table -1: Details of Mumbai Master Plan

Line	Corridor	Length (Km)
Line 2 A	Dahisar-D.N. Nagar	18.6
Line 2 B	D.N.Nagar-Mandale	23.6
Line 3	Colaba-SEEPZ	33.5
Line 4	Wadala-Kasarwadavali	32.3
Line 5	Thane-Bhiwandi-Kalyan	24.9
Line 6	Swami Samarthnagar-Vikhroli	14.5
Line 7	Dahisar (E)-Andheri (E)	16.5
Line 4A Extn.	Kasarwadavali –Gaimukh	2.67
Line 7A.	Andheri(E) – Airport,	3.1
Line 8	Airport Metro (CSIA-NMIA)	35.0
Line 9	Dahisar (E) – Mira Bhayander	10.4
Line 10	Gaimukh – Shivaji Chowk	11.2
Line 11	Wadala-CSTM	13.6
Line 12	Taloja – Kalyan	25.0
Line 13	Ghodbunder Bridge to Virar	25.0
Line 14	Kanjurmarg- Badlapur	45.0
Total		**337.1**

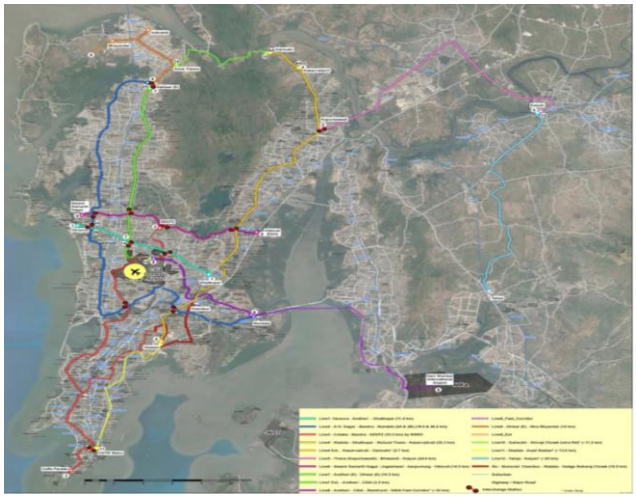

Fig- 4 Mumbai MRTS Network Plan

3.3 Navi Mumbai Metro: CIDCO

In addition to Metro taken up by MMRDA, CIDCO, the planning authority in Navi-Mumbai, on the other end, has initiated Navi Mumbai Metro Network as follows:

Table -2: Navi Mumbai Metro Network

Phase	Terminal	Length
I	Belapur-Kharghar-Taloja-Pendhar	11.10 km
II	MIDC-Taloja-Kalamboli-Khandeshwar (extension to Airport proposed)	10.30 km
III	Interlink between Pendhar and MIDC	2 km
Total		**23.40 km**

3.4 Existing Suburban Rail Network: Proposed and in operation

Mumbai suburban railway is a mass transit system carrying more than 7.65 million people daily (Central Railway: 4.18 million and Western Railway 3.47 million as per 2016-17 statistics) and it is considered as the lifeline of MMR.

Mumbai region is served by two of India's zonal railways, the Western Railway (WR) and the Central Railway (CR). The Western line runs northwards from Churchgate terminus station in Island City, which exclusively serves sub-urban passengers, parallel to the west coast. The Central Railway runs from CSMT, Mumbai (Chhatrapati Shivaji Maharaj Terminus) station situated very close to Churchgate in Island City and serves large part of central to the east of Mumbai.

Central Railway also has a harbour line which now basically serves Navi Mumbai.

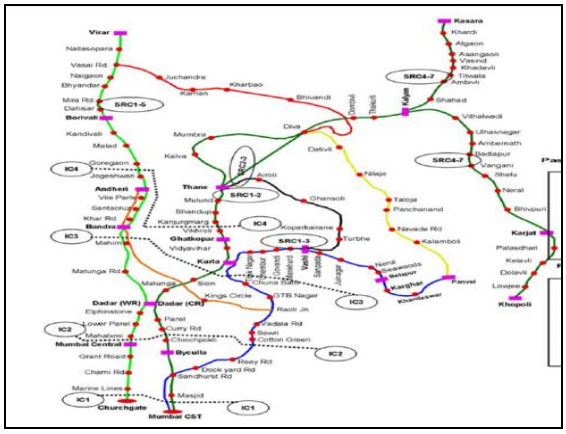

Fig- 5 Mumbai Suburban Rail Network

3.5 Population and Employment of MMR: Present and Future

To collect the planning parameters i.e. Population and Employment, various sources were available such as Population Census-2011, Economic Census-2013, CTS Study 2005, MCGM CMP Plan-2014, Regional Plan for MMR-2017-19 and CTS Study 2019. To simplify the work, Regional Plan for MMR was used for the said study as it is based on population census 2011 and the MCGM CMP plan was only for MCGM area. Further, during detailed study of CTS Study 2019, it is found that they have used Economic Census 2013 for Employment data and the combination of CTS 2019 and Regional Plan is used for Population and Employment of MMR.

Table -3: Population & Employment of MMR

Details	2017	2021	2026	2031	2041
Population	24.88	26.52	27.76	29.32	32.17
Employment	10.24	11.13	11.97	12.99	14.91

It can be seen that Population will increase by 7.29 million in MMR during the period 2017 to 2041. Further, it can be seen that the employment will increase by 3.67 million in MMR during period 2017 to 2041.

3.6 Land Use Data: Regional Plan

The Draft Regional Plan 2016-2036 reflected the existing land-use, updated for the horizon year of 2016, at the regional level and also at more disaggregate levels as well. MMR area contains a mix of all land-use categories in varying proportions. The study area spreads around 4,311.75 Sq km area, which is dominated with the agricultural land in the regions outside the urban agglomerations. Some of the agriculture areas lie within the peri-urban areas, while most of it is seen in the rural areas. The existing land-use pattern of the MMR area during 2017 reflects that the available developed land area totals about 638.64 Sq km, which is approximately 14.81% of the total area. Land Available for future development totals about 573.27 Sq km i.e. approximately 13.30% and the non-developable land comes out to be around 3099.85 Sq km i.e. approximately 71.89%.

3.7 Traffic Survey and Household Surveys

As a part of Secondary Data Traffic Survey and Household Surveys of CTS 2005 study, CMP-2014 and CTS -2017 was collected. To validate the secondary data, primary surveys were planned for major links across Mumbai City. The surveys were carried out on EEH, WEH and Bandra-Kurla Link Road. It is found that due to Covid-19 Pandemic, Public Transport users have reduced due to safety concern and thus public transport commuters have shifted to Road based transport. Further, major private companies have a Work from Home Policy during pandemic resulting into no realistic traffic collection. Thus, recent most data of traffic in 2017 is projected to 2021 for this research work.

Household Surveys are used for Four Stage Travel Demand Modeling and the collection of such data is a tedious task which can be done by appointing certain agencies which take residential properties society permission. It was thus decided to use existing Household surveys for the project.

3.8 Road Network Inventory: Existing and Proposed

The Major Road Network Inventory is done from Google Earth Software in which the kmz of each road is being exported for travel demand modeling. The widths of each road is cross verified with secondary data from CTS Study and the type of road is verified from Google Maps (One way or two way). The said data is updated with proposed road network inventory in MMR from Ongoing projects, DPR Studies, news articles etc. The same is subject to change as it's a continuous process and will update everyday.

4. RESULTS AND DISCUSSIONS

4.1 General

As per the methodology and with the help of travel demand model, the analysis have been completed and the results are presented in this chapter. Further with the help of outcomes of model, the same has been analyzed into estimating Social and Environmental Impact. In addition to this, it also includes Impact on Traffic Scenario of MMR. All these analysis are used to create a standard tool for Need of MRTS.

4.2 Stepwise Analysis for Travel Demand Analysis:

The detailed analysis has been carried out as follows:

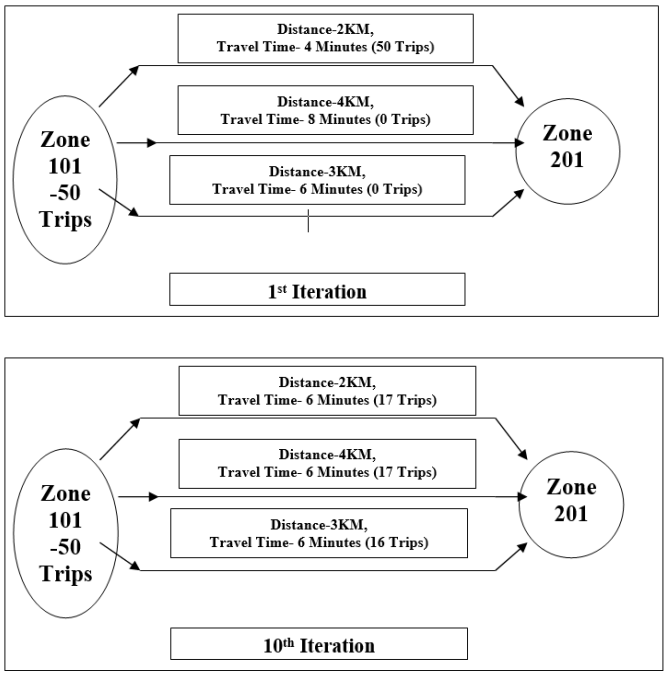

Fig -6: Detailed analysis for Travel Demand Analysis

It can be seen that iterations are performed till the point all available routes are assigned equal trips based on travel time, travel distance and in such a way that if further trips are added its re-iterated to achieve the equilibrium.

4.3 Development of Standard MRTS Necessity Tool (SMNT):

As a part of project, an additional exercise has been done to develop a tool which can be used for other metropolitan or developing cities across India to exercise the need of Mass Rapid Transit System and also the Quantum of it and to assess its environmental Impact. The Tool is for Study Purpose only, however the decision pertains to the concerned authority for its utilization or not. The SMNT is developed based on the impact of MRTS for MMR and the same can be used based on availability of following data:

Table - 4: Parameters and its range

Sr. No	Description of Parameters	Range
1.	Metro Ridership per Km	20,000-25,000 per km per day
2.	Change in Average Trip Length Mode Wise	7.5%-10%
3.	Change in Average Travel Speed on Urban Roads	15%-25% for developing cities 25%-40% for metropolitan cities
4.	Change in Travel time on urban roads	10%-20%
5.	Average Congestion on Urban Roads	Not greater than 35%

4.4 Travel Demand Model Results:

The Four Stage Travel Demand Model Analysis was performed for following scenarios:

1. **Year 2021 with Existing Transport Network**
2. **Year 2026 with and without existing Transport Network**
3. **Year 2031 with and without existing Transport Network**
4. **Year 2041 with and without existing Transport Network**

The results of the Model shows, Mode wise Trips per day for all the analysis years as follows:

Table -5: Mode wise Trips per day

Sl. No.	Year	Metro in Operation, Cumulative Length in km	Cumulative Metro Ridership (in Lakhs/day)	Daily Metro Ridership per km	% of Overall Length of Metro	% of Overall Metro Ridership/ day	Daily Travel Demand (Road Based Modes): lakh person trips/day			MRTS Modes (Suburban, Metro & Monorail): lakh person trips/day	Total Travel Demand: Road Based Modes and MRTS Modes	Percentage Trips: Road Based Modes	Percentage Trips: MRTS Modes
							Private (2W+Car) and IPT Modes (Auto+Taxi): lakh person trips/day	Bus Mode: lakh person trips/day	Total: lakh person trips/day :				
1	2021	11.4	3.60	32,000	2%	3%	48.81	30.36	79.17	89.88	169.05	47%	53%
2	2026	322.5	84.96	26,000	69%	79%	42.9	10.59	53.49	142.77	196.26	27%	73%
3	2031	423.2	93.54	22,000	91%	87%	44.67	10.62	55.29	156.48	211.77	26%	74%
4	2041	467.0	107.43	23,000	100%	100%	48.66	11.4	60.06	180.12	240.18	25%	75%

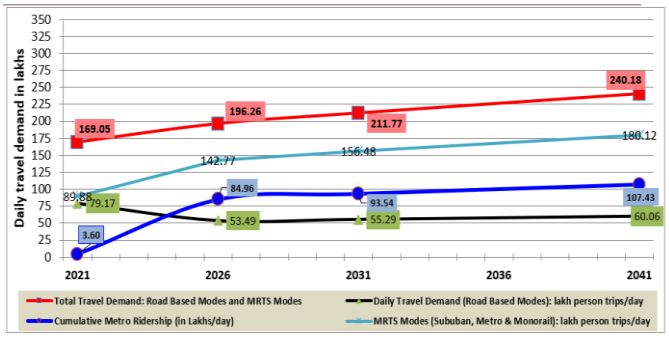

Chart -1: Total Travel demand: Road based Modes and MRTS Modes

Table -6: Analysis of Vehicle Fuel Parameter

Year	Length of Metro in Operation (km)	Road Based Vehicles (without metro)	Road Based Vehicles (with metro)	Daily Reduction in Vehicle due to metro (in lakhs)	% Reduction in Vehicle due to Metro (d=c*100/b)	Average Trip Length	Veh-km reduction (vehicles in lakhs-km)	Vehicle Fuel Parameter (in Lakh litre)	
								Daily Reduction in Fuel use	Daily Reduction in Fuel use
2021	11.4	44.95	43.91	1.04	2.31%	14.05	14.62	1.46	2.31%
2026	322.5	68.49	37.76	30.73	44.87%	11.97	367.85	36.79	44.87%
2031	423.2	70.94	39.78	31.16	43.92%	10.88	338.91	33.89	43.92%
2041	467	74.96	44.39	30.56	40.77%	9.94	303.85	30.39	40.77%

Table -7: Total Emissions Saving (CO2 Equivalent in tones)

Year	Total Emissions (CO2 Equivalent in tones)			No. of Trees Equivalent
2021	35215.26	34776.18	439.0804	19958
2026	45149.45	28859	16290.45	740475
2031	46184.95	30918.34	15266.61	693937
2041	47879.07	35219.69	12659.37	575426
			Per Year	28771

Table -8: Reduction in Traffic Congestion Level

Year	Average Trip Length (Road Based Modes) in km			Average Trip Length (MRTS Modes) in km		Reduction in Vehicular Trip Length	Reduction in Suburban Trip Length	Increase in Metro Trip Length	Travel Speed (kmph)	Weighted Travel Time in Minutes (Road Based)	Free Flow Travel Time in Minutes (Road Based)	Traffic Congestion Level (%)
	Private Vehicles (2W+Car) IPT Modes (Auto+ Taxi)	Bus Mode	Weighted Trip Length, km (Road Based Modes)	Metro & Mono Rail	Suburban							
2021	11.9	17.5	14.0	5.9	30.7	0.0%	0.0%	0.0%	20.5	41	21	95%
2026	10.3	13.3	10.9	6.6	26.8	-22.4%	-12.7%	11.9%	32.7	20	16	22%
2031	9.6	11.4	9.9	7.7	24.8	-29.2%	-19.2%	30.5%	36.6	16	15	9%
2041	9	10.5	9.3	8.9	24.2	-33.9%	-21.2%	50.8%	37.0	15	14	8%

4.5: SMNT Tool Results:

The Outcome of SMNT Tool is self understood and the same can be used to derive at a optimized number of Km of MRTS required for a particular city based on Ranges as defined above in Table No. 10.

Table -9: Input Table for SMNT Tool

Sr.No.	Name of City	Proposed MRTS Length	Estimated Ridership (Lakhs per day)	Actual Speed	Daily Travel Demand		
					Road	Bus	MRTS
1	Mumbai	467	107.43	20.50	48.66	11.4	180.12
2	Nashik	50	10	25	10	2	10

Table -10: Output Table for SMNT Tool

Ridership Per KM	Average Trip Length			% Change in Trip Length/km			Increased Travel Speed on Roads	Change in Travel Speed in %	Actual Travel Time (in Min	Reduced Travel Time	Change In Travel Time	Free Flow Travel Time in Min	Congestion in %
	Road	Bus	MRTS	Road	Bus	MRTS							
23004	10.75	10.91	23.25	-21.95%	-37.83%	33.89%	37.77	84.25%	31.47	20.73	-34.11%	16.13	28.56%
20000	2.21	1.91	1.29	-2.35%	-4.05%	3.62%	27.25	9.02%	5.30	5.11	-3.65%	3.31	54.16%

For Example, Average Traffic Congestion shall be less than 35%, in Mumbai City its 28.56% subject to 467 km of Metro is implemented, thus it can be seen that the network can be reduced upto a value wherein congestion is approx 35% which will be cost effective. However the Nashik city example assuming data is actual, the Congestion level is 54% however Travel Time is not reducing considerable, thus Metro network Length shall be revised to meet range levels. Basically this SMNT tool can be a secondary check taking up MRTS projects for implementation.

5. CONCLUSIONS

An attempt has been made in this study with the help of technical approach to assess the need of MRTS in various cities of Developing Countries. To make this study more technically acceptable, very minute details and parameters are considered which has authenticated the output of the study. However, city specific parameters are kept variable based on which true assessment will vary from city to city. Based on the Mumbai study, an Standard MRTS Necessity Tool have been developed which can be used for various developing cities to assess the need of MRTS and its Quantum and its impact based on input of city specific parameters. The detailed conclusions arrived at from this study are as follows:

1. To assess the need of MRTS there is a need of detailed data availability of existing various transport modes, its network, population and employment of region etc

2. The secondary data such as Traffic, Household Surveys and Preference surveys improves the Travel Demand Model.

3. Four Stage Travel Demand Model gives output in various forms such as Average Trip Length, Zone to Zone Boarding/Alighting etc which makes assessment of social and economic impact easier.

4. Implementation of Proposed MRTS Network for Mumbai Metropolitan Region will lead to Congestion level to be reducing drastically from 95% to 9% in one decade time period and further to 8% in one decade

5. Thus, it can be concluded that form Traffic point of view MRTS Network Recommended upto one decade i.e. upto 2031 shall be prioritized and focused.

6. Reducing congestion by 1% by adding 44km of Metro is Not advisable. However No addition will further increase congestion. Thus MMR shall be reassessed after one decade to examine the need of additional network for MMR.

7. Approximately 40% reduction in fuel use is estimated on commissioning of entire Metro Network for MMR.

8. Saving in fuel and reduction in Emissions has arrived to equivalent of 28,771 Trees Planted per Year by 2041

9. It has further resulted into reduction in Travel time by 1.8 minutes per km per vehicle, which is a considerable reduction.

10. Standard MRTS Necessity Tool (SMNT) is dependent on MRTS Network Proposed, Daily Travel Demand, Average Speed and Metro Ridership.

11. Standard MRTS Necessity Tool (SMNT) gives output in terms of Average Trip Length, Improved Travel Speed, Travel Time and Congestion level.

The Study work has further detailed scope available which can be taken up for future research such as converting SMNT Tool into an Android Application or a Python Language Software. Further, the same tool can be developed for other new modes of transport such as Metro Neo etc. The Impact Assessment carried out in this study will be helpful to assess the budget provisions to be allocated for MRTS projects city wise which will optimize the fund allocation and will serve the county/state in Ideal way.

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