# MUMBAI METRO

**SAURABH SANKHE**
**MANSI SAWANT**
**SHAIL SHAH**
**ANKIT SHAH**
**CHAITALI SHAH**




**THE HUMANITIES SECTION**
**THADOMAL SHAHANI ENGINEERING COLLEGE**
**UNIVERSITY OF MUMBAI**

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Prepared for

**THE HUMANITIES SECTION**

Prepared by

**SAURABH SANKHE**
**MANSI SAWANT**
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**ANKIT SHAH**
**CHAITALI SHAH**




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# LETTER OF TRANSMITTAL

October 20, 2014

Ms. Chumki Biswas
The Humanities Section
Thadomal Shahani Engineering College
Bandra, Mumbai – 400050

Dear Madam

We are glad to present to you this report and survey on "Mumbai Metro". At a glance, this report deals with the Mumbai's very first Metro's planning, challenges faced, how it changed the way people travel, and the plans that the future holds. It also highlights the common man's reception to the Mumbai Metro (Line 1).

The successful analysis of our survey report would not have been possible without your constant guidance and help in preparing the report. We also thank all those people who have helped us in conducting the survey.

Through this report, we intend to create awareness about the Metro and show the real picture, without any prejudices. It is important to know the strong and weak areas of any system; knowing so and working on the weak areas can help make it a better place. This was our driving factor for working on this report and survey.

Yours Sincerely

Saurabh Sankhe

Mansi Sawant

Shail R. Shah

Ankit Shah

Chaitali Shah

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# EXECUTIVE SUMMARY

With a population reaching close to 25 million, the people of Mumbai have always faced the challenge of going from Point A to Point B. Due to highly congested roads during peak hours, travelling has not always been the best experience for the average Mumbaikar.

Reliance and Mumbai Metropolitan Region Development Authority (MMRDA) realized this problem and decided to join hands to make transportation safer, faster and more comfortable. After years of proper planning, and with a few major & minor setbacks, the result was finally in front of everyone: The Mumbai Metro Line One.

This report has been created to make the reader aware about the history and appreciate the world-class features of the Mumbai Metro. It includes a brief history of the metros around the world, the blueprints of the three lines of the Mumbai Metro, and the infrastructure behind it. This report also includes a survey taken at various stations of the Metro, to give an insight of what actual Metro-travellers think about the Mumbai Metro.

# 1. INTRODUCTION

## 1.1 Origin

This report is a part of the subject "Bussiness Communication and ethics". It is for the third year (semester V) of IT Engineering, of Thadomal Shahani Engineering College, which is affiliated with the University of Mumbai.

## 1.2 Purpose and Scope

The report seeks to enlighten the reader about the various features of the Mumbai Metro Line 1. It also gives insight into the minds of the metro-users. The survey aims to find out what the customers think about the Mumbai Metro and how satisfied they are using it. Our aim is to keep up with the positives and work on the negatives to make the Metro a better means of transport for everyone.

## 1.3 Limitations

The data collected for the survey is very limited in quantity, due to a lack of time and resources. The time given for making this report was comparatively less. Also, most of the information presented has been researched from a limited number of sources.

## 1.4 Background

Mumbai Metro, an initiative by Reliance Infrastructure, Veolia Transport and the Mumbai Metropolitan Region Development Authority, is a system designed to attempt to solve the problem of congestion in the city of Mumbai, Maharashtra. It consists of three lines (only one line is currently operational). It will be built in three phases over a 15-year period, with overall completion expected in 2021. When complete, the core system will comprise three high-capacity metro railway lines, spanning a total of 63 kilometres.
Line 1 connects Andheri and Ghatkopar, making travel time about half of what it was before. Lines 2 and 3 will be fully operational by 2030.

## 1.5 Methods

This report has made use of various websites as a means of obtaining information. With a group of 5 working on this report, each one gathered information on a particular topic. The survey was taken inside the Mumbai Metro trains and also on various stations by the entire group. From the data, interpretations could be made and was noted. The data and information was compiled by one person and presented to the teacher for further guidance on how to improve. A final copy was made and given for printing.

# 2. OVERVIEW OF THE METRO

## 2.1 Definition of Metro

Metros, short for metropolitan railways are defined by the International Association of Public Transport (L'Union Internationale des Transports Publics, or UITP) as urban guided transport systems "*operated on their own right of way and segregated from general road and pedestrian traffic. They are consequently designed for operations in tunnel, viaducts or on surface level but with physical separation in such a way that inadvertent access is not possible. Rail systems with specific construction issues operating on a segregated guideway (e.g. monorail, rack railways) are also treated as Metros as long as they are designated as part of the urban public transport network.*"

Rapid transit is a type of high-capacity public transport generally found in urban areas. Unlike buses, trams or light rail, rapid transit systems operate on an exclusive right-of-way which is usually grade separated in tunnels or elevated railways. The Mumbai Metro falls in the category of 'elevated railways'.

An elevated railway (also known in Europe as overhead railway) is a rapid transit railway with the tracks above street level on a viaduct or other steel, concrete or brick structure. The railway may be standard gauge, narrow gauge, light rail, monorail or a suspension railway. Elevated railways are usually used in urban areas where otherwise there would be a large number of level crossings.

Modern services on rapid transit systems are provided on designated lines between stations typically using electric multiple units on rail tracks, although some systems use guided rubber tyres, magnetic levitation, or monorail. The stations typically have high platforms, without steps inside the trains, requiring custom-made trains in order to avoid gaps. They are typically integrated with other public transport and often operated by the same public transport authorities, but does not exclude a fully segregated light rail transit. It is unchallenged in its ability to transport large numbers of people quickly over short distances with little use of land.

The world's largest rapid transit system by both length of track (1,355 km)and number of stations (468 stations in total)is the New York City Subway. By length of passenger route, the world's longest single-operator rapid transit system is the Shanghai Metro. The busiest rapid transit systems in the world by annual ridership are the Tokyo subway system,

the Seoul Metropolitan Subway, the Moscow Metro, the Beijing Metro, and the Shanghai Metro.

## 2.2 Metros around the World

Rapid transit began with the opening in 1863 of the Metropolitan Railway, now part of the London Underground. However, the smoke caused discomfort for passengers in operating steam trains through tunnels and limited the appeal of this mode of transport. Between 1863 to 1890 there were numerous proposals to build pneumatic or cable-hauled railways in London to overcome this problem, but none proved successful. Smoke was less of a problem in steam-hauled elevated railways, starting with the West Side and Yonkers Patent Railway in New York City in 1870 (although this line opened unsuccessfully as a cable-hauled railway in 1868). The opening of London's City & South London Railway in 1890 overcame the smoke problem by using electric traction and led to the development of electric underground railways in Berlin, Boston, Budapest, Glasgow, New York City, and Paris by 1904.

*Figure 2.1 Construction of the Metropolitan Railway, 1855*

### 2.2.1 First Tunnels

Before any plans were made for transit systems with underground tunnels and stations, several railway operators had used tunnels for freight and passenger trains, usually to reduce the grade of the railway line. Examples include Trevithick's Tunnel from 1804, built for the Penydarren locomotive, the 1829 Crown Street Tunnel at Liverpool and the 1.13 miles (1,811 metres) long 1836 Lime Street Tunnel also at Liverpool, of which a part is still used today making it the world's oldest used tunnel.

The first urban underground railway was the Metropolitan Railway, which began operations on January 10, 1863. It was built largely in shallow tunnels and is now part of the London Underground. It was worked by steam trains, and despite the creation of numerous vents, was unhealthy and uncomfortable for passengers and operating staff. Nevertheless, its trains were popular from the start and the Metropolitan Railway and the competing Metropolitan District Railway developed the inner circle around central London (completed in 1884) and an extensive system of

suburban branches to the northwest (extending into the adjoining countryside), the west, the southwest and the east (mostly completed by 1904).

### 2.2.2 Electrification

The first electrified urban railway, London's City & South London Railway underground railway, opened in 1890, in deep tubular tunnels, leading to the term "tube", which was eventually applied to the London Underground. It was originally planned to be cable-hauled, but the bankruptcy of the company that contracted to supply the cable-haulage technology forced the railway company to consider the brand-new technology of electric traction, because its Parliamentary Act prohibited use of steam power. It operated locomotive-hauled trains with three carriages, initially without windows, because it was considered that passengers would not need to know where they were if they were in tunnels.

The UK's only elevated railway opened in 1893 in Liverpool. The Liverpool Overhead Railway was the world's fourth oldest metro and was the world's first fully formed elevated railway to run electric trains from the start. The LOR pioneered Electric Multiple Units of three car trains. Automatic and electric light signals was also a first for the railway. The presence of the "El" was one aspect that earned Liverpool the nickname of "Britain's North American City". The LOR was demolished in 1957 with Liverpool today served by a partially underground urban rail network known as Merseyrail.

A major breakthrough in the development of modern electrically driven rapid transit occurred when the American inventor Frank J. Sprague successfully tested his system of multiple-unit train control (MUTC) on the South Side Elevated Railroad (now part of the Chicago 'L') in 1897. MUTC, which allowed all the motors in an entire train to be dependably controlled from a single point, freed rapid transit systems from dependence on locomotive-hauled coaches.

### 2.2.3 Systems in Europe

The first non-underground urban rail line was the first line of Athens metro system. Istanbul Tünel is the second-oldest subterranean urban rail line in the world, after the London Underground (1863). It is an underground funicular with two stations, connecting the quarters of Karaköy and Beyoğlu. Tunnel construction works started on June 30, 1871. On July, 1872 British company "The Metropolitan Railway of Constantinople to the Galata Pera" was registered. On December 5, 1874

the construction was completed and started carrying people on January 17, 1875.

Budapest inaugurated the first electrified underground line on the continent, the M1, in 1896. It ran from Gizella tér (now Vörösmarty tér, the city centre) to City Park and the local zoo, a distance of 3.7 kilometres (2.3 mi). It is now part of the Budapest Metro and has largely been restored to its original condition. The Budapest system was also the first electric underground railway with overhead cables rather than the more common third rail system. The 10.4 kilometres (6.5 mi) Glasgow Subway in Scotland opened the same year and used cable haulage until it was electrified in 1935. In 1898 the technically out-dated metropolitan railway Wiener Stadtbahn in Vienna was inaugurated, which was operated by steam trains.

*Figure 2.2 The M1 in Budapest*

The first line of the Paris Métro opened in 1900. Its full name was the Chemin de Fer Métropolitain, a direct translation into French of London's Metropolitan Railway. The name was shortened to métro, and many other languages have since borrowed this word.

The Madrid Metro opened on October 17, 1919 under the direction of the Compañía de Metro Alfonso XIII. Metro stations served as air raid shelters during the Spanish Civil War. Today, Madrid's subway is one of the longest systems in the world. Barcelona Metro followed in 1924.

The first underground in the USSR (in Russian метрополитен metropoliten or метро metro) opened in 1935 in Moscow. The first line — between Sokolniki and Park Kul'tury — was 11.2 km long.

### 2.2.4 Systems in Americas

The Toronto Subway opened in 1954. One experimental trainset consisted of the first aluminum subway cars, which reduced weight and therefore operating costs. With the next car order in 1963, only aluminum was used. The new cars, at 75 feet/23 m, were at the time the longest in the world. The Montreal Metro, was the second subway system in Canada and was inaugurated in 1966 as part of Expo 67 that would be held in Montreal.

In Brazil, the first underground opened in 1974 in nation's largest city and economical "capital" São Paulo, and now well busily carries some four million passengers on an average weekday as part of the São Paulo Metro. Part of it consists of converted older railways; some of its stations actually date from the 1880s. Underground lines have been built also in Rio de Janeiro, Belo Horizonte, Recife, Porto Alegre and capital Brasília.

Metro de Santiago is the metro system serving Santiago, the capital of the Republic of Chile. It is a network of five lines with a total of 85 stations, and the only South American rubber tired metro.

Non-capital Medellín, Colombia is served by one of the few profitable metro systems in the world. Operated by the Metro de Medellin Company, moves less than 500.000 passengers a day. This system operates in elevated infrastructure in downtown area and on-level parallel to the river. The construction of the system had astronomical cost overrun that lead to a great public debt, that still is in the budget.

Bay Area Rapid Transit (BART) in the San Francisco Bay Area and The capital's Washington Metro in Washington, D.C. opened in 1972 and 1976 respectively, as part of changing attitudes towards transportation in the United States, leading to subway and LRT systems opening in many cities that had done without.

The most recently completed fully underground heavy rail metro line in North America is the LACMTA Red Line in Los Angeles, which goes from Union Station in downtown Los Angeles, through the mid-Wilshire area, East Hollywood, central Hollywood, and ending 17 miles away in North Hollywood in the San Fernando Valley.

*Figure 2.3 LACMTA*

## 2.2.5 Systems in Asia

Asia's first cities to have subway lines were Tokyo in 1927 and Osaka in 1933. Other major Japanese cities with subway systems are Yokohama, Sapporo, Kobe, Kyoto, Fukuoka, and Sendai.

China's first subway system, Beijing subway, began operation in 1969 only. Tianjin (1984), Shanghai (1993), Guangzhou (1997), Wuhan

(2004), Shenzhen (2004), Nanjing (2005), Dalian (2005) and many other cities also have rapid transit systems in operation.

*Figure2.4 Beijing subway*

In 1979, now Chinese Hong Kong's subway line, the MTR, began operations. It currently has nine lines, including four that run underneath Victoria Harbour. By 1982, the British section of the Kowloon-Canton Railway, then known as KCR East Rail, started to provide metro-like service upon electrification was completed. 2007 saw the merger of KCR into the MTR system.

India is rapidly expanding their urban rail systems as well and notable that first rapid systems appeared not in capital. India's oldest usual metro is in Kolkata preceded by elevated rapid transit Chennai MRTS. Capital Delhi was the third only. Other cities like Mumbai, Bengaluru, Chennai, Hyderabad carries a construction of metros. Recently Patna and some other cities has hired engineers and civil planners to find a location of future metro lines.

Since 1974, a number of cities in South Korea have also developed modern and extensive subway systems. The largest, Seoul, has twelve lines over approximately 314 km of track. Busan, Daegu, Incheon, Daejeon and Gwangju also have subway systems. Seoul & Incheon is connected by metro.

Pyongyang in communist North Korea notably has a well adorned and deep metro with non-geographical names of stations (unique in the world) and was built to serve as a bomb shelter in case of a war.



### 2.2.6 Systems in Africa

Cairo since 1987 is the first African city with a metro system, partly converted from a railway line. It is currently under development. Modern tram system of Tunis called metro but is not a rapid transit. Second African metro will be Algiers. Pretoria, Lagos and some other African cities has plans for building a metro network.

*Figure 2.5 Cairo Metro*

# 3. MUMBAI METRO PROJECT

The Mumbai Metro is a 3-phase project which is to be built over a period of 15 years. When complete, the core system will comprise three high-capacity metro railway lines, spanning a total of 63 kilometres. 1 line is currently operational and 2 more lines are being planned.

## 3. 1 Need of Metro

Metro will reduce travel time on the 12-km Versova-Andheri-Ghatkopar corridor to 21 minutes as against 71 minutes that it takes to cover the stretch by road.

Areas which would benefit from metro connectivity have already seen a price appreciation of 400 per cent over the past eight years, and this trend is set to continue with the metro railway link's imminent launch.

Metro system is much preferred in any city for their high-capacity and attractive features. They move fast and are environment-friendly. With this, the metro trains offer excellent financial viability.

Mumbai's first metro railway link, which connects the north-western suburb of Versova-Andheri with Ghatkopar on the north-eastern fringe soon, is expected to be a game changer for the mega polis' realty landscape, property consultant Jones Lang LaSalle (JLL).

According to JLL, surrounding regions would definitely experience a boom in terms of new offerings and price hikes, since developer’s interest here has increased.

Maharashtra government was looking for the means to better the traffic and transportation scene in Mumbai. The government wanted to come up with something that would meet the future travel needs of the commuters well. It was this exploration of idea that brought the various options of mass transit system in the picture. A detailed study was done in this area under the guidance of Indo-German Technical Co-operation by assigning the consultancy work to TEWET in alliance with DE-Consult and TCS in the year 1997-2000. A mass transit passage from Andheri to Ghatkopar was recommended in the study. Meanwhile, DMRC (Delhi Metro Rail Corporation) chalked out the master plan for Mumbai metro, suggesting an extension of Andheri-Ghatkopar route to Versova. Subsequently, the construction work of the metro system in Mumbai gained pace and was performed under the Public Private Partnership (PPP) format.

If considered from the point of view of Mumbai, the metro system is much needed for following reasons:

1. Several pockets in the city and its suburban areas are not connected by rail-based mass transit system
2. For the protection of environment
3. Limitations that are faced in the expansion of road network
4. Present rail and road scenario not apt for future travel needs
5. The role of bus system is limited in the area of offering feeder services to railways
6. Bus network alone cannot match the future travel demands

Hence, in order to meet these challenges and to make traveller's journey smooth and fast, the metro system in Mumbai has been planned. Besides, for the convenience of the passengers, elucidative Mumbai metro map has also been prepared.

Mumbai Metro is going to run on a dedicated elevated corridor and shall have highest levels of comfort for the passengers viz. fully air-conditioned world class coaches, provision for lifts and escalators at stations, modern automatic fare collection system, highest levels of passenger security systems etc.

Some of the attractive and technical features of the Mumbai metro system are mentioned below:

- Four or Six Coaches
- Single class
- Air conditioned
- 80 kmph maximum speed
- 33 kmph average speed
- m/sec2 acceleration
- 1.2 m/sec2 deceleration
- 1500 accommodation capacity
- 60,000 pphd system capacity
- Automatic Ticket Collection
- Train control with Driver
- Operation Control Centre
- Closed Circuit Television
- Dynamic visual displays and loudspeakers

In a day, 200-250 services will be completed, accommodating about 11 lakh passengers. Daily its operations will commence from 5.30 am to midnight.

Thus, a metro was a solution which Mumbai needed for speed, comfort and safety of Mumbai travelers.

## 3.1 Blueprint of the Metro

This project has been divided into 3 parts: Line 1, 2 and 3. Line 1 connects Versova and Ghatkopar, Line 2 connects Dahisar and Mankhurd, and Line 3 connects Colaba and SEEPZ.

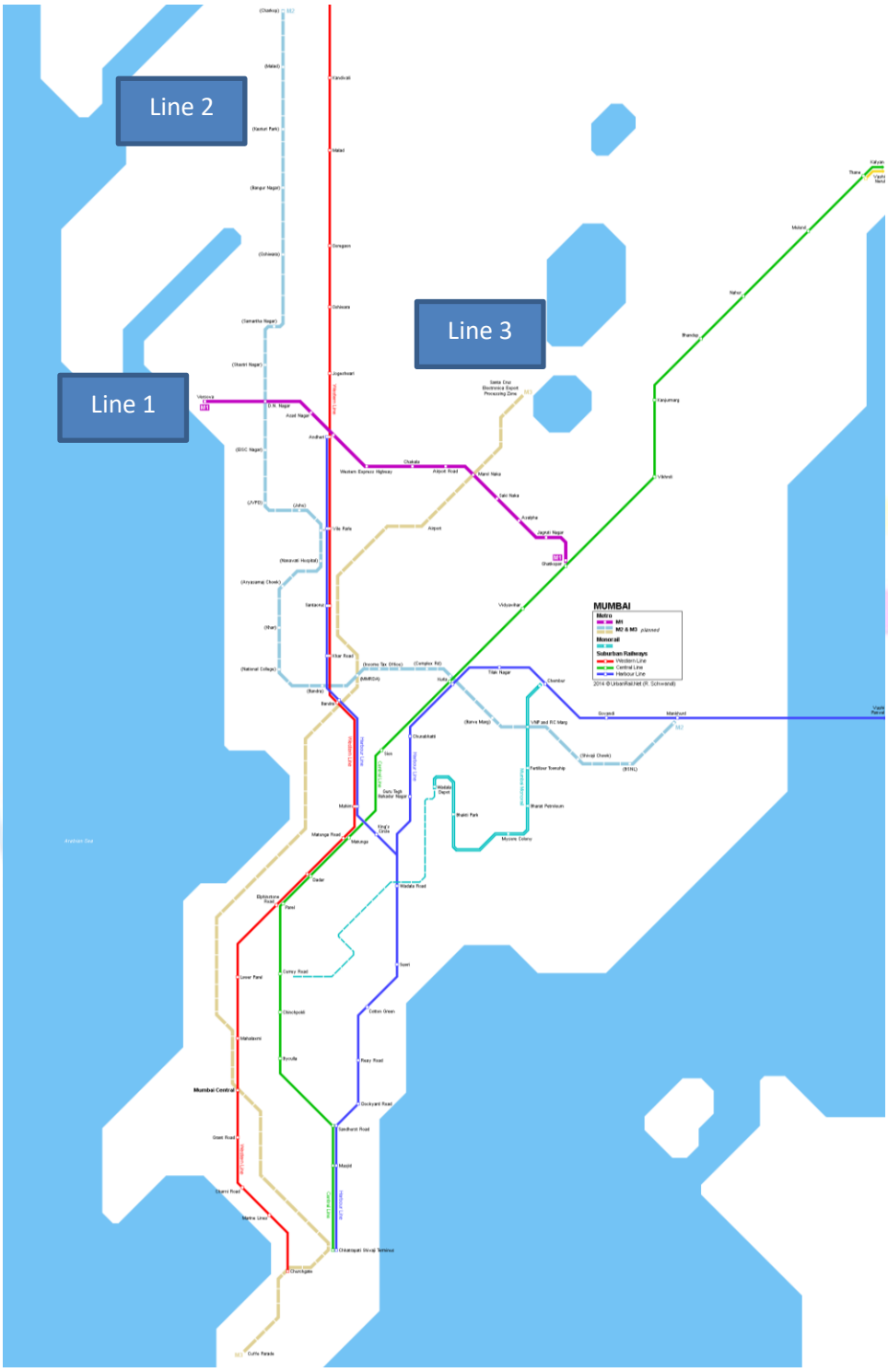


*Figure 3.1Railway System of Mumbai*

### 3.1.1 Line 1


*Figure 3.2 A map showing Line 1*

Line 1 connects Versova and Ghatkopar via Andheri. It is an 11.40 km fully-elevated line, consisting of 12 stations. It connects the eastern and western suburbs of Mumbai.

Line 1 is operated by Mumbai Metro One Pvt Ltd (MMOPL). The MMOPL is a joint venture company owned by Reliance Infrastructure, Veolia Transport and the Mumbai Metropolitan Region Development Authority (MMRDA).

The first metro service was flagged off by Maharashtra Chief Minister Prithivraj Chavan, along with Reliance Chairman Anil Ambani and wife Tina Ambani, on 8 June at 10:10 am from Versova station. As of August 2014, it has a daily ridership of 300,000-500,000 people. Prior to the Metro, it took about 71 minutes to reach from Versova to Ghatkopar. Now it only takes 21 minutes.

Here are some details of this line:-

| | |
|---|---|
| **Project Name** | Versova-Andheri- Ghatkopar Metro Corridor |
| **Format** | PPP (Public Private Partnership) |
| **Construction period** | 2008-2014 |
| **Total cost** | 2,356 crore |
| **Route Length:** | 11.4 km (elevated) |
| **Stations:** | 12 |
| **Tracks:** | 2 |
| **Track Gauge:** | 1,435 mm (4 ft 8 1⁄2 in) |
| **Minimum Radius:** | 100 metres (330 ft) |
| **Electrification:** | 25 kV AC at 50 Hz via overhead catenary |
| **Platform Length:** | 135m (6 coaches) |
| **Car Depot location:** | DN Nagar |
| **Coach Length:** | 22m |
| **Maximum Speed:** | 80 kmph |
| **Average Speed:** | 35 kmph |
| **Seating arrangement:** | Parallel to coach |
| **4 coach capacity:** | 1178 passengers |
| **6 coach capacity:** | 1792 passengers |
| **Estimated ridership:** | 6.65L passengers per day |
| **Environment in coach:** | Air Conditioned |
| **Ticketing System:** | Automatic Collection |
| **Interchange facilities:** | Andheri (Western, Harbour Railway)<br>Ghatkopar (Central Railway)<br>DN Nagar (Line 2)<br>Marol Naka (Line 3) |

The contract for the Versova–Andheri–Ghatkopar corridor was awarded to the Mumbai Metro One Pvt Ltd (MMOPL), a joint venture company owned by Reliance Infrastructure, Veolia Transport and the MMRDA, in March 2007. Simplex Infrastructure Ltd was the main technical contractor.

| Package | Awarded to |
|---|---|
| Civil Works – Viaduct | Simplex Infrastructure Ltd |
| Civil Works – Stations | Sew Infrastructure Ltd |
| Civil Works – Special Bridges | |
| Civil Works – Depot Earthworks | Shyam Narayan & Bros |
| Rolling stock | CSR Nanjing |
| Signalling system | Siemens |
| Power Supply Traction & SCADA | ABB |
| E&M | |
| Communication system | Thales |
| Trackwork | VNC Rail One |
| Automatic Fare Collection | Indra |
| Escalators | Schindler |
| Lifts | OTIS |
| Depot Machinery & Plant | Awarded to various suppliers |
| Depot Civil Works | Ahluwalia Contracts (India) Ltd. |

The foundation stone for the project was laid by the then Prime Minister Manmohan Singh on 21 June 2006, and the work order for the same was issued on 21 January 2008, but actual work on the corridor began only on 8 February 2008.At the time of commencement of work, MMOPL stated that it aimed to complete the project in a record 30 months, although the concession agreement specified the period of construction to be five years. In September 2011, MMOPL officials claimed that trial runs on the first section of the corridor, the 3-km Versova–D.N. Nagar–Azad Nagar stretch, would start by February 2012, with a view to opening the stretch to commuters by March or April 2012.The deadline for completion of Line 1 has been shifted several times. The following months have all, at some point of time, been announced as the deadline for completion of the project - July and September 2010, July 2011, March and November 2012, September 2013 (Phase 1: Versova to Airport Road) and December 2013 (Phase 2: Airport Road to Ghatkopar), and 31 March 2014. According to the MMRDA, the main causes for the delays were shifting the utility services, absence of the right of way due to encroachments and obtaining permission from the railway authorities.

The MMOPL blamed the delay in construction on the MMRDA. RInfra officials stated that the MMRDA had to acquire land along the route and provide "right of way" to the MMOPL by December 2008. Although it was supposed to have been given a 59% right of way with land free of encumbrances, the MMOPL started work with right of way being made available only on 45% of the land. As of August 2008, the MMRDA had only freed up 20% of required land. The lack of maps of underground utilities made the task more difficult. As per the contract between the MMOPL and the MMRDA, the MMRDA was supposed to hand over complete right of way to the MMOPL by mid-2008. The MMOPL eventually received nearly 100% of the land required for the project in December 2011, with the exceptions of the minaret of a mosque near Andheri metro station and a portion of the roof of Maheshwar Temple near Jagruti Nagar station that still needed to be demolished. Both impediments were resolved in October 2012 and the MMRDA finally obtained 100% right of way along the entire alignment of Line 1.

*Figure 3.3 Marol Naka Station Under Construction*

By October 2011, the majority of the corridor's track-support pillars and girders had been laid, and the 12 individual stations were 70% complete, with most of the stations rising above platform level. However, land acquisition and right-of-way issues, along with problems with the construction of a Metro-related viaduct, delayed the line's predicted completion to summer 2012.

On 1 May 2013, a successful 2 km trial run from Versova to Azad Nagar stations was conducted on Line 1 in the presence of Maharashtra Chief Minister Prithviraj Chavan, who stated that the line would open to the public from September 2013. However, MMRDA officials told Business Standard in August 2013 that the metro would be delayed further as it had not received approval from the Central Railway Safety Commissioner, and also did not complete various amenities, including lifts, staircases, canteen and seating arrangement for commuters. The first major trial run on Line 1, began at 6:45pm IST on 3 June 2013 from Versova station, and covered the 7 km stretch to Airport station by 7:05pm, according to MMRDA additional commissioner S.V.R. Srinivas, who was on board the train. Trial runs had been conducted for the past month, the most notable being the trial run on 1 May 2013, that was officially flagged off by

the Chief Minister. However, trials prior to the June 3 trial, were restricted to the three kilometres between Versova and Azad Nagar stations on JP Road.

Seven metro trains ran the full stretch of Line 1 on 6 December 2013 at high speed to conduct "system integration" checks. The trial run was the first time that several trains ran back-to-back on Line 1. The trains maintained a frequency of three to three-and-a-half minutes and achieved the precision timing of 21 minutes for the full run. MMOPL officials stated that the trial was conducted to check the speed and reliability of the trains, and also the working of the control systems, signals, energy-efficient lighting system, on-board passenger announcement system and train-to-control-room radio communication system. They also tested whether trains stopped properly at platforms and doors opened as desired. Several more tests were conducted before the metro opened to the public.According to the information given by the MMRDA to a Right to Information (RTI) query filed by activist Anil Galgali, around 5% of the civil works of the line were still pending as of December 2013. The reply to the RTI query stated that Versova, D.N. Nagar, Azad Nagar, Chakala and Airport Road stations were 99% complete as of December 2013. Andheri, Saki Naka, Marol and Western Express Highway stations were in the range of 95-98%. Construction work at Ghatkopar was 90% complete, Asalfa and Jagruti Nagar stations were 80% and 85% complete respectively.

*Figure 3.4 A Metro trial in December 2013*

On 6 February 2014, RInfra announced that construction of the metro line had been completed, along with signal testing and system integration. It also stated that it had already received approvals from relevant authorities including the fire department, and electrical inspector general. However, the construction of approach roads to stations such as Jagruti Nagar and Asalfa Road had not been completed, although this work was to be undertaken by the MMRDA, and not MMOPL. Engineers used over 210 different designs to construct the pillars on the corridor. The MMOPL along with the Mumbai Fire Brigade and the Mumbai Police jointly conducted a fire mock drill successfully at the Airport Road station on 14 March 2014. The purpose of the mock drill was to assess the preparedness of the three agencies in case of an emergency. The drill was the last one conducted as part of a joint Central Disaster Management Plan, prepared through MCGM to take care of passengers and property in situation of eventuality. During trials in mid-March 2014, the Mumbai Metro ran time-tabled trains at a headway of almost 4 minutes. The trials were a part of reliability, availability, maintainability and

sustainability (RAMS) tests that are a part of any normal railway operations network.

A 10-member team of the Research, Design and Standards Organisation (RDSO) began conducting oscillation trials along the entire 11.4-km stretch of Line 1 on 31 January 2014. The trials included study of train behaviour like acceleration and deceleration, suspension, emergency brake distance and track parameters, and adherence to safety and technical specifications.Oscillation trials were conducted to test the track-worthiness of new or modified design of rolling stock. Emergency braking distance trials aim at testing the braking potential.MMOPL stated that the trials were completed in a record time of 11 days, much ahead of the RDSO's scheduled time of 22 days. After completing the tests, the RDSO had to submit it's report to the Chief Commissioner of Railway Safety, Lucknow for final certification, after which the MMOPL could approach the Commissioner of Metro Railway Safety (CMRS) for safety trials.However, the submission of the report by the RDSO was delayed a public interest litigation (PIL) filed in the Bombay High Court on the height of Mumbai Suburban Railway station platforms. The RDSO had to divert its resources to inspect the suburban railway platforms, due to commuters falling into the gap between the platform and the trains. The MMOPL was granted a "speed certificate" from the RDSO on 2 April. MMRDA and MMOPL authorities jointly applied to the CMRS for safety certification on April 4.

Then CMRS for the western circle P.S. Baghel began physically inspecting the line on 18 April, and completed it on 28 April. Baghel inspected the entire metro system including the rolling stock, workshops, depot, operation control centre, corridor, stations, tracks and overhead equipment. Following the inspection, Baghel concluded, "Prima facie, I found all the constructions and specifications of the Metro quite satisfactory, but there are a few finishing works remaining which would be taken care of very soon."The CMRS required certain minor changes such as levelling of the access area at the Jagruti Nagar station (towards Ghatkopar), and improving the quality of elevators and stairs. These conditions had to be accepted and implemented before the metro could begin operations.The CMRS also stated that he would travel to Lucknow to discuss the inspection with RDSO officials and then cross check all the other necessary approvals, including rolling stocks, from the Railway Board. The line received safety clearance from the CMRS on 2 May 2014.On the same day that the CMRS awarded the certificate for commercial operation, the MMRDA in reply to an RTI query stated that 98% of the project work was complete and some minor works were still in progress. The MMOPL clarified that the RTI information provided by MMRDA was based on the monthly progress report of January 2014, and that all

project works had been completed as had been announced in February.

The CMRS safety check is the last statutory certification requirement before the line is opened to the public.However, the MMRDA had to also obtain approval for the locomotives from the railway board. The Congress-NCP government had wanted to open the line by 24 April 2014, the voting day in Mumbai for the 2014 general elections, with Chief Minister Prithviraj Chavan, who was also the MMRDA chairperson, especially keen on the date. Congress candidates Gurudas Kamat and Priya Dutt, and NCP candidate Sanjay Dina Patil also wanted the line to open then, so as to gain political mileage.The MMOPL approached the Railway Board for approval of rolling stock (includes the rakes and wheel) on 22 April. MMRDA and MMOPL officials stated that the line would open within 7 days of receiving approval from the Railway Board. Despite the MMOPL submitting the necessary paperwork on 22 April, the Railway Board did not grant approve until late May 2014. According to railway officials, this was because the rakes and wheels used in the metro were "of a new kind, with newer dimensions", and required close inspection. Another reason given for the delay was the change of government at the Centre following the 2014 general elections. Railway Minister D.V. Sadananda Gowda gave the final approval on 5 June. MMOPL Chief Executive Abhay Mishra announced on 7 June that the metro would open the following day.

Even prior to the opening of the metro line, pedestrians, commuters and some media outlets expressed major concerns about the dispersal of pedestrian and vehicular traffic under the metro stations. This prompted the MMRDA to take up the development of Station Area Traffic Improvement Scheme (SATIS) throughout the route. A key proposal of the SATIS was the integration of the metro rail system with the BEST. The BEST and the BMC jointly worked towards relocating existing bus stops. Dedicated bus stops were built, and BEST bus feeder routes were created along the metro corridor. These stops have indicators that flash timings of next metro train's arrival. Similarly, indicators were provided inside the metro coaches that flash information about BEST bus routes for onward journey from respective stations. The MMRDA widened the 1.8 m-2.5 m footpaths below metro stations by an additional 1.5 metres, and declared a 330 metre area around the stations as a "Metro-Influence-Zone" where illegal parking and hawking are prohibited. The Mumbai traffic police will ensure that there is no illegal parking around the station areas, and the Municipal Corporation of Greater Mumbai (MCGM) will prevent illegal hawking along the metro stations.


*Figure 3.5 CM Prithvraj Chauhan and Anil Ambani posing for the media at Andheri, July 2014*

The first metro service was flagged off by Maharashtra Chief Minister Prithivraj Chavan, along with Reliance Chairman Anil Ambani and wife Tina Ambani, on 8 June at 10:10 am from Versova station. Chavan's appearance at the inauguration came despite the fact that he had threatened to boycott the ceremony the previous day to protest RInfra's decision to raise fares.

## 3.1.2 Line 2

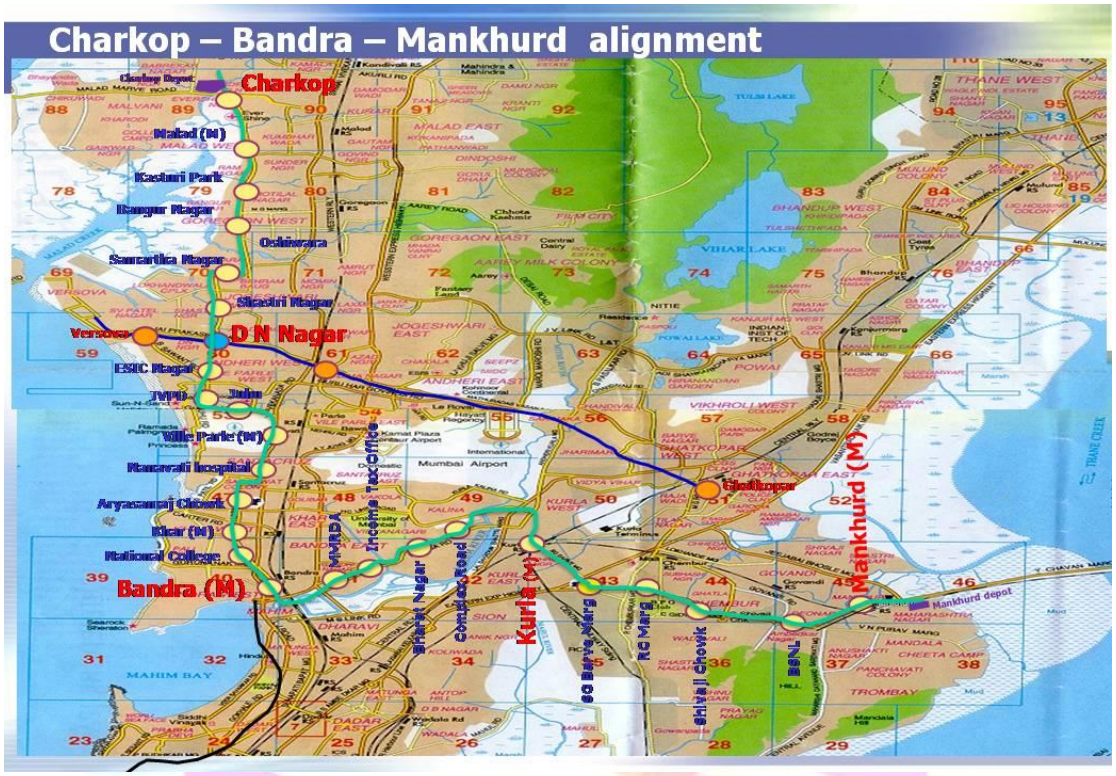


*Figure 3.6 Map showing Line 2*

The Charkop-Bandra-Mankhurd Corridor of Mumbai MRTS begins from the Northern Suburbs of Mumbai at Charkop and stretches up to Mankhurd (via Bandra and Kurla) in the East. The route length of the Corridor is 31.87 km. This corridor is planned as elevated for its entire length having 27 Metro Stations. Car Shed facilities have been planned at both ends of corridor at Charkop and Mankhurd. Construction has not started yet as it is in the planning stage.

The 27 metro stations are : Charkop, Malad, Kasturi Park, Bangur Nagar, Oshiwara, Samartha Nagar, Shastri Nagar, DN Nagar, ESIC Nagar, JVPD, Juhu, Vile Parle, Nanavati Hospital, Aryasamaj Chowk, Khar, Bharat Nagar, National College, Bandra, MMRDA, Income Tax Office, Complex Road, Kurla, Bavre Marg, RC Marg, Shivaji Chowk, BSNL, and Mankhurd.

Here are some details of this line:-

| | |
|---|---|
| **Project Name** | Charkop – Bandra – Mankhurd Corridor |
| **Format** | PPP (Public Private Partnership) / BOT (Built Operate Transfer) |
| **Project Implementing Agency** | Govt. of Maharashtra / Mumbai Metropolitan Region Development Authority / Mumbai Metro Rail Corporation |
| **Total cost** | Rs. 7660 Cr. |
| **Route Length:** | 31.871 (elevated) |
| **Stations:** | 27 |
| **Tracks:** | 2 |
| **Track Gauge:** | 1,435 mm (4 ft 8 1⁄2 in) |
| **Minimum Radius:** | 100 metres (330 ft) |
| **Electrification:** | 25 kV AC at 50 Hz via overhead catenary |
| **Platform Length:** | 135m (6 coaches) |
| **Car Depot location:** | Charkop<br>Mankhurd |
| **Coach Length:** | 22m |
| **Maximum Speed:** | 80 kmph |
| **Average Speed:** | 35 kmph |
| **Seating arrangement:** | Longitudinal |
| **4 coach capacity:** | 1178 passengers |
| **Estimated ridership:** | 6.65L passengers per day |
| **Environment in coach:** | Air Conditioned |
| **Ticketing System:** | Automatic Collection |
| **Interchange facilities:** | Bandra (Western, Harbour Railway)<br>Kurla (Central Railway)<br>DN Nagar (Line 1)<br>Marol Naka (Line 3)<br>V. N. Purav Marg (Mono Rail-Line 1)<br>Mankhurd (Harbour Line) |

Here is the present status of Line 2:-

- Government of Maharashtra (GoM) accorded approval to the bid document on 26thMarch, 2009.
- Urban Development Department, GoM on 31st July, 2009 published Gazette Notification under Tramways Act, 1886 for this corridor.
- In its 125th meeting held on 3rd August, 2009, Authority approved the Project.
- Bhoomi-pujan ceremony was held on 18th August, 2009 by Her Excellency President of India.
- Special Purpose Vehicle (SPV) "Mumbai Metro Transport Pvt. Ltd." (MMTPL) incorporated on 29th October, 2009.
- Concession Agreement between GoM and MMTPL has been signed on 21st January, 2010.
- GoM vide Govt. Resolution dated 22nd October, 2010 nominated Mumbai Metro Rail Corporation Ltd. (MMRC) as the Project Implementing Agency (PIA) for this project.
- MMRC gave approval for alignment & station locations and handed over Right of Way (RoW) for 19 km.
- Western Railway, Central Railway, Public Works Department, Airport Authority of India and Roads & Traffic Department of Municipal Corporation of Greater Mumbai have granted the in-principle approval with conditions.
- Ministry of Environment and Forests (MoEF) has granted Coastal Regulation Zone (CRZ) clearance the alignment and Metro Car Sheds with conditions on 20th December, 2011. In spite of all preliminary work completed by Concessionaire; the Concessionaire expressed inability to start the work due to the two critical conditions laid down by MoEF such as no work is permitted in CRZ except stabling which should be constructed on stilts with gaps / open spaces to be provided in between for proper sunlight and ventilation.
- MMRDA/MMRC is persuing with MoEF for allowing washing, repairing and maintenance outside CRZ –I area in Car Shed.

### 3.1.3 Line 3


*Figure 3.7 A Map showing Line 3*

Metro Line 3 (Colaba – Bandra – SEEPZ) will be 32.50 km long and fully underground with 27 stations. It connects major CBDs of Nariman point and Bandra-Kurla Complex, Domestic and International Airport and industrial areas of MIDC and SEEPZ. It will connect various areas in island city that are not served by Suburban Railways - Kalbadevi, Worli, Prabhadevi, Airport area and Andheri (E).

The project is funded by Japan International Co-operation Agency (JICA) who will provide loan assistance to the tune of Rs. 13,235 cr. The rest of the expenditure will be made available by Govt. of India, Govt. of Maharashtra/ MMRDA in the form of equity and subordinate debt and funds from MIAL.

Here are some details of this line:-

| | |
|---|---|
| **Project Name** | Colaba – Bandra – SEEPZ Metro Corridor |
| **Format** | Engineering, Procurement and Construction (EPC) |
| **Project Implementing Agency** | Mumbai Metro Rail Corporation |
| **Total cost** | Rs. 23,136 cr. |
| **Route Length:** | 32.5 km (Fully Underground) |
| **Stations:** | 27 |
| **Tracks:** | 2 |
| **Track Gauge:** | 1,435 mm (4 ft 8 1/2 in) |
| **Minimum Radius:** | 100 metres (330 ft) |
| **Electrification:** | 25 kV AC at 50 Hz via overhead catenary |
| **Platform Length:** | 185m (8 coaches) |
| **Car Depot location:** | Aarey Colony |
| **Coach Length:** | 22m |
| **Maximum Speed:** | 80 kmph |
| **Average Speed:** | 35 kmph |
| **Seating arrangement:** | Longitudinal |
| **8 coach capacity:** | 2278 passengers |
| **Estimated ridership:** | 13.65L passengers per day |
| **Environment in coach:** | Air Conditioned |
| **Ticketing System:** | Automatic Collection |
| **Interchange facilities:** | Churchgate, Grant Road, Mumbai Central, Mahalaxmi & Mahim (Western Railway)<br>CST (Central Railway)<br>Marol Naka(Line 1)<br>Income Tax Station (Line 2)<br>Sant Ghadge Maharaj Chowk (Mono Rail-Line 1) |

The status of line 3 is:-

- The Central Cabinet accorded approval for the project on 27th June 2013.
- Loan Agreement signed by JICA on 17th Sept 2013
- The project is notified under Metro Act by MoUD on 18th Sept 2013.
- The process for appointing General Consultant (GC) and Pre-Qualification of contractor for civil works is in progress.
- The project is expected to finish around 2021.

# 4. INFRASTRUCTURE OF LINE 1

This chapter discusses the various facilities and the features of Mumbai Metro Line 1 (Versova-Anheri-Ghatkopar)

## 4.1 Metro Trains

A locomotive or engine is a rail transport vehicle that provides the motive power for a train. A locomotive has no payload capacity of its own, and its sole purpose is to move the train along the tracks. In contrast, some trains have self-propelled payload-carrying vehicles. These are not normally considered locomotives, and may be referred to as multiple units, motor coaches or railcars. The use of these self-propelled vehicles is increasingly common for passenger trains, but rare for freight. Mumbai metro basically has these kind of locomotives.

Some of the advantages of multiple units are as follows:

**Energy efficiency**

Multiple units are more energy efficient than locomotive-hauled trains and more nimble, especially on down grades, as much more of the train's weight (sometimes all of it) is placed on driven wheels, rather than suffering the dead weight of unpowered coaches.



**No need to turn the locomotive**

Many multiple units have cabs at both ends; therefore, the train may be reversed without uncoupling/re-coupling the locomotive, providing quicker turnaround times, reduced crew costs, and enhanced safety. In practice, the development of driving van trailers and cab cars has removed the need for locomotives to run-around, giving easy bi-directional operation and removing this MU advantage.

**Reliability**

Multiple unit trains have multiple engines, where the failure of one engine usually does not prevent the train from continuing on its journey. A locomotive drawn passenger train typically has only a single power unit; the failure of this single unit temporarily disables the train. However, as is often the case with locomotive hauled freight trains, some passenger trains utilize

multiple locomotives, and are thus able to continue at reduced speed after the failure of one locomotive.

Six international firms - Siemens, Bombardier, Alstom, Rotem-Hyundai, Chunyun, and Nippon Sharyo - were shortlisted to provide rolling stock for the line, but CSR Nanjing was ultimately chosen to supply rolling stock.CSR Nanjing was awarded a contract in May 2008 to supply 16 trains of 4 cars each for a total fee of INR6 billion (equivalent to INR9.1 billion or US$150 million in 2014). The design of the rakes is derived from the Chinese domestic Type A design, with the stainless steel body widened by 200 mm to increase capacity by 72 to 390 passengers. These trains were CSR's first 25 kV AC metro trains, and the first metro trains to be built in China for India. The first rake was shipped from Shanghai on 23 March 2010, and the last rake arrived at Mumbai port by the end of February 2014.

*Figure 4.1 A Locomotive arriving from China, 2010*

Line 1 was allotted 64 coaches, making up a total of 16 four-coach trains of which 14 operate on the line. The remaining two trains are kept on standby - one in maintenance standby (cold standby) which is in the yard and the other on operation standby (hot standby) which is the line. All coaches are air-conditioned and have humidity control, and designed to reduce noise and vibration. Each coach is approximately 2.9 metres (9.5 ft) wide and has 48 seats. A coach has a capacity of 375 passengers, and a single four car train has a total capacity of 1500 passengers. The coach body is made of lightweight stainless steel, with fire resistant metal doors. Coaches have metallic silver colour exteriors, and can be covered with vinyl sheets to display advertisements. The interior features anti-skid floors, and longitudinal seats with dedicated space to accommodate wheelchairs. Trains on Line 1 are fitted with the VTS Firetide 7010 video transmission system. Coaches are also fitted with LED displays showing dynamic route map, and LCD TVs for entertainment, information and advertising. Windows in coaches are made of double glazed laminated glass to shut out noise. Each coach has 8 externally hung, sliding bi-parting doors except the pilot cabin which has only 2. Doors are broad to enable wheelchair access. The maximum gap between the station platform and the doors is 85 mm. Trains are outfitted with a number of features for safety and convenience, including 3D route maps, first-aid kits, fire-fighting equipment and intercom systems permitting communication with the train driver. Passengers can press a button inside each coach to directly communicate with the train pilot in case of an emergency. Each coach also contains a black box to assist in accident investigations.

The rolling stock is cleaned daily in an automated washing plant utilizing eco-friendly technology. The washing plant lies on the track leading into the depot, and can be used by all trains entering or exiting the depot. The plant pre-wets the coaches, before mixing the chemicals in water. It then cleans takes 3 minutes to clean the coaches evenly from all sides. According to an MMOPL official, "The only action the Metro pilot will have to take is slow the train down to under 5 kmph while in the passage of the plant. Any train that does not need to be washed will pass the automated wash plant without any hindrance by moving at a speed of more than 5 kmph. A panel displays all data like the number of trains washed, the process a train is going through, the water and the chemical indicator. The trains can be cleaned in less then three minutes with just 600 litres of water, of which 80% is recyclable." Manual washing with pressure pipes would require 3 hours and 3,000 litres of water. The entire train can be washed in one pass due to precise brush arrangements. Reverse osmosis removes stains on glass and the smell left after washing, at the final stage of the plant. According to the MMOPL, the process uses no acid, less water and a chemical-free, natural and water-based detergent.

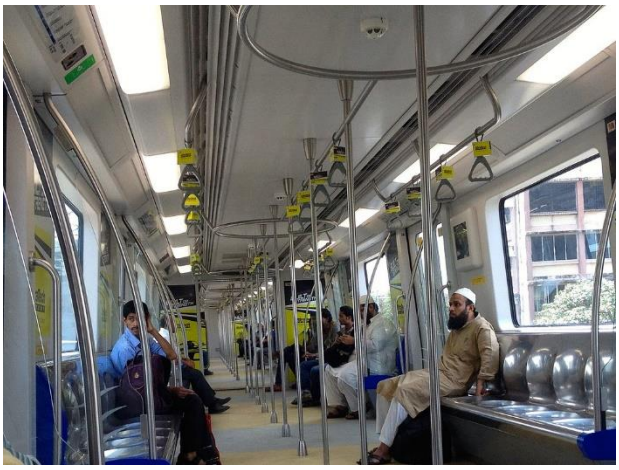

*Figure 4.2 Interior of a Mumbai Metro Train*

If a metro train pilot is incapacitated due to any reason, a "dead man device" is activated within a few seconds bringing the train to a halt. A train pilot also has the option to switch the train to auto mode in case he/she is unwell. The Operation Control Centre (OCC) immediately receives information that the train has stopped between stations, and will dispatch a station controller to the stalled train, who can then drive it to the next station. The OCC will also control the movement of other trains on the same line to avoid any accidents.

## 4.2 Power, Signal and Communications

The ABB Group was awarded the contract for supplying power systems to Line 1 on 31 July 2008. ABB will be responsible for the supply, installation, testing and commissioning of traction electrification, power supply, power distribution and SCADA system for the first metro corridor. A 30 metre neutral section has been provided between the Chakala and Airport Road stations to ensure uninterrupted power supply. This neutral section divides the entire overhead equipment section into two parts - one from Versova to the neutral section at Chakala station, and the other from Ghatkopar to the neutral section at Airport Road station - and makes them function independently. Power, at 25,000V, is fed from the D.N. Nagar and Marol receiving sub-stations (RSS) for the stretch from Versova to Chakala station, and Ghatkopar to Airport Road respectively. If one RSS fails, the neutral section can be switched on so that either of the substations can run the entire line. Diesel generator sets of 180KV capacity are provided at each station to run the essential load during power failure. Diesel generator sets of 1000KV at DN Nagar Depot work station will run the control rooms and the essential load during power failure. The centralised system will help the technical staff restore power supply as soon as possible.

The choice of 25KV alternating current (AC) power supply was criticized by MMRDA director (technical) S P Khade in an article in a railway industry magazine. Khade wrote that the current method of power supply could be dangerous for buildings close to the metro line and a hazard during the monsoon. He also warned that parting of overhead wires and other equipment could be dangerous for those on the road below, as they would hang down from the elevated corridor. He instead favoured 1,500V direct current (DC) power supply, which he claimed was used by 97% of metros around the world. He also argued land required for a DC substation would have been one-third of what is needed for an AC substation, and that DC trains were lighter, leading to higher pick-up speeds, lower power requirements and a lighter load on the elevated structure. Khade explained that he did not take up the issue as MMDRA director, because he claimed that the decision to use 25KV had been made before assumed the post.

Line 1 features an advanced signaling system, including an automatic train protection system (ATPS) and automated signaling to control train movements. Siemens supplied the signalling and train control systems required for the project, while Thales Group supplied the communication systems. The network's signaling and train control systems will be based on LZB 700M technology.

## 4.3 Bridges

Line 1 contains a 1284 metre steel bridge, modeled on the Howrah Bridge in Kolkata, crossing the Western Line at Andheri. It is the first steel-and-concrete bridge over the Mumbai Suburban Railway. Construction of the bridge, which is supported by 3 pillars, started in early 2012 and completed on 23 December 2012. The metropolitan administration claims the bridge was built in 288 days which is a record. It cost INR350 million (equivalent to INR400 million or US$6.5 million in 2014). The bridge was constructed by Braithwaite Burn & Jessop Construction Company (BBJ), Kolkata.

*Figure 4.3 Metro bridge over Western express Highway*

Interestingly, BBJ had also fabricated the Howrah Bridge. Due to restriction in working hours and non-availability of space, the steel girder had to be pre-fabricated at BBJ's Heavy Plant Yard in Kolkata. It was designed such that it could be disassembled during transportation and reassembled at the site when all four columns of the bridge were ready. It took 6–7 days to transport it to Mumbai on a piecemeal basis. The bridge was initially supposed to be made of concrete but due to changes in plans, it was changed to a steel bridge. The bridge faced several challenges - the biggest being building a pillar in the middle of the tracks without restricting train traffic even for a day.

Another notable bridge on Line 1, is the 175 metre long cable-stayed bridge over the Jogeshwari Flyover on the Western Express Highway. The bridge is the first and highest cable-stay bridge for a metro in Asia. It is also Mumbai's second cable-stayed bridge after the Bandra Worli Sea Link. The Jogeshwari flyover is 13 metres above ground level and the metro line travels at a height of 19.5 metres above ground level. The highest point of the bridge is 39 metres above ground level. Construction on the bridge started in mid-2009. It was expected to be completed by April 2010. Due to delays it was completed on 24 August 2012. The bridge was built by MMOPL with the help of Switzerland based, VSL International Ltd. The steel cables which hold and support the bridge are anchored to two Y-shaped pylons that weigh over 1000 tonnes.

The contract for cable stay bridge over the Western Express Highway and two other cantilever bridges over Andheri and Mithi River were awarded to SEW Constructions Limited.

## 4.4 Stations


*Figure 4.4 Versova Station*

Line 1 has 12 stations, with two successive stations being at a distance of about 1 km from each other.

This table shows a list of stations.

| Line 1 | | | |
|---|---|---|---|
| **#** | **Station Name** | **Inter-station distance (km)** | **Connections** |
| 1 | Versova | 0 | None |
| 2 | D.N. Nagar | 0.955 | Line 2 (planned) |
| 3 | Azad Nagar | 0.796 | None |
| 4 | Andheri | 1.36 | Andheri railway station (Western Line, Harbour Line, Indian Railways) |
| 5 | Western Express Highway | 1.007 | None |
| 6 | Chakala | 1.264 | None |
| 7 | Airport Road | 0.725 | None |
| 8 | Marol Naka | 0.598 | Line 3 (planned) |
| 9 | Saki Naka | 1.075 | None |
| 10 | Asalpha | 1.123 | None |
| 11 | Jagruti Nagar | 0.862 | None |
| 12 | Ghatkopar | 1.056 | Ghatkopar railway station (Central Line) |

The following are some of the features, common to all stations:-

1. Ticketing

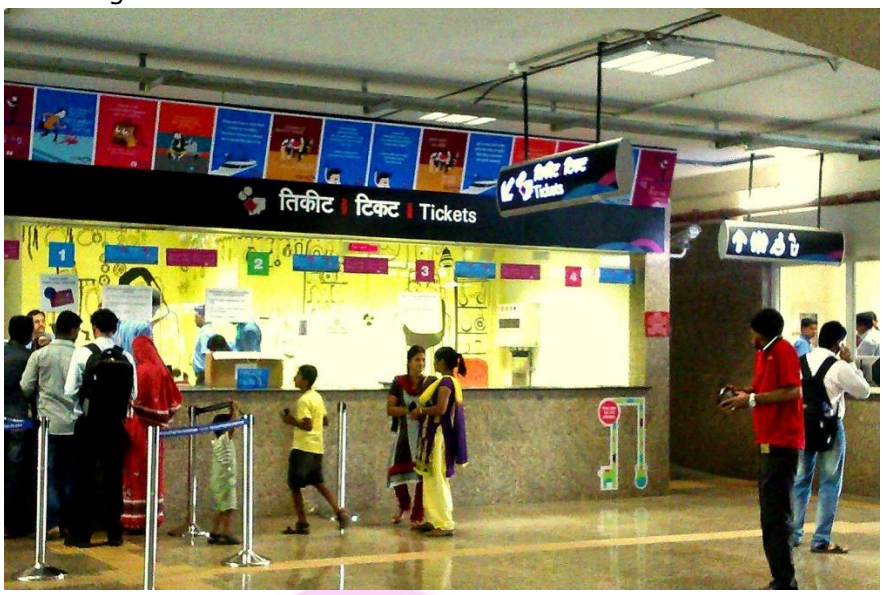


*Figure 4.5 A Ticket window in Saki Naka*

Any person wishing to travel on the Metro Railway shall, upon payment, be issued with a ticket (Token / Smart Card) by Mumbai Metro One Pvt. Ltd. or by an agent authorized by Mumbai Metro One Pvt. Ltd. on its behalf.

The best way to travel on the metro is with a Smart Card. This is an electronic card that can be obtained over the counter from Customer Care of any metro station or authorized channel. Smart Card can be obtained by paying security deposit of Rs.50, Smart Card can be loaded with Store Value Pass or Trip Based Monthly Pass.

The Store Value Pass is an electronic purse with some pre-loaded monetary value as per your choice. Each time you use the metro, the ticket value will be deducted from the monetary value stored in the Smart Card at the exit gate as per fare chart. The minimum recharge value is Rs.100 and maximum monetary value that can be stored is Rs.3000.

Buying a Smart Card will help you save time by avoiding queues at ticket counters.

2. Fares

Initially, a promotional fare of Rs. 10 (one-way) was introduced for adults. Children below the age of 12 could ride for Rs. 5. This offer ended in August 2014. The revised fare is as follows:-

| | V | DN | AZ | AND | WEH | CHK | APR | MAR | SKN | ASA | JN | GHK |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V | | 10 | 20 | 20 | 20 | 30 | 30 | 30 | 30 | 40 | 40 | 40 |
| DN | 10 | | 10 | 20 | 20 | 20 | 30 | 30 | 30 | 30 | 40 | 40 |
| AZ | 20 | 10 | | 10 | 20 | 20 | 20 | 20 | 30 | 30 | 30 | 40 |
| AND | 20 | 20 | 10 | | 10 | 20 | 20 | 20 | 20 | 30 | 30 | 30 |
| WEH | 20 | 20 | 20 | 10 | | 10 | 20 | 20 | 20 | 20 | 30 | 30 |
| CHK | 30 | 20 | 20 | 20 | 10 | | 10 | 10 | 20 | 20 | 20 | 30 |
| APR | 30 | 30 | 20 | 20 | 20 | 10 | | 10 | 10 | 20 | 20 | 20 |
| MAR | 30 | 30 | 20 | 20 | 20 | 10 | 10 | | 10 | 20 | 20 | 20 |
| SKN | 30 | 30 | 30 | 20 | 20 | 20 | 10 | 10 | | 10 | 10 | 20 |
| ASA | 40 | 30 | 30 | 30 | 20 | 20 | 20 | 20 | 10 | | 10 | 10 |
| JN | 40 | 40 | 30 | 30 | 30 | 20 | 20 | 20 | 10 | 10 | | 10 |
| GHK | 40 | 40 | 40 | 30 | 30 | 30 | 20 | 20 | 20 | 10 | 10 | |

**EXPLANATIONS TO THE ABBREVIATIONS USED IN THE ABOVE TABLE FOR VARIOUS STATION NAME:**

**V** – Versova; **DN** – D N Nagar; **AZ** – Azad Nagar; **AND** – Andheri; **WEH** – Western Express Highway; **CHK** – Chakala; **APR** – Airport Road; **MAR** – Marol Naka; **SKN** – Saki Naka; **ASA** – Asalpha; **JN** – Jagruti Nagar; **GHK** – Ghatkopar



3. Facilities

- Escalators have been provided from the road level to the concourse levels and from the concourse level to platform level for the convenience of passengers.

- Elevators have been provided at all the metro stations, especially for senior citizens, differently abled passengers etc.

- Tactile paths are provided for the visually impaired passengers which will guide them from entering the metro station to boarding the train and vice versa.

- Ramps are provided which will be located right next to the elevators to help passengers on wheelchairs to access the elevators.

- Wheelchairs are available on demand at all metro stations to cater to the needs of the passengers.

- First Aid services are available at all metro stations to cater to the needs of the passengers

*Figure 4.6 A Video Transmission System (VTS) is provided in the train so train movement and activities inside the train can be monitored easily.*

- All stations have separate washrooms for ladies, gents and differently abled passengers

- Drinking water is available at all stations for the convenience of passengers.

- Real time updates on train services, timings, disruptions etc shall be provided through the PIDs.

- Real time announcements shall be made through PAS during disruptions, emergencies etc.

- There are emergency evacuation plan signages at all stations which will assist passengers in terms of information required for evacuation during emergencies.

- Signages have been placed at metro stations with information about directions, entry and exits, layouts, utilities etc.

- There are 2 PHPs at platforms which will help the passenger contact the station controller directly in case of an emergency.

- There are 3 ESPs located on each platform. This plunger enables a passenger to stop an incoming train during an emergency.

- Customer Care centers are located at every station. A passenger can acquire all the required information or assistance from these centers.

- ATMs are located at each metro station for the convenience of passengers

- Various food and beverage facilities are available to passengers at all the metro stations.

- Convenience stores are available at all the metro stations.

# 5. Survey

## 5.1 Background of the survey

A survey was conducted at the Metro stations and inside the train on 5th October, 2014. People of all age groups who have used the Mumbai Metro at least once were asked to fill in a questionnaire. The following was our questionnaire:-

Form No:

**Mumbai Metro**

Which stations do you usually use?

☐ Versova ☐ DN Nagar
☐ Azad Nagar ☐ Andheri
☐ Western Express Highway ☐ Chakala
☐ Airport Road ☐ Marol Naka
☐ Saki Naka ☐ Asalpha
☐ Jagruti Nagar ☐ Ghatkopar

Where are you going?

☐ Office ☐ School/College
☐ Social visit ☐ Other _____

How frequently do you use the Metro?

☐ Almost daily ☐ A few times a week
☐ A few times a month ☐ Every now and then

What mode of transport has the Metro replaced?

☐ Rikshaw/Taxi ☐ Bus
☐ Train ☐ Other

Please rate the pricing of the tickets.

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
Disappointing Exceptional

Was the Metro clean?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
Disappointing Exceptional

Was the Metro safe and comfortable?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
Disappointing Exceptional

Why do you like the Metro?

☐ Disabled-friendly ☐ Ease of transport
☐ Air-conditioning ☐ Speed
☐ Comfortable ☐ Other _____

Please rate the overall quality of the Metro.

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
Disappointing Exceptional

Phone/E-mail:

Place of Residence:

## 5.2 Statistical Analysis

Here is the result of individual questions:-

1. Which stations do you usually use?

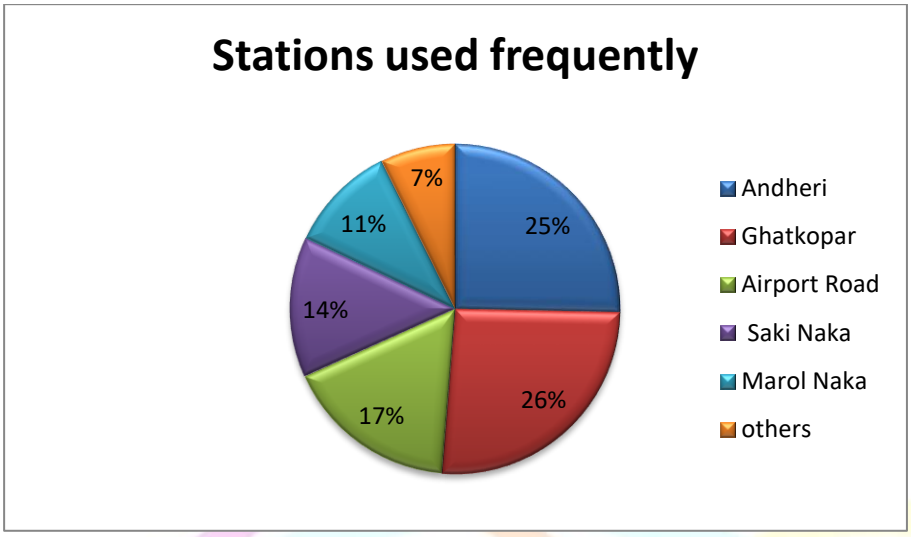


*Chart 1*

This shows that Ghatkopar is most frequently used, followed by Andheri, Airport Road and Saki Naka. It may be because of railway lines at Andheri and Ghatkopar.

2. Where are you going?

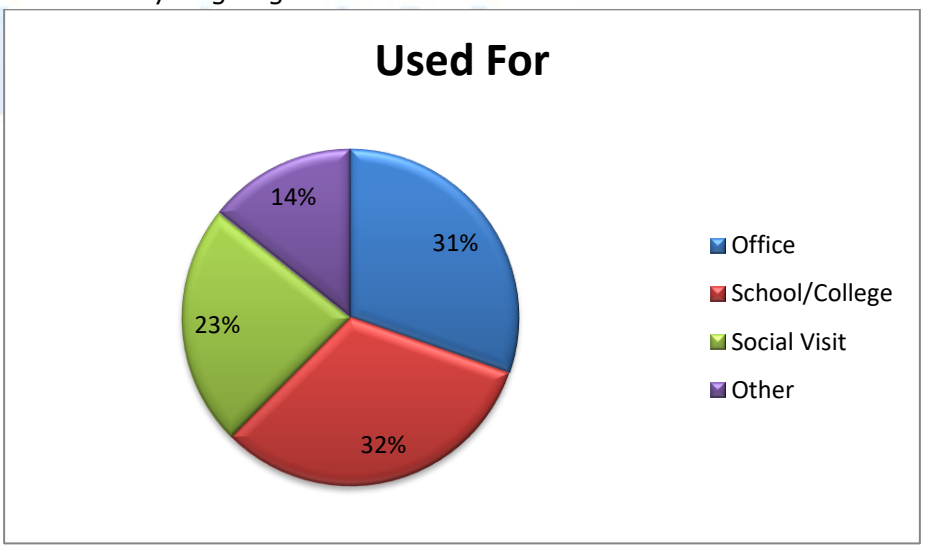


*Chart 2*

This shows that the metro is largely used for going to offices and educational institutes.

3. How frequently do you use the Metro?

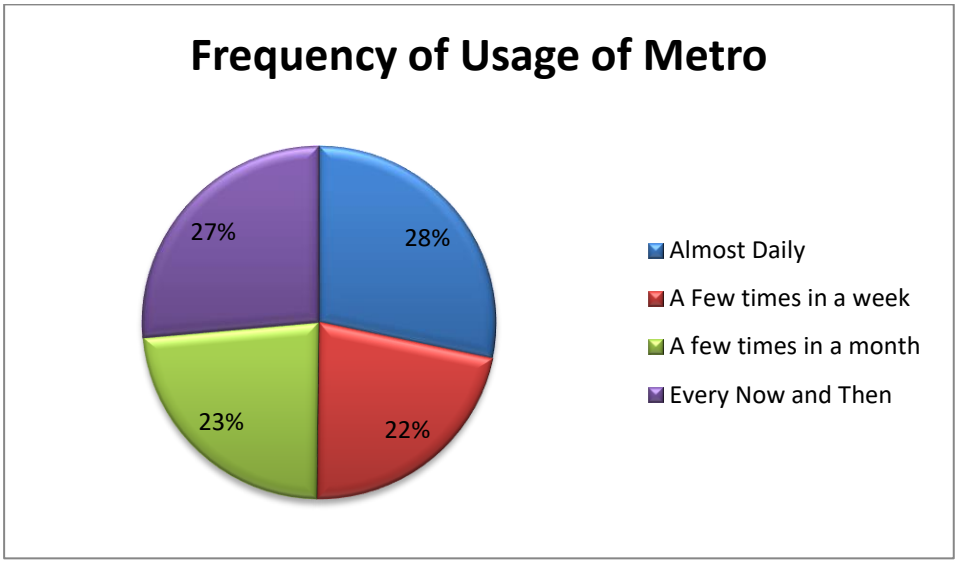


*Chart 3*

This shows that there are many people who use the metro daily. There are also almost equal number of people who use it sporadically.

4. What mode of transport has the Metro replaced?

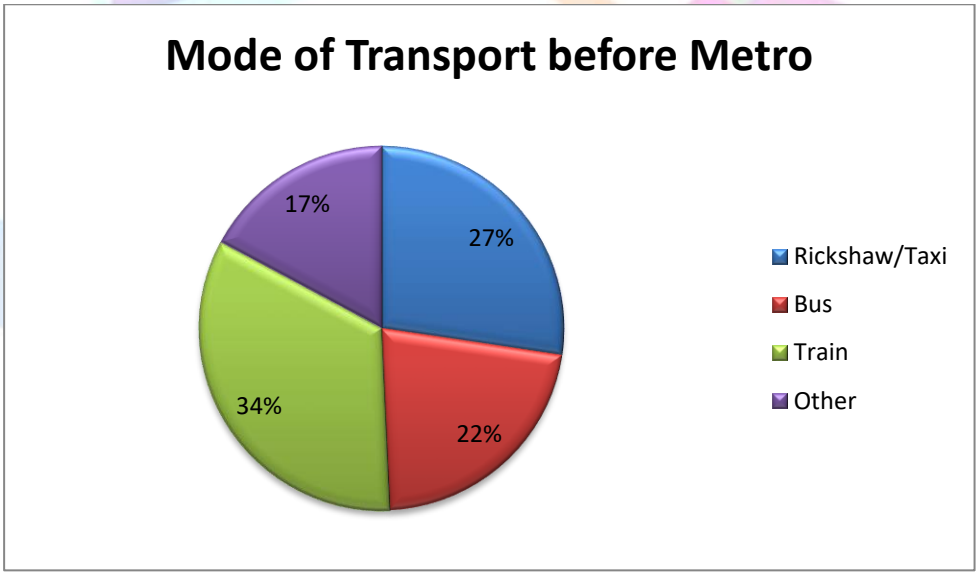


*Chart 4*

This graph clearly indicates that most commuters have switched over from Train to Metro. It may be because travelling by metro is more convenient and also faster.

5. Rate the ticket pricing

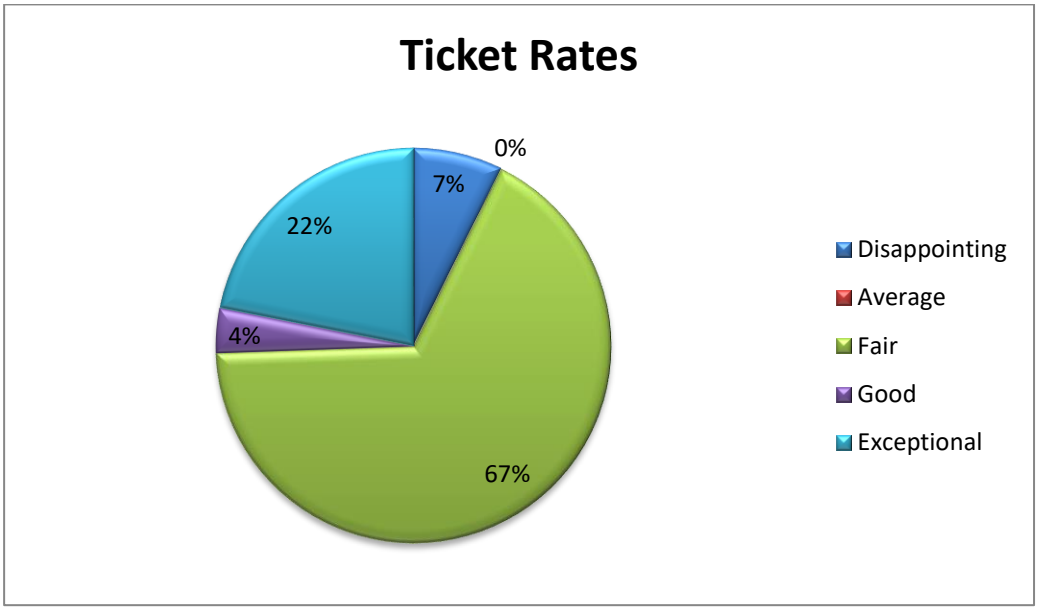


*Chart 5*

As it is shown, 67% of the people have graded the pricing as 'fair'. So, most of the people are okay with the fair. 22% of the survey-takers find the pricing to be 'exceptional', while 7% find it to be 'disappointing'. So, on average, the Metro has done a decent job with the pricing.

6. Was the Metro clean?

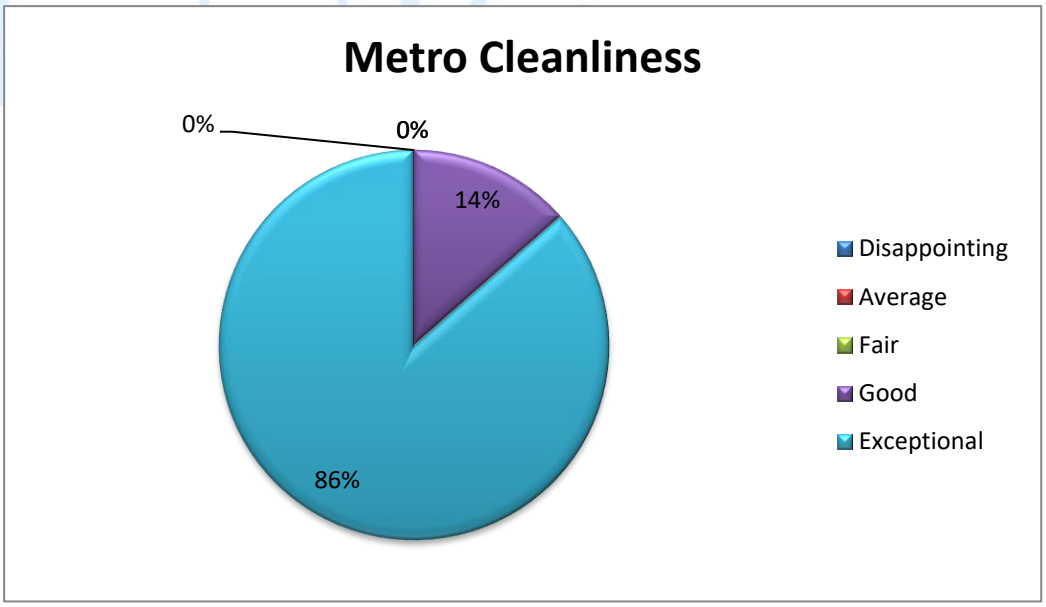


*Chart 6*

A good majority of people have rated the cleanliness of the Metro as 'exceptional'. The rest of the people have said that it was 'good'. It can be concluded that the Metro has done an excellent job in maintaining hygiene.

7. Was the Metro safe and comfortable?

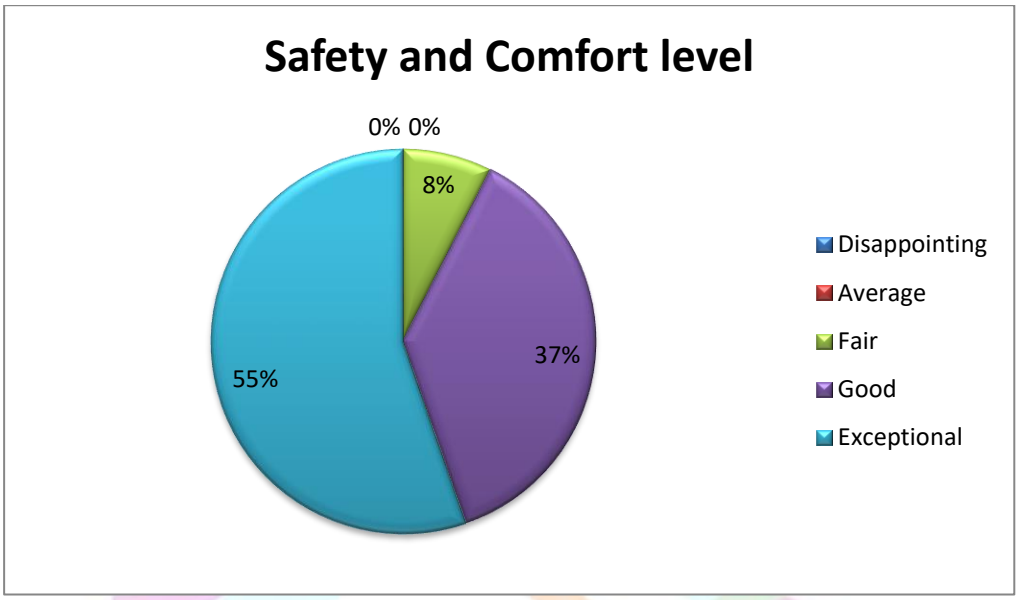


*Chart 7*

Nothing negative was commented on the safety and comfort of using the Mumbai Metro. All the ratings varied from 'Good' to 'Exceptional'. Since a majority, 55% of the people found the Metro to be 'Exceptionally' safe and comfortable, it can be said that the Mumbai Metro has done a fine job here too.

8. Why do you like the Metro?

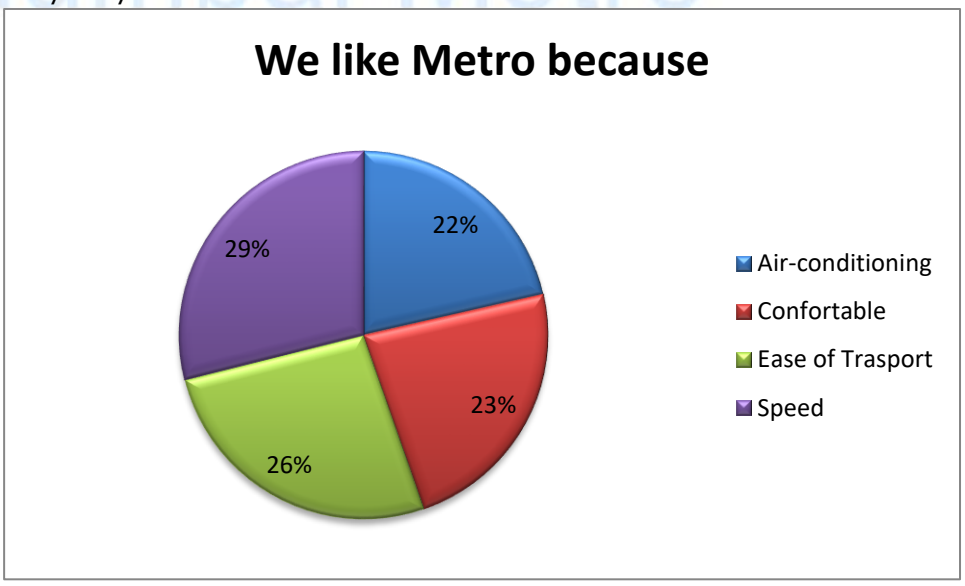


*Chart 8*

Here, Air-conditioning, comfort, ease of transport and speed have been given almost equal importance. So, the people have many reasons to like the metro.

9. Rate the overall quality of the Metro.

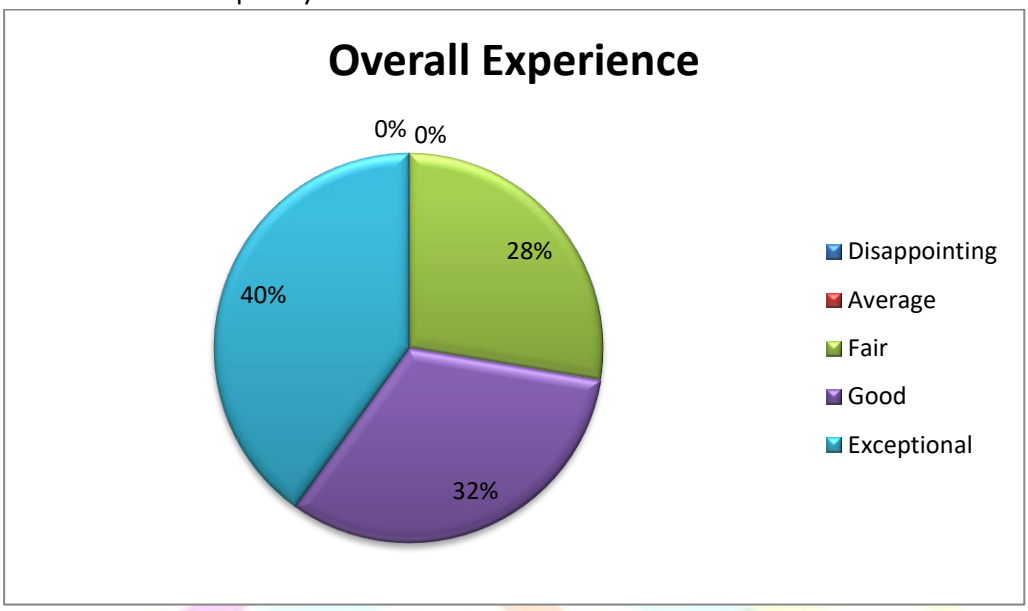


*Chart 9*

A huge majority (40%) have rated the Mumbai Metro as 'Exceptional'. 32% have rated it as 'Good' and 28% of the people as 'fair'. It can be concluded that the masses are happy with the metro.



## 5.3 Summary of the Survey

By the statistical survey, the Mumbai Metro Line 1 has been doing very well in the city. People, mainly college-goers and office workers, are enjoying this new mode of transport. A huge mass of crowd are travelling day in and day out. The problem of jam traffic near Saki naka-Marol is reduced to great extent.

The metro is exceptionally clean. The pricing of the tickets to be quite reasonable and the whole experience of travelling has been quite comfortable and safe. It has replaced many modes of transport such as train, bus and rickshaws.

We look forward for the Line 2 and Line 3 to start as fast as possible.

# LIST OF REFERENCES


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6. Survey conducted by the group.