

KEY POINTS

- ADB financing will support 58 kilometers of metro rail lines in Mumbai composed of: (i) Line 2A, from Dahisar to D.N. Nagar; (ii) Line 2B, from D.N. Nagar to Mandale via Bandra; and (iii) Line 7, from Dahisar to Andheri (east).
- Each train will consist of six railcars that are equipped with regenerative braking systems and closed-circuit television (CCTV) surveillance to ensure passenger security and real-time track monitoring.
- The fully air-conditioned metro lines will have advanced communication-based train control signaling systems, with each coach having a capacity of up to 300 passengers.
- Maha Mumbai Metro (M3) Operation Corporation Limited (MMMOCL) has been established to manage the operation and maintenance of the Mumbai Metro.

Moving Millions with the Mumbai Metro

Sharad Saxena
Principal Transport Specialist
South Asia Department
Asian Development Bank

INTRODUCTION

On 26 February 2019, the Asian Development Bank (ADB) approved a \$926 million loan for the Mumbai Metro Rail Systems Project.¹ The project will support work including the (i) design, manufacture, testing, and maintenance of 378 energy-efficient rolling stock carriages; (ii) procurement, installation, and testing of an advanced signaling, train control, and platform access system for 58 kilometers (km) of metro lines; and (iii) establishment of a Mumbai Metro operations organization. It will contribute to the development of a modern and safe rail-based urban transit system, which is expected to reduce pollution and traffic congestion, increase public transport ridership, and improve the overall quality of the city's transport system.

BACKGROUND

Mumbai, the capital of the state of Maharashtra, is one of India's largest metropolitan areas. It is also known as the financial capital of the country. The Mumbai Metropolitan Region (MMR) covers an area of about 4,355 square km with a population of more than 18 million.² Hosting the two major ports that handle more than 30% of India's sea trade—Mumbai Port Trust and Jawaharlal Nehru Port Trust—the MMR makes a very substantial contribution to the country's economy. Data show that the state of Maharashtra produced about 15% of India's gross domestic product in 2017, about 40% of which is estimated to be from the MMR.³

¹ ADB. 2019. *Report and Recommendation of the President to the Board of Directors: Proposed Loan to India for the Mumbai Metro Rail Systems Project*. Manila. <https://www.adb.org/projects/documents/ind-49469-007-rrp>.

² Government of India, Office of the Registrar General and Census Commissioner. 2011. *Census: Population Enumeration Data*. New Delhi. http://www.censusindia.gov.in/2011census/population_enumeration.html.

³ Government of Maharashtra. 2018. *Economic Survey of Maharashtra: 2017–2018*. Mumbai. https://mahades.maharashtra.gov.in/files/publication/ESM_17_18_eng.pdf; and G. Clark and T. Moonen. 2014. *Mumbai: India's Global City*. Washington, DC. https://www.jpmorganchase.com/corporate/Corporate-Responsibility/document/gci_mumbai_02.pdf.

CURRENT PUBLIC TRANSPORT SYSTEM

The current public transport system in Mumbai is extremely crowded, unsafe, and slow. Among all users, vulnerable groups including the poor, women, and children are the worst affected. The public transport share of trips has declined steadily—from 88% in 1994 to 78% in 2005, and 70% in 2015. Yet, Mumbai still has one of the highest rates of public transport among cities worldwide. The primary reasons for the decline are the expansion of the urban area and the inability of the existing public transport system to serve the increasing demand. This has resulted in a 400% increase in private vehicles from 2008 to 2015.

The suburban railway lines carry more than 7.5 million passengers per day, often under “super dense crush load” conditions that exceed 14 passengers per square meter. As a result, the rail system in Mumbai has become the most crowded public transport system in the world. Each train carries about 5,000 passengers, more than

its actual design capacity of 1,750 passengers. Suburban trains have severe safety problems, with more than 3,000 fatalities per year due to overcrowding and right-of-way encroachment. These constraints, in addition to the overwhelming demand, also limit the speed of the rail service and its ability to accommodate more passengers.

Meanwhile, the bus system operated by the state-owned Brihanmumbai Electric Supply and Transport Undertaking carries more than 5 million passengers per day in highly congested conditions.

The rail system in Mumbai has become one of the most crowded public transport systems in the world.



Commuters hang on the outside of a local train in Mumbai. According to some estimates, more than 5,000 people can cram into trains designed to carry no more than 1,750 passengers (photo by Satish Krishnamurthy).

PLANS FOR A NEW METRO SYSTEM

Increased public transport capacity in Mumbai is crucial to addressing commuting problems and, consequently, improving livability; providing safe and convenient mobility, especially for the poor, women, and children; arresting the decline in public transport mode share; and enabling the city to develop to its potential. The geographic and infrastructure constraints and extremely high population density in Mumbai make a metro rail system a viable solution to its commuting problems. The government has thus developed a plan for 12 metro lines covering 276 km.

The first line of this metro network (Line 1) has been operating since 2014. This single metro rail line, from Versova to Ghatkopar, carries about 400,000 passengers per day. It has reduced travel

The geographic and infrastructure constraints and extremely high population density in Mumbai make a metro rail system a viable solution to its commuting problems.



Source: Asian Development Bank.

time along the corridor from 71 minutes to 21 minutes and addressed traffic congestion by shifting the demand for travel via private vehicles toward informal public transport modes to the Metro. Line 1 was built and now operates through a public-private partnership model.

For subsequent lines, however, the Government of Maharashtra has decided to entrust construction to the Metropolitan Mumbai Regional Development Authority (MMRDA). The scale of investment for the multiple lines is very large, and it is difficult for metro rail systems to meet equity return expectations of the private sector. Hence, the proposal is to follow a model whereby the government finances the assets using its own funds and development assistance, and then outsources service contracts for operation and maintenance. This is common practice for most metro systems worldwide.

Line 3, which extends from South Mumbai (Colaba) to the Santacruz Electronic Export Processing Zone, will be an underground line covering 34 km and is being developed by the MMRDA with assistance from the Japan International



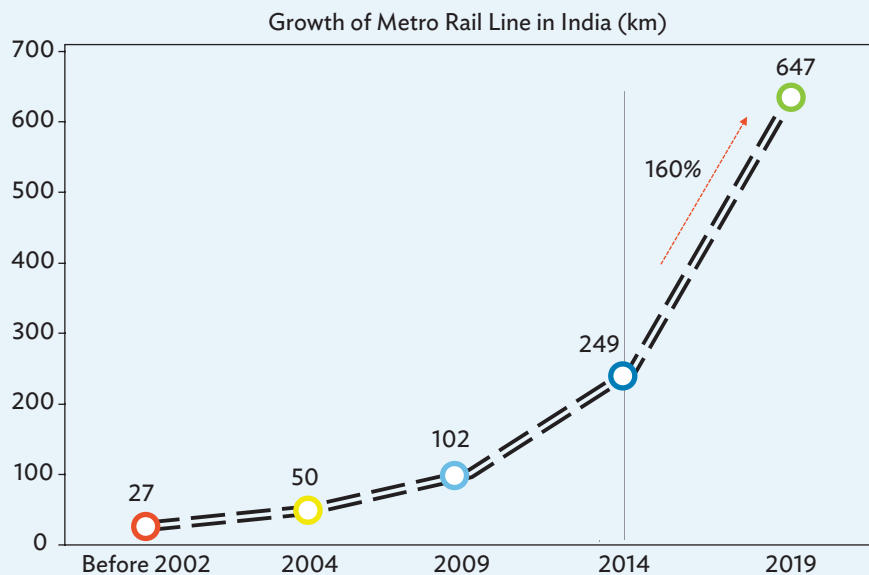
Mumbai's lone metro. Line 1 is the first of 12 planned metro lines to improve public transport comfort and safety in Mumbai (photo by Fly2Blue).

Cooperation Agency. For the other lines, which are currently at different stages of planning and construction, the MMRDA is seeking financing from development agencies, including ADB, the Japan International Cooperation Agency, and the New Development Bank.

India's Metro Rail Story

The first rapid transit system in India was the Kolkata Metro, which began operation in 1984. The next was Delhi Metro, which was launched in New Delhi in 2002. The Delhi Metro has the country's largest network and established good practices of metro project implementation and operation and management, backed by a strong institutional mechanism of acquiring, accumulating, and scaling expertise within its organization, such as an extensive training program.

Following the success of the Delhi Metro, many cities in India began exploring options to implement metro rail projects. There are currently 10 operational rapid transit (or metro) systems in India covering 647 kilometers. Another 880 kilometers of lines are under construction.



km = kilometer.

Source: Ministry of Housing and Urban Affairs.

PROJECT OUTPUTS AND HIGH-LEVEL TECHNOLOGY

ADB is providing financial assistance to the following lines: (i) Line 2A from Dahisar to D. N. Nagar, (ii) Line 2B for D. N. Nagar–Bandra–Mandale, and (iii) Line 7 from Dahisar to Andheri (East). The aggregate length of these lines is about 58 km. ADB will assist the MMRDA in financing the procurement of rolling stock, signaling and train control systems, and station access and platform systems; and support multimodal integration. The project, which is expected to cater to about 2,000,000 passengers per day after operations stabilize (Table 1), will improve urban transport safety and comfort and provide residents, especially the poor and vulnerable, with enhanced access to economic opportunities and social service facilities.

Table 1: Daily Ridership Estimates

Year	Maximum Design Capacity (PPHPD)		Daily Ridership	
	Line 2	Line 7	Line 2	Line 7
2024	36,150	18,100	1,406,500	570,400
2031	38,500	18,600	1,658,950	667,700

PPHPD = passengers per hour per direction.

Source: Metropolitan Mumbai Regional Development Authority estimates.

The new Metro lines also offer an opportunity to create a modern public transport system with innovative technological features:

- **Extra safety.** The new Metro lines will be elevated, hence will not have residents living alongside and exposed to passing trains. The elevated tracks also eliminate the risk of flooding, which is a perennial problem for suburban trains during the dreaded Mumbai monsoon.
- **Driverless trains.** There are four grades of automation (GoA) in metro or subway systems. Mumbai’s will have the highest—GoA 4—in which the trains can operate automatically at all times; among its features are automated doors, obstacle detection, and emergency operation. While initially Mumbai Metro will not operate in “driverless mode,” it will use sophisticated monitoring and automation technologies that will contribute enormously toward safety.
- **Extra protection.** Passengers will not be able to cross the metro lines between platforms nor can they be accidentally pushed onto the lines during peak hours. The new Metro will have platform screen doors that open only when the train has arrived at the platform.
- **Saving energy.** The trains will use regenerative braking. Traction motors will become generators that feed electricity back to the power grid, thus reducing the overall energy consumption.

- **Speedier operation.** The Metro will use modern signaling systems that employ communications-based train control technology. This will allow more trains to run at shorter intervals safely.

DEVELOPMENT IMPACT OF METRO RAIL SYSTEM

Once all the 12 lines are complete, the metro network will provide easy access across Mumbai. The Metro will also relieve pressure on the existing suburban railway and buses, reducing overcrowding and enhancing safety. It will pave the way for smart urban growth in India’s financial capital. In the process, it will also reduce emissions from vehicles—carbon dioxide emissions are expected to fall by about 166,000 tons a year.

By 2021, the metro rail corridor development in Mumbai should result in a substantial improvement to its urban transit system, with the overall public transport share expected to reach around 80%. Table 2 shows the changes in projected mode shares from 2014 to 2034.

Table 2: Projected Mode Share with Planned Metro, 2014–2034

Modes	Person-Trip Share (%)			
	2014	2019	2024	2034
Car	8.5	10.3	9.5	8.6
Two-wheeler	10.8	8.1	7.5	6.8
Auto rickshaw	4.2	4.6	2.3	2.1
Taxi	4.9	6.5	2.0	2.0
Bus	25.6	23.5	12.6	11.4
Suburban rail	43.5	44.2	38.7	38.1
Metro and monorail	2.4	2.8	27.4	30.9
Total	100.0	100.0	100.0	100.0

Note: Numbers may not sum precisely because of rounding.

Source: Municipal Corporation of Greater Mumbai.

The Metro will relieve pressure on the existing suburban railway and buses, reducing overcrowding and enhancing safety.

Bus share is also expected to drop, as bus services are redesigned to primarily serve as a major access and egress mode for the suburban train and metro systems. Consequently, the overall informal public transport and share of private vehicles is expected to decrease from around 30% to about 20%. The mode shift will improve travel conditions for commuters on suburban trains, reducing fatalities and accidents associated with overcrowding on trains. The additional metro lines are expected to reduce the number of private vehicles in use, informal public transport, and bus trips in the city. As motorized vehicles are major contributors to poor air quality, this modal shift can contribute to a better

urban environment by reducing vehicle emissions as well as environmental, business, and social costs associated with traffic congestion. Road safety will also improve.

Low ticket prices will bring comfortable public transport within reach of low-income commuters, and some stations will be easily accessible to serve the poor areas in the city. Female commuters will also benefit from women-only carriages, mobile applications for security, separate ticket counters, and reporting desks to address incidents of harassment.

About the Asian Development Bank

ADB is committed to achieving a prosperous, inclusive, resilient, and sustainable Asia and the Pacific, while sustaining its efforts to eradicate extreme poverty. Established in 1966, it is owned by 68 members—49 from the region. Its main instruments for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.

ADB Briefs are based on papers or notes prepared by ADB staff and their resource persons. The series is designed to provide concise, nontechnical accounts of policy issues of topical interest, with a view to facilitating informed debate. The Department of Communications administers the series.

The views expressed in this publication are those of the authors and do not necessarily reflect the views and policies of ADB or its Board of Governors or the governments they represent. ADB encourages printing or copying information exclusively for personal and noncommercial use with proper acknowledgment of ADB. Users are restricted from reselling, redistributing, or creating derivative works for commercial purposes without the express, written consent of ADB.

Asian Development Bank
6 ADB Avenue, Mandaluyong City
1550 Metro Manila, Philippines
Tel +63 2 632 4444
Fax +63 2 636 2444

www.adb.org/publications/series/adb-briefs



Creative Commons Attribution 3.0 IGO license (CC BY 3.0 IGO)

© 2019 ADB. The CC license does not apply to non-ADB copyright materials in this publication.

<https://www.adb.org/terms-use#openaccess>

<http://www.adb.org/publications/corrigenda>

pubsmarketing@adb.org