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METRO: MUMBAI'S NEW VIBRANCY

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Abstract
Cities play a significant role in the development and expansion of the economy. One of the biggest issues facing Indian cities and urban areas today is the growing urban population and rural-urban migration, making it difficult to provide sustainable infrastructure for everyone. The purpose of this research is to understand the importance of metro rail in urban areas. To comprehend the role that mass transit plays in urban development and commuters' preferences. Recently, metro rail has emerged as an alternative mode of mass transportation in urban areas with burgeoning populations, increased traffic congestion, and increased pollution. The metro rail system has significantly improved city connectivity. Mumbai's planned metro system will be able to meet the need for fast connectivity.

JEL Classification: R4, R1.

Key Words: Infrastructure, Metro, MRTS, Mumbai Metropolitan Region, Mumbai.

Metro: Mumbai's New Vibrancy

The Mumbai Metropolitan Region (MMR) spans 4355 square kilometers. There are five districts in it. Mumbai City and Suburban, Thane, Navi Mumbai, certain areas of Raigad, and the recently established district Palghar, which has nine municipal councils and eight municipal corporations, are all included. Mumbai City is one of these districts and the nation's financial and economic center. When compared to other cities in the nation, its GDP contribution is significantly higher.

Need For a Metro In Mumbai Metropolitan Region

To minimize air and noise pollution, a good transportation system should be used in conjunction with clean energy. Ample space can be set aside for transportation systems to ensure that public transportation is used efficiently. As the city's population exceeds one million, it is considered a metropolitan region comprised of two or more cities. According to the 2011 census, the total population of the Mumbai Metropolitan Region (MMR) is around 20 million people. The region covers an area of 6,355 square kilometers. With such an increase in population, the share of public transportation must increase in order for the transportation system to be used efficiently. According to the DMRC project report, public transportation should make up between 40 and 50 percent of the city's total population if it surpasses one million. When the population surpasses five million, more than seventy-five percent should use public transportation. A population of over 12 million should have access to 88–91 percent public transportation. In this case, expanding the mass transit system would be better for the development of cities. The mass transit system in Mumbai offers various advantages. Firstly, it will cover 90% of the population through rail, increasing mass transit is share to 88%. Secondly, it will replace the bus system and suburban railways for around 30% of trips, reducing traffic jams and congestion and improving daily traveler safety. Finally, it will reduce fuel costs and air pollution.

Table 1: Master plan for Mumbai Metro

Phase	Line	Name of the corridor	Length (km)
Phase I (2006–2011)	1	Versova - Andheri – Ghatkopar	11.07
	2	Bandra - Kurla – Mankhurd	13.37
	3	Colaba - Bandra – Seepz	38.24
Phase II (2011–2016)	4	Charkop - Dahisar	7.5
	5	Ghatkopar – Mulund	12.4
Phase III (2016–2021)	6	BKC - Kanjurmarg via Airport	19.5
	7	Bandra (E) - Dahisar (E)	16.5
	8	Hutatma Chowk – Ghatkopar	21.8
	9	Sewri – Prabhadevi	3.5

In 2004, the aforementioned master plan called for 32 kilometers of subterranean track and 146.5 kilometers of track overall. It was estimated to have cost 19,525 crore and was divided into three phases. In 2009, additional changes were made to the metro line. The original plan, which called for Hutatma Chowk to Ghatkopar, was changed to Hutatma Chowk to Carnac Bunder. The MMRDA decided to extend the Colaba-Bandra-SEEPZ metro line from 21.8 kilometers to 33.5 kilometers in order to accommodate the increased ridership between the Chhatrapati Shivaji Maharaj International Airport and Bandra. There are 27 stations on this, the city's first underground rail line. The Western Express Highway line from Bandra to Dahisar was one of the additional metro lines that MMRDA announced in 2012 in addition to its current plan. The purpose of this line was to ease traffic on the Western Line and Western Suburban Railways. The state government proposed a 30 km, 28 station metro line in 2013 that would run from Wadala to Kasarvadavali. With the success of the metro rail line in Mumbai compared to monorail, the MMRDA intends to convert the Lokhandwala-SEEPZ-Kanjurmarg monorail route into a metro rail line. The metro plan was revised in 2012 with a total length of 160.90 kilometres. Two new lines were proposed in 2015. New lines were proposed from Andheri (west) to Dahisar (west) and Bandra Kurla Complex (BKC) to Mankhurd. The total length of metro lines in Mumbai is 337 kilometres. The master plan was updated with all the revisions, including the new metro line, and is shown in the table given below:

Table 2: Upgraded Master Plan

Line	Name of Corridor[27]	Length (km)	Stations	Estimated cost	Status	Opening
1	Versova–Andheri–Ghatkopar	11.40	12	₹4,321 crores	Operational	June 8 2014
2	2A: Dahisar-Charkop-Andheri West	18.5	17	₹6,410 crores	Operational	April 2, 2022
	2B: Andheri West-Mandala	23.6	22	₹10,986 crores	Under construction	--

3	Colaba - Bandra – SEEPZ	33.5	27	₹24,430 crore	Under construction	--
4	Wadala–Ghatkopar-Mulund–Teen Hath Naka–Kasarvadavali	32.32	32	₹14,549crore	Under construction	--
4A	Kasarwadavali-Gaimukh	2.7	2	₹949 crores	Under construction	--
5	Thane-Bhiwandi-Kalyan	24.9	17	₹8,417 crores	Under construction	--
6	Lokhandwala-Jogeshwari-Kanjurmarg	14.5	13	₹6,716 crores	Under construction	--
7	Dahisar (East) - Bandra (East)	16.5	13	₹6,208 crores	Operational	April 2, 2022
7A	Andheri-CSMIA	3.17	2	TBA	Under construction	--
8	Chhatrapati Shivaji Maharaj Interanational Airport – Navi Mumbai International Airport	35		₹15,000 crores (approx)	Proposed	--
9	Dahisar (East)-Mira-Bhayander	10.3	8	₹6,518 crores	Under construction	--
10	Gaimukh-Shivaji Chowk (Mira Road)	9.2	9	₹5,000 crores	Approved	
11	Wadala-CSMT	12.7	11	₹8,739 crores	Approved	
12	Kalyan-Dombivali-Taloja	20.7	17	₹5,865 crores	Approved	
13	Mira Bhayander-Virar	23	TBA	₹6,900	Proposed	
14	Kanjurmarg-Badlapur	45	TBA	₹13,500	Approved	
Total		337	202	₹1,40,814+ crores		

Review of Studies Pertaining To MRTS in Mumbai

To enhance the transportation studies in Mumbai, numerous studies on travel patterns, network characteristics, and the level of traffic congestion were discussed.

1. Mass Transport Study (1969): This study was conducted to determine the city's sixth and seventh rail corridors. Travel projection was done up to 1981.
2. Indian Railways conducted a techno-economic feasibility study of the 7th corridor in 1974. The underground South-North corridor stretches approximately 17.38 km from Colaba to Bandra, while the elevated East-West corridor stretches 4.1 km from Bandra to Kurla.
3. The Mumbai Metropolitan Region Development Authority (MMRDA) examined the Mankhurd, Vashi, and Panvel East-West Corridor in 1975.

4. Mumbai Metropolitan Region (MMR) Comprehensive Transport Study, 1993. Rs. 7000 crore is allocated for transportation improvement, and Rs. 11,300 crore is invested. Rs. 570 crore for buses and ferries and Rs. 3730 crore for the highway program.
5. The German company TEWET completed the 57 km long metro network at an estimated cost of RS. 12000 crore.
6. The Konkan Railway Corporations suggested creating the SKYBUS,a brand-new transportation network.

Fare Structure

The Metropolitan Region Development Authority (MMRDA) has fixed fare slabs. The fare structure is Rs 10 for the first three km, Rs 20 for 3–12 km, Rs 30 for 12–18 km, Rs 40 for 118–24km, Rs 50 for 24 - 30 km, Rs 60 for 30 – 36 km, Rs 70 for 36 – 42 km and Rs 80 for a distance of more than 42 km. For existing metro line 1 ((Versova-Ghatkopar)the fare structure is Rs 10 for the first two kilometres, Rs 20 for 2 - 5 km, Rs 30 for 5 – 8 km and Rs 40 for a distance of more than 8 km as it had conflict regarding the fare revisions with Reliance Infrastructure .

Externalities: Impact on Environment Assessment

MRTS system impact on environment is assessed by various protection works, compensation for the loss of trees, compensatory afforestation, additional compensatory measures, monitoring of air / water quality, and noise pollution during construction activities. here are two types of externalities associated with building up a metro line. They are positive and negative externalities. The construction of a metro line has several positive externalities, including less traffic jams, safer and more affordable services, less fuel used, less pollution, better roads, and more job opportunities. A metro line's negative externalities include deforestation, tree-cutting, pollution from construction, loss of land, relocation, and resettlement. Mumbai Metro Rail Corporation Ltd. (MMRC) is dedicated to energy- and environmentally-friendly policies and strives to provide clean, green, and comfortable transportation.

MMRC Aims to Work towards the Following Goals For Environment

1. To supplement the existing green cover along the corridor
2. Develop 'Green transportation' in the city by making better use of resources and lowering emissions and waste.
3. Raise environmental awareness among stakeholders, provide training, and incorporate environmental safeguards into project execution and subsequent stages.
4. Comply with all applicable environmental legislation and regulations, as well as other environmental initiatives to which we are committed.
5. Encourage our employees to take on environmental initiatives, resulting in a strong environmentally conscious culture.
6. Ensure that our contractors and subcontractors are adhering to this policy.

MMRC will work to reduce energy consumption with the following goals in mind:

1. Developing energy-efficient technologies at the design stage for maximum benefit.
2. Energy-efficient smart lighting, enhanced air conditioning and ECS systems, platform screen doors, smart signage, occupancy sensors, and other features are being implemented in Green Metro Stations using LEDs.
3. Optimizing the design of stations to decrease building energy use.
4. Introducing technology that matches passenger occupancy to dim or turn off unnecessary lighting.

5. Optimally harnessing natural light to enhance station/depot lighting. ·
6. Purchasing energy-efficient Rolling stock and assured Regenerative energy braking.
7. Providing smart elevators and escalators at stations.
8. Encouraging depots and substations to use solar power, water harvesting, and smart lighting, among other things.
9. Reasoning ahead based on commuter needs.
10. Relying on coasting while operating trains and shortening station stays.
11. Running in 'Energy Saving mode' during off peak time.
12. Determining areas that require improvement by regularly auditing the current installation.
13. Optimizing the "Air conditioning load inside coaches" based on the needs of the passengers..
14. Continuously sensitizing staff about energy conservation.
15. Seek a long-term sustainable solution to meet its energy needs and reduce dependency on fossil fuels.
16. Increase the share of renewable energy in its overall power consumption in-8uohouse, by generating solar power for non-traction or car depot purposes.

Table 3: Estimated Reduction in Trips, Fuel Costs, and Pollution

	Year 2021	**Year 2031**	**Year 2041**
Reduction in Vehicle Trips / Day	4,56,771	5,54,556	6,65,468
Reduction in Fuel Consumptions: Petrol and Diesel (in L)/Day	2,43,390	2,95,495	3,54,593
Avg. Daily Money Savings due to Reduction in no. of Vehicle Trips (Rs. lakhs)	158.14	191.99	230.39
Reduction In Pollution Emission Due To Reduction in the Number of Vehicle Trips (Tonnes/Year)	6,800	8,256	9,907

Source: https://www.mmrcl.com/en/project/environmental-benefits

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