Presented by Team Banrakas

# Transforming Traffic

A Case Study on Reducing Traffic Congestion in Greater Mumbai

# Executive Summary

2024

## Project Overview

## Situation

The Municipal Corporation of Greater Mumbai faces **severe road congestion issues,** negatively impacting residents' quality of life and the **city's economic efficiency**. This congestion results in longer travel times, increased pollution, higher commuter stress levels, and **disrupts the movement** of goods and services, affecting businesses and the economy.

## Objective

To deliver a **comprehensive analysis** of Greater Mumbai's road congestion issues and develop a detailed report that analyzes the **current state** of road congestion, offers **actionable recommendation**s, and explores innovative solutions for **future implementation.**

## Case Study Breakdown

Understanding the impact due to traffic congestion

Comprehensive Analysis of Greater Mumbai’s issues

Actionable and Innovative Recommendations

Implementation and Solution Analysis

## Analysis Breakdown

*Realising the problem and necessity for solution*

*Cracking the bottleneck points in the existing system*

*Proposing appropriate solutions aligning with the identified issues.*

*Ensuring effective and measurable progress on implementation*

## Analysis Breakdown

- Economical
- Environmental
- Social

- Current Conditions & Patterns
- Existing infrastructure
- Contributory factors

- Use of technology
- Infrastructural Development
- Changes in policies
- Better management

- Short-term & Long-term actions
- PESTEL & MCDA analysis
- Risk mitigation, KPI and overall impact

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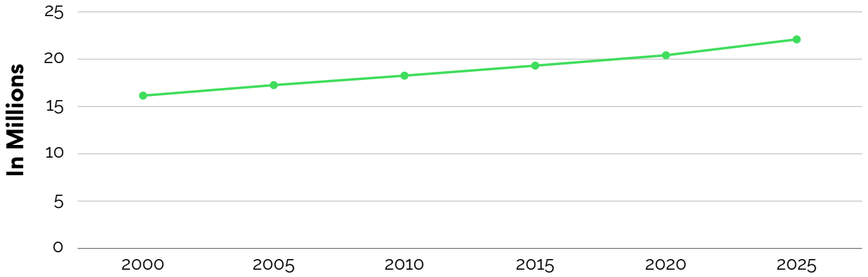
# Overview of Road Congestion in Mumbai

## Population and Vehicle Density

With a **population exceeding 20 million** and an area of 603 km$^2$, Mumbai experiences **extremely high vehicle density**.
Vehicle density has increased by over 16% since 2014, with approximately 25.46 lakh (2.546 million) registered vehicles, including 8.19 lakh (819,000) cars.



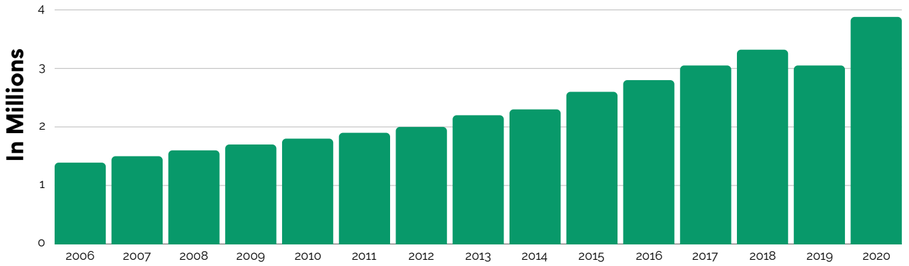

**Mumbai's Population Over the Years**

## Economic Impact

Traffic congestion costs Mumbai an estimated **₹20,000 crore (approx. $2.5 billion) annually** in terms of lost productivity, fuel wastage, and environmental damage.

## Traffic Growth

Over the past decade, Mumbai has registered **more than 1 lakh (100,000) new vehicles annually**. This continuous influx of vehicles exacerbates the congestion, even as infrastructure development struggles to keep pace.

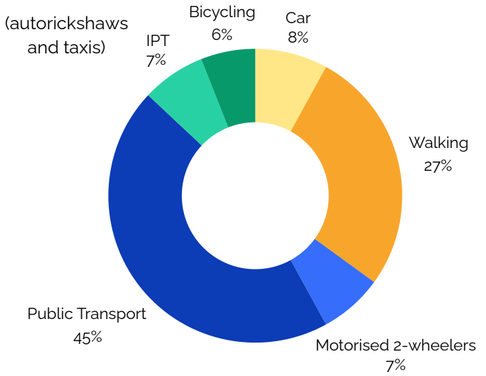



**Motor vehicles registered across Mumbai from financial year 2006 to 2020**

## Public Transport Usage

Despite the heavy congestion, around **52% of daily commuters use public transport**. Mumbai's suburban rail network handles 7.5 million passengers daily, which is 2.5 times its intended capacity, leading to overcrowding.

- Trains: 7.5 million
- Buses: 2.8 million
- Vehicle Population by 2030: Expected to double to 8.4 million




**Modal Split- Source: TUMI e-bus mission factsheet Mumbai 2022**

## Commuting Time

On average, Mumbaikars spend around **2 hours daily in traffic**, equating to approximately **44 hours per month** for daily commuters.

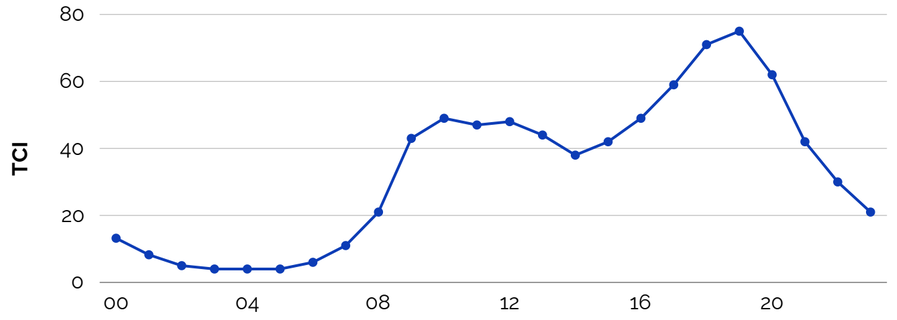
The **average travel time for a 10 km commute being about 45-60 minutes** during peak hours. This results in significant time lost that could be otherwise productive.

**Average vehicular speeds** on major roads during peak hours range between **8-10 km/h**. In central areas, speeds can plummet to as low as 5 km/h.

## Road Network

The total road network in Mumbai is **less than 2,000 km**, while the length of vehicles, if lined up back-to-back, would stretch approximately 3,300 km.

However, **only 12% of the city's area is dedicated to roads**, compared to 30-35% in many global cities. This discrepancy highlights the severe overcapacity and congestion on the city's roads.




**Average Hourly Traffic Congestion in Mumbai**

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# Impact Overview of Congestion on the City

## Multifaceted Impacts of Road Congestion

**Environmental Impacts**
- Air Pollution
- Carbon Footprint
- Noise Pollution
- Urban heat islands

**Economical Impacts**
- Loss of Productivity
- Increased Fuel costs
- Increased operational costs
- Infrastructure Wear and Tear

**Social Impacts**
- Increased Commute Time
- Respiratory problems & Mental stress
- Accidents & Pedestrian risk
- Reduced social interactions

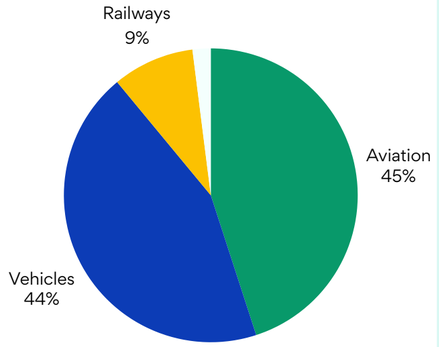
## Carbon Footprint

**22.8 KGg**
GHG footprint

Shows the total amount of **greenhouse gas emissions produced in Mumbai**, measured in CO2 equivalents

## Mumbai's GHG emissions

The transport sector, emitted **82,21,902 tCO2Eq of carbon** in 2019, making up 24% of Mumbai's total GHG emissions.

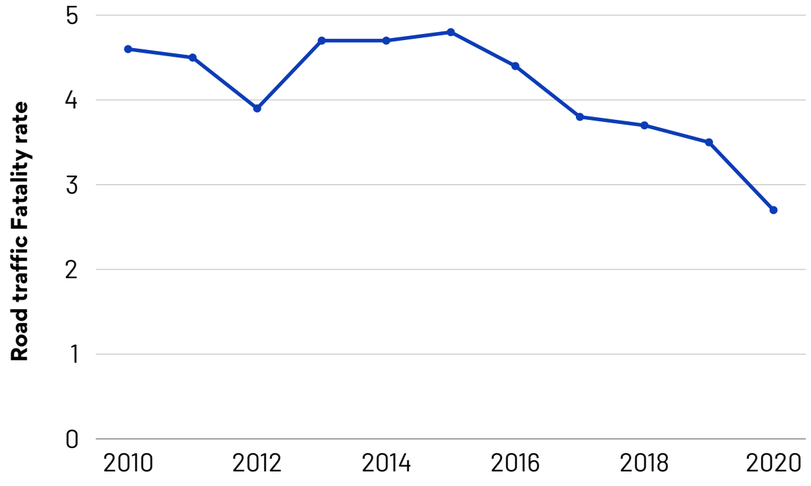



## Economic Drain from Traffic Congestion

| | |
|---|---|
| Productivity loss | ₹8,000 crore |
| Fuel costs | ₹4,500 crore |
| Operational costs | ₹3,500 crore |
| Maintenance costs | ₹1,500 crore |

According to a research report by the Observer Research Foundation (ORF), Mumbai experiences significant economic losses due to traffic congestion. The study reveals that the city incurs an **economic loss amounting to INR 410 billion annually** as a direct consequence of traffic jams. It is coupled with the substantial amount of time lost by commuters, who spend an average of 121 hours each year stuck in traffic.

## Road traffic Fatality rates, 2011 to 2020




In 2020, Mumbai saw a road traffic fatality rate of **2.7 deaths per 100,000 population**, with rates declining annually. Addressing road congestion is crucial to further reducing fatalities and improving road safety through better traffic management and safer driving practices.

# Environmental Impacts

## Air Pollution

- **Emissions:** Traffic congestion contributes to 25% of Mumbai's overall CO2 emissions.
- **Pollutants:** Elevated levels of pollutants such as PM2.5 (25 µg/m³ above WHO safe levels) and NOx significantly impact air quality.

## Carbon Footprint

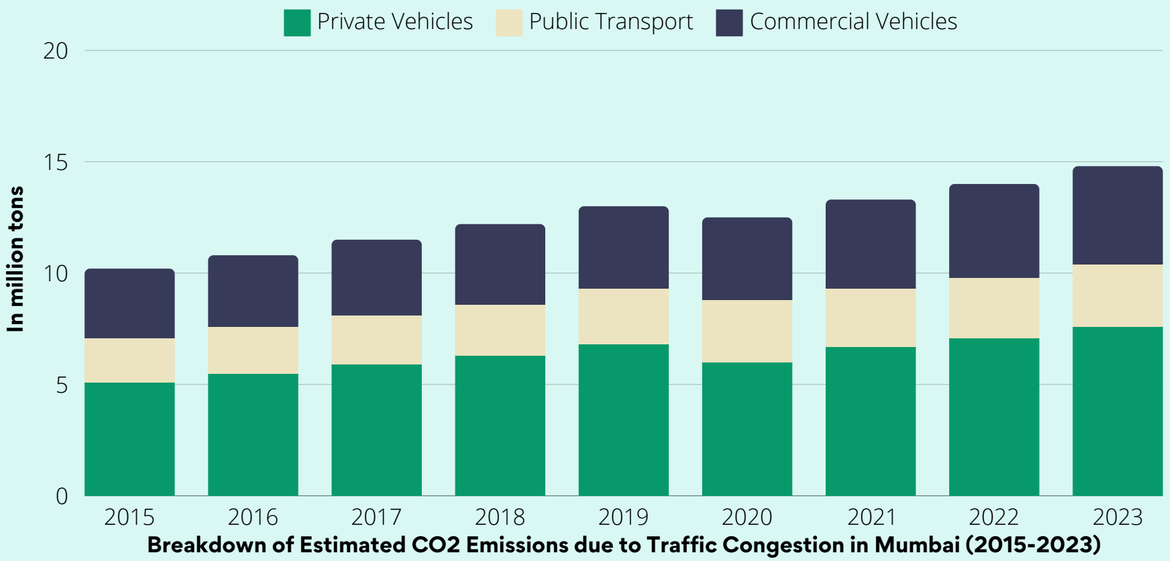
- **Increased CO2:** Road congestion leads to an additional 1.5 million tonnes of CO2 emissions annually.
- **Comparative Impact:** Equivalent to the emissions produced by 300,000 cars operating continuously for a year.

## Noise Pollution

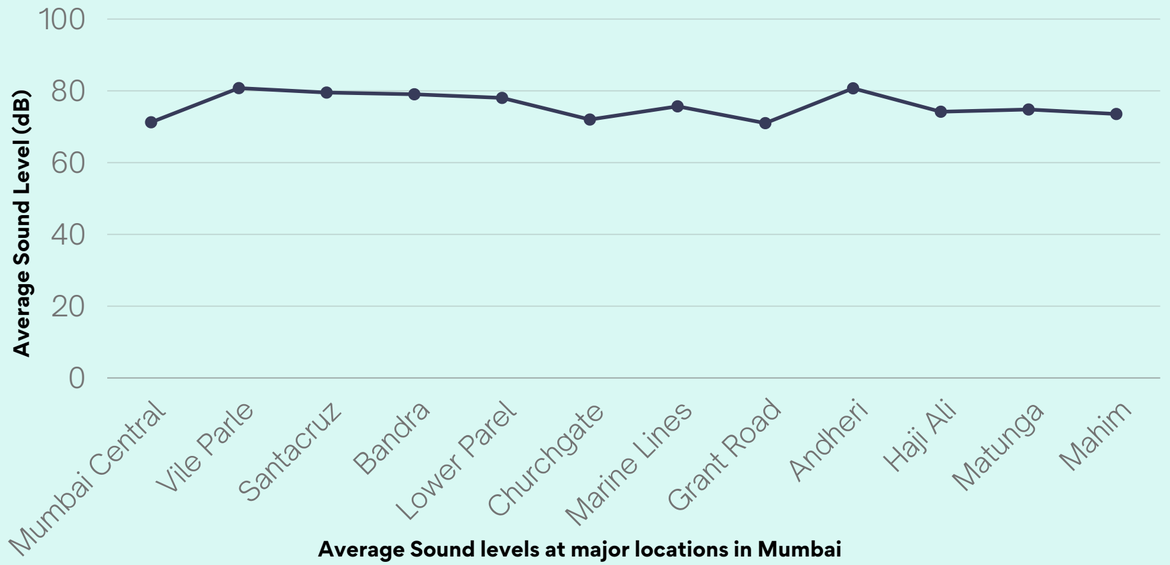
- **Noise levels:** Average noise levels in congested areas exceed 80 dB, well above the permissible limit of 55 dB in residential areas.
- **Health effects:** Prolonged exposure to high noise levels is linked to hearing problems and increased stress.

## Urban heat islands

- **Urban heat:** Traffic congestion exacerbates the urban heat island effect, increasing average temperatures in congested areas by 2-3°C compared to less congested zones.



Breakdown of Estimated CO2 Emissions due to Traffic Congestion in Mumbai (2015-2023)



Average Sound levels at major locations in Mumbai

# Economical Impacts

## Lost Productivity

- **Time loss:** Delays in traffic result in a productivity loss estimated at ₹8,000 crore (approx. $1 billion) annually due to employees being late to work or having reduced working hours.

## Fuel Wastage

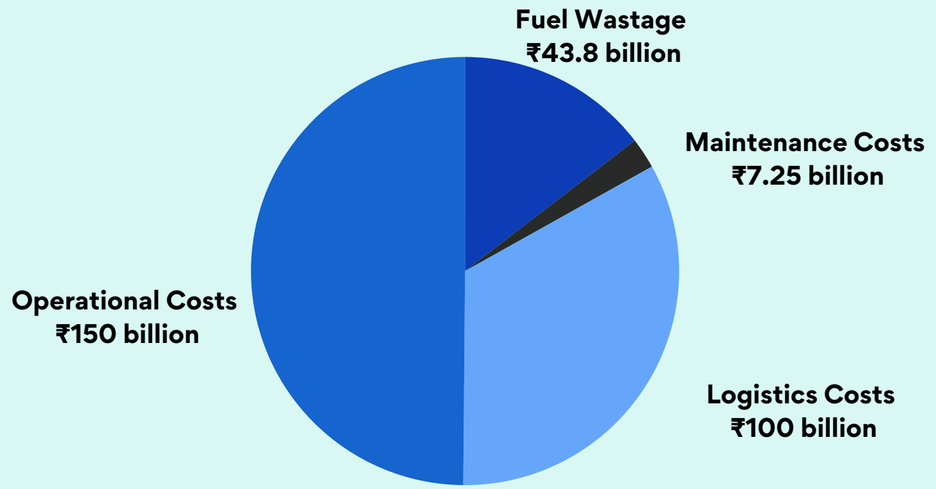
- **Fuel costs:** Congestion causes excess fuel consumption, amounting to ₹4,500 crore (approx. $560 million) per year.
- **Fuel efficiency:** Vehicles in congested traffic consume 30% more fuel on average compared to free-flowing traffic.

## Logistics and Delivery

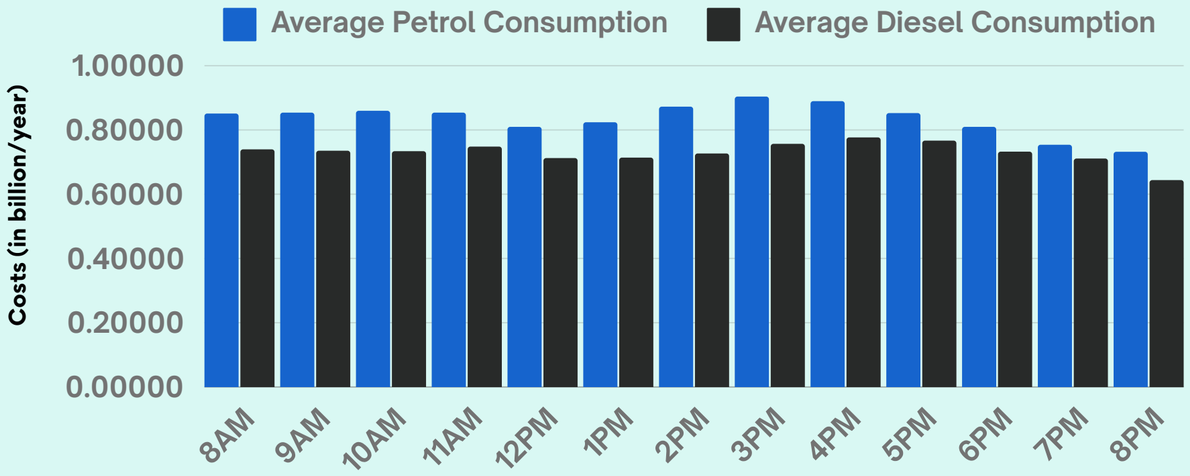
- **Increased operational costs:** Logistics companies face increased costs due to delays, amounting to an additional ₹3,500 crore annually.
- **Supply chain disruption:** Delays impact the delivery of goods, affecting business operations and increasing costs.

## Infrastructure Wear and Tear

- **Maintenance costs:** Frequent congestion leads to higher wear and tear on roads, increasing maintenance costs by approximately ₹1,500 crore (approx. $185 million) per year.




**Breakdown of the Economic Costs due to Traffic Congestion**




**Breakdown of Fuel Consumption against Time**

# Social Impacts

## Increased Commute Time

- **Average Commute:** 2-3 hours daily per person.
- **Lost Personal Time:** Commuters lose ~700 hours annually, impacting family and leisure time.
- **Congestion Impact:** Drivers spend an additional hours yearly in traffic, emitting an extra 313 kg of CO2, equivalent to what 100 trees absorb annually.

## Health Issues

- **Air Pollution:** Traffic congestion increases PM2.5 and NOx. PM10 levels in Wadala (194) and Andheri (190) exceed the safe limit of 100.
- **Respiratory Problems:** 20% of commuters report increased respiratory issues from traffic fumes.
- **Mental Stress:** 60% of daily commuters experience high stress and fatigue due to more traffic time.

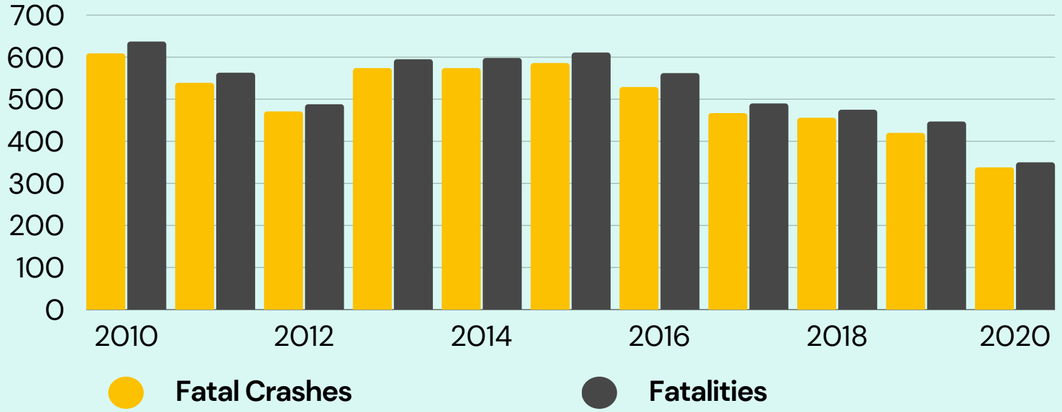
## Road Accidents

- **Accidents:** Congestion correlates with higher accident rates, with 42,000 injuries and 1,500 fatalities reported annually in Mumbai.
- **Pedestrian Risk:** High congestion areas see a 30% increase in pedestrian accidents.

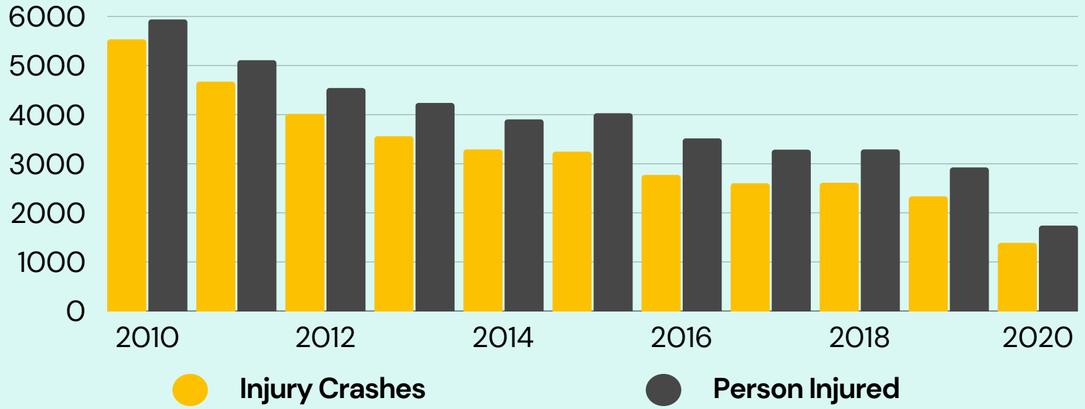
## Quality of Life

- **Reduced Social and Family Time:** 70% of commuters have significantly less time for social activities, and 65% spend 40% less time with family due to long commutes.
- **Health Decline:** 40% of commuters exercise less, raising sedentary lifestyle disease risks, while 25% face increased anxiety and depression.

### Fatal crashes and deaths, 2010 to 2020




### Injury crashes and non-fatal injuries, 2010 to 2020



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# In-Depth Analysis of Greater Mumbai's Road Congestion: A MECE Approach

## Comprehensive analysis

- **Current Traffic Conditions**
  - Congestion Hotspots
  - Peak Hour Analysis
  - Travel Time
  - Traffic Volume
- **Infrastructure Analysis**
  - Current Infrastructure
  - Road Capacity Analysis
  - Condition and Maintenance
  - Road Network Limitations
- **Public Transport Systems**
  - Overview of Transport System
  - Modal Split of Transport
  - Limitations and Challenges
  - Reliability and Connectivity
- **Transport Demand Patterns**
  - Analysis of Demand
  - Affordability
  - Commuter Behaviour
  - Trip Purposes
- **Population Growth and Urbanization**
  - Growth Trends
  - Population Increase
  - Migration
  - Urban Sprawl
- **High Vehicle Ownership**
  - Growth Rate
  - Economic Growth
  - Urban Expansion
  - Financial Accessibility
- **Policy and Governance Issues**
  - Government Policies
  - Implementation Gaps
  - Public Awareness
  - Infrastructure Challenges

## Breakdown

1. **Current Traffic Conditions:** Identify congestion hotspots, peak hour traffic, travel time, and overall traffic volume.
2. **Infrastructure Analysis:** Evaluate road capacity, condition, maintenance, and network limitations.
3. **Public Transport Systems:** Review transport system, modal split, limitations, challenges, and reliability.
4. **Transport Demand Patterns:** Analyze demand, affordability, commuter behavior, and trip purposes.
5. **Population Growth and Urbanization:** Examine growth trends, population increase, migration, and urban sprawl.
6. **High Vehicle Ownership:** Investigate vehicle ownership growth, economic factors, urban expansion, and financial accessibility.
7. **Policy and Governance Issues:** Scrutinize government policies, implementation gaps, public awareness, and infrastructure challenges.

"Mumbai's traffic congestion not only hampers daily commutes but also significantly impacts the city's economic productivity and residents' quality of life." - **Dr. Rakesh Sharma, Urban Planning Specialist**

"The elevated levels of air pollution in congested areas are a serious health concern, leading to increased respiratory issues and other chronic diseases among the population." - **Dr. Anjali Mehta, Public Health Department**

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# Current Traffic Condition

## Peak Congestion Hotspots

**Western Express Highway (WEH):**
- Goregaon
- Andheri
- Bandra

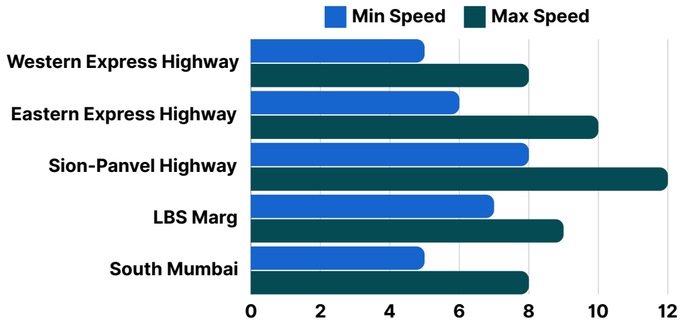
**Eastern Express Highway (EEH):**
- Vikhroli
- Ghatkopar
- Sion

**Sion-Panvel Highway**
- Chembur
- Mankhurd
- Vashi

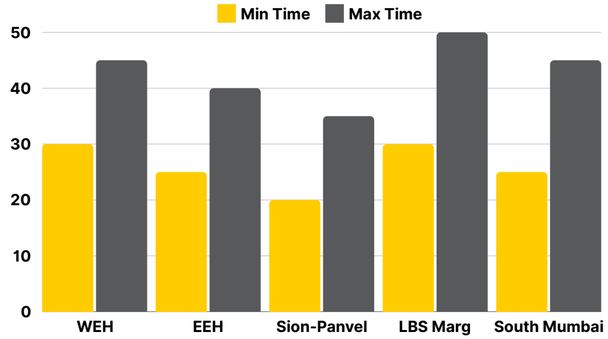
**LBS Marg**
- Mulund
- Bhandup
- Ghatkopar

**South Mumbai**
- Worli Sea Face
- Marine Drive
- Ghatkopar

## Speed during Peak Hours



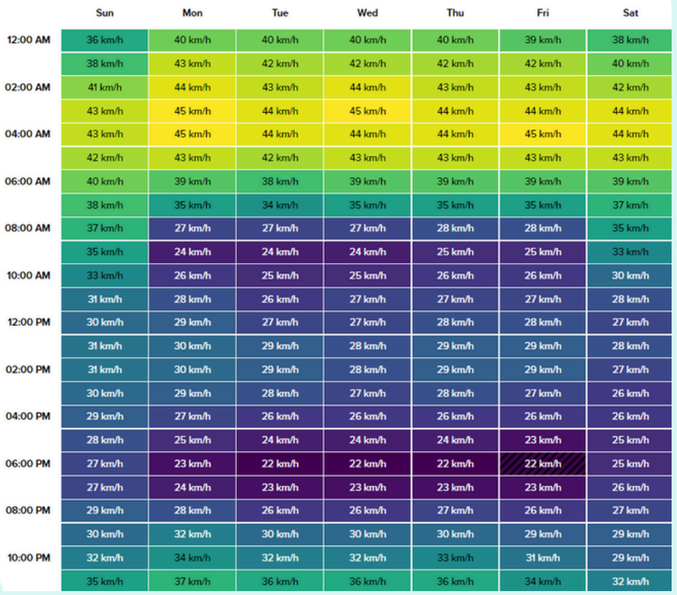

## Time Delay




## Peak Hour Analysis

| | Morning Peak Hours | Evening Peak Hours | Weekend Congestion (Saturday) |
|---|---|---|---|
| **Duration** | **8:00 AM - 11:00 AM** | **5:00 PM - 8:00 PM** | **4:00 PM - 9:00 PM** |
| **Worst Congestion** | **8:30 AM - 9:30 AM** | **6:00 PM - 7:00 PM** | **6:00 PM - 7:00 PM** |
| **Major Hotspots** | **Western Suburbs to South Mumbai:** Major traffic movement from residential areas like Borivali and Andheri towards commercial zones like Bandra-Kurla Complex (BKC) and South Mumbai. | **South Mumbai to Western and Eastern Suburbs:** Heavy traffic as office workers return home, causing congestion on WEH, EEH, and connecting roads. | **Shopping Areas and Malls:** Areas like Lower Parel, Andheri, and Powai experience higher congestion due to weekend shopping and entertainment. |
| **Average Travel Speed** | **6-8 km/h** | **5-7 km/h** | **7-10 km/h** |

## Heat map illustrating the average speeds throughout a week



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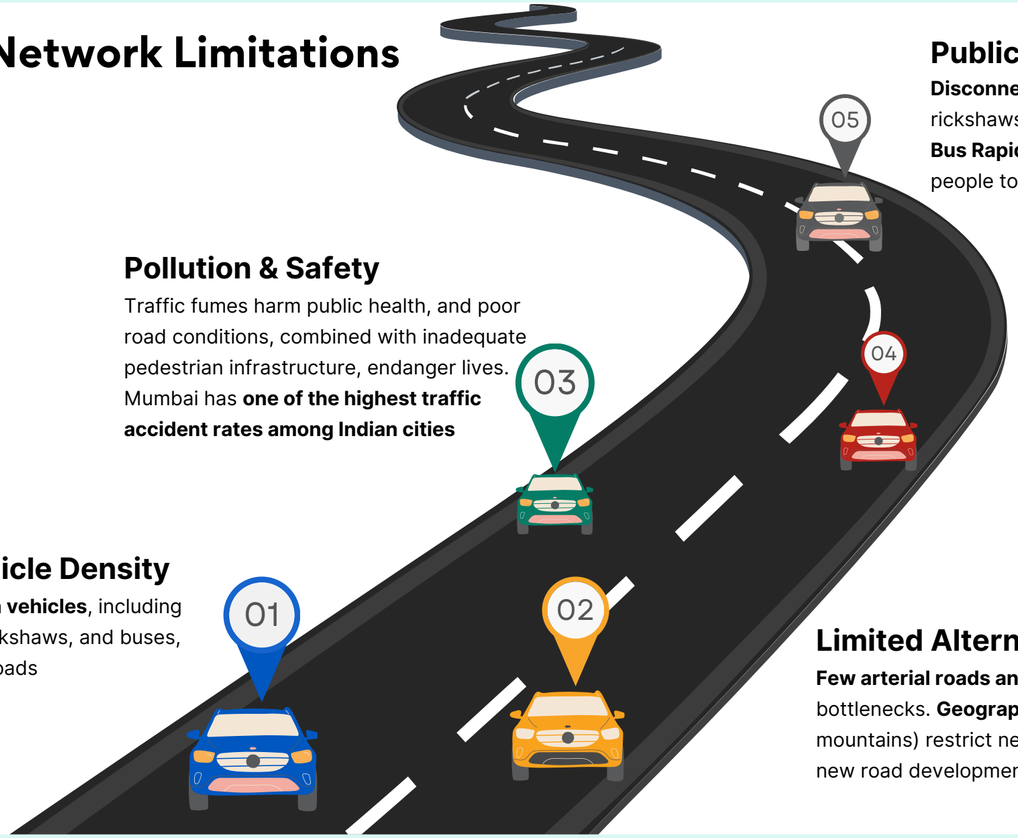
# Unveiling the Challenges: An Infrastructure Analysis of Congestion in Mumbai

## Road Network Limitations




### Public Transport Woes

**Disconnected systems** (trains, buses, rickshaws) and an **underdeveloped Bus Rapid Transit (BRT) system** push people towards private vehicles

### Pollution & Safety

Traffic fumes harm public health, and poor road conditions, combined with inadequate pedestrian infrastructure, endanger lives. Mumbai has **one of the highest traffic accident rates among Indian cities**

### Limited Road Space

**Encroachments and inadequate parking** push vehicles onto streets, further restricting traffic flow

### High Vehicle Density

**Over 3 million vehicles**, including cars, taxis, rickshaws, and buses, clog narrow roads

### Limited Alternatives

**Few arterial roads and flyovers** create bottlenecks. **Geographic constraints** (sea, mountains) restrict network expansion, limiting new road development opportunities

| S. No. | Name of Road | Description | Observed Peak Volume in PCU | Capacity (as per IRC 106:1990) | V/C | LOS | % Increase |
|---|---|---|---|---|---|---|---|
| 1 | Lady Jamshedji Road | 4-Lane Road | 3517 | 2900 | 1.21 | F | 20% |
| 2 | Dubey Road | 4-Lane Road | 4078 | 2400 | 1.69 | F | 70% |
| 3 | MIDC Central Road | 6-Lane Road | 4125 | 4300 | 0.95 | E | 5% |
| 4 | Sahar Road | 6-Lane Road | 4628 | 4300 | 1.07 | F | 10% |

## Current Infrastructure Status

**Overcapacity Roads:** Major routes like the Western and Eastern Express Highways have peak hour speeds of 10-15 km/h due to excessive traffic.

**Potholes:** Only 21 km of road concretization completed; ₹275 crore allocated for pothole repairs hasn't sufficed, leaving many roads in disrepair.

**Insufficient Network:** With only 2,000 km of roads for 20 million people and 3 million vehicles, frequent bottlenecks are inevitable.

**Delayed Projects:** Critical projects like the Goregaon-Mulund Link Road are delayed, with completion expected by 2028, hindering congestion relief efforts.

**Poor Traffic Management:** Inefficient signal timings and weak enforcement worsen the traffic chaos.

## Condition and Maintenance

**Uneven Network:** Roads favor north-south travel, causing congestion and underused east-west lanes. 72% of road space serves only 28% of the population.

**Unsuitable Material:** Bitumen roads (used since 1930s) are prone to potholes, especially during monsoons. A switch to concrete is planned but requires better execution.

**Monsoon Mayhem:** Potholes (around 70,000 in 2003) damage vehicles and cause traffic jams. Patchwork repairs offer temporary relief.

**Space Encroachment:** Informal shops, garbage, hawkers, parking, and even animals eat away at road space. An estimated 25% is lost to encroachments alone.

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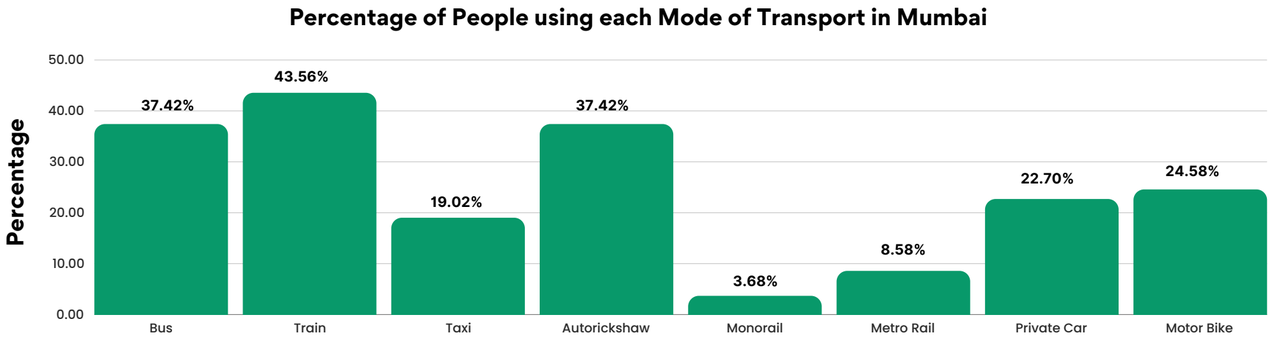
# Overview of the Public Transport System

## Mumbai Public Transport: An Overview

- **Local Trains (Western & Central Lines):** The backbone of Mumbai's commute, carrying millions daily with efficiency and punctuality.
- **BEST Buses (Red Buses):** Extensive network connecting the city affordably, though slower due to traffic.
- **Metro Rail:** A growing network offering a faster and more comfortable travel option.
- **Taxis & Auto-rickshaws:** Convenient but prone to traffic congestion, negotiate fares or use meters.




## Reliability

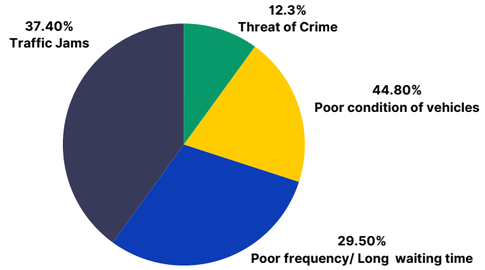
**Last-Mile Connectivity Matters:**
65% of Mumbai's population relies on public transport, making last-mile connectors crucial. Issues include taxis and rickshaws refusing rides, long queues for feeder buses, and crowded footpaths.

**Perceptions of Reliability:**
70% of respondents found Mumbai's public transport unreliable. Despite being second in accessibility (transport within a 10-minute walk), reliability is still a concern.

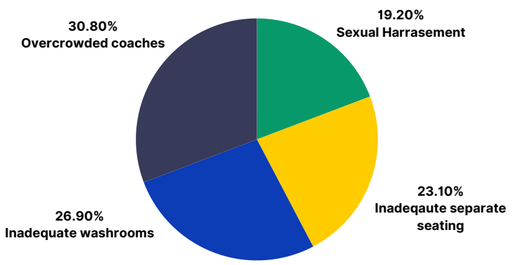
| S. No. | Reasons | Average Waiting Time |
|---|---|---|
| 1 | Waiting for rides (taxi, bus, trains) | 26 minutes |
| 2 | Traffic Congestion(non-toll plaza) | 36 minutes |
| 3 | Congestion at toll plazas | 22 minutes |
| 4 | All Reasons | 66 minutes |

## Limitations and Challenges

- **Main Problems:** Poor frequency, long waiting times, traffic congestion, vehicle conditions, and crime threats.
- **Women Commuters:** Overcrowded coaches, inadequate and unclean public washrooms, insufficient seats for women, and stations not elderly, differently-abled, or child-friendly.
- **Current Construction:** Ongoing metro and flyover construction worsens traffic congestion, causing long-term issues like traffic jams, time loss, and higher mobility costs in MMR.
- **Safety Concerns:** 37.4% of commuters report women facing sexual harassment in transit.
- **Project Challenges:** Lack of coordination, proper financing, and timely project implementation and completion.




Problems Identified by all commuters




Problems Identified by women commuters

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# Transport Demand Patterns

## Analysis of Demand

**1. Current Situation:**
- Mumbai's public transport share is ~70%, one of the highest globally.
- Suburban rail handles 7.5 million trips daily; local buses carry 5 million trips daily.

**2. Metro Rail System:**
- Mumbai plans 12 metro lines covering 277 km to tackle transport challenges.
- Completion will boost public transport share to ~75%.

**3. Affordability and Subsidies:**
- Public transport subsidies are crucial, with 75% of motorized trips relying on public transit.
- Public transit costs take a larger income share for the poor than for the middle class.

| Year | Car | Two wheeler | Three wheeler | Taxi | Buses | LCV | HCV |
|---|---|---|---|---|---|---|---|
| 2005 | 29.20 | 15.92 | 5.46 | 0.45 | 48.97 | 17.20 | 82.80 |
| 2010 | 25.50 | 17.28 | 7.12 | 0.54 | 49.56 | 19.70 | 80.30 |
| 2015 | 28.10 | 19.35 | 8.22 | 0.54 | 43.77 | 19.80 | 80.20 |
| 2020 | 28.90 | 19.09 | 7.38 | 0.49 | 44.08 | 19.70 | 80.30 |

## Trip Purposes

### Work/Employment 40-50%

Daily commutes to office buildings, industrial areas, and commercial hubs like Nariman Point, BKC, and Lower Parel.

### Education 20-25%

Students traveling to schools, colleges, and universities across the city and neighbouring areas.

### Shopping 10-15%

Visits to local markets, malls, and retail shops, especially Colaba Causeway, Linking Road, and Crawford Market.

### Social/Recreational 10-15%

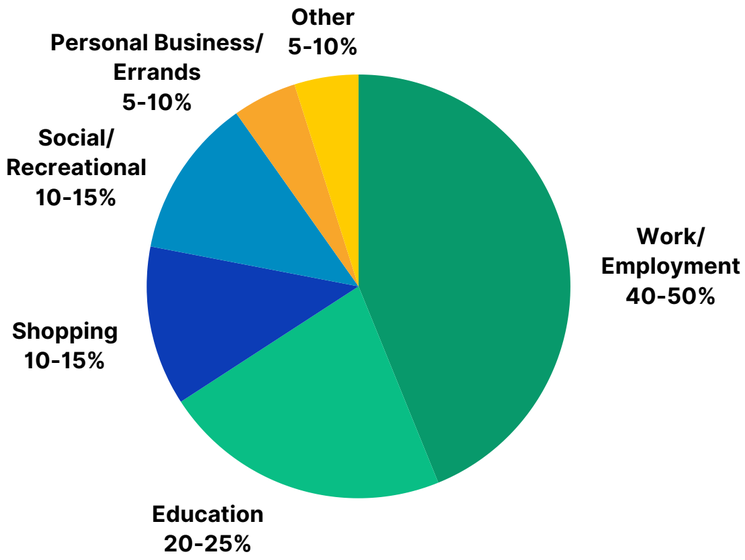
Visits to friends, family, parks, beaches, theatres, and restaurants. Popular spots include Marine Drive, Juhu Beach, and Sanjay Gandhi National Park.

### Personal Business/Errands 5-10%

Activities like banking, medical appointments, and other personal errands, spread throughout the city.

### Religious/Miscellaneous trips 5-10%

Religious trips, cultural events, and miscellaneous reasons. Key sites include Siddhivinayak Temple, Haji Ali Dargah, and various churches and temples.




Trip Purpose Breakdown for commuters

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# Population Increase and Urbanization

## Factors leading to Migration

**Pull Factors**

- Better Education
- Improved health care
- Improved job prospects

**Push Factors**

- Lack of Health Care & Education
- Unemployment
- Poverty
- Agricultural Distress

## Slum Formation in Dharavi

**Higher Estimate 869565**



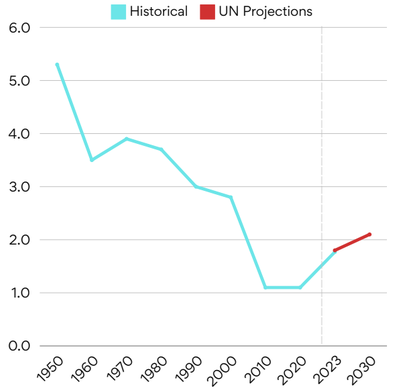
**Lower Estimate 3300000**

Dharavi houses over 1 million people within a mere 535 acres, translating to a mind-boggling density of approximately **869,565 people per sq mi (2,174,834 per sq km)** .

## Population Change Rate

Mumbai's estimated population stands at **21,673,1491**.

Mumbai had an annual population increase of around **1.77%** from 2023-2024.



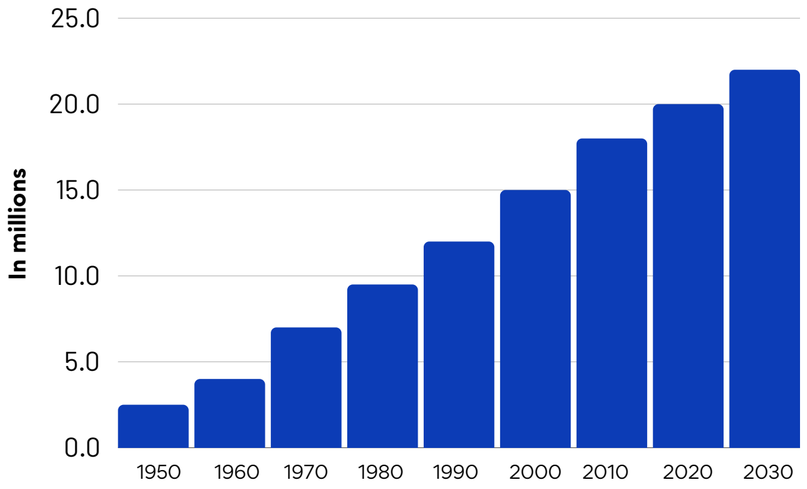

## Urban Sprawl

| | |
|---|---|
| Population Density | 21000 per sq km |
| Average Property Price | ₹22,000 per sq ft |
| Slum Proportion | 42% of population |
| Income Inequality | Gini Coefficient = 0.55 |

- Urban sprawl **escalates infrastructure costs and commute times**, strains transport networks, and devastates forests and wetlands.
- In Mumbai, **expansion stretches** north to Vasai-Virar and east to Bhiwandi alongside the Central Railway line, industrial development along Thane creek into Navi Mumbai.
- This growth, influenced by **state policies discouraging central city growth**, encroaches on ecological zones like Sanjay Gandhi National Park, Matheran Eco-Sensitive Zone, and Karnala Bird Sanctuary.

## Population Growth from 1950 to 2030

In Mumbai, natural increase is a significant driver of population growth, with a fertility rate of about two children per woman. This results in an **annual population growth of approximately 5%**, equivalent to **1 million new births each year**.



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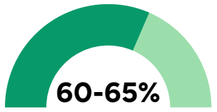
# Vehicle Ownership

## Vehicle Growth

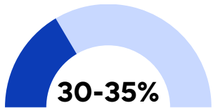
The number of vehicles in Mumbai has grown exponentially. In the past decade, vehicle registration data shows an **annual growth rate of approximately 8-10%**. As of the latest figures, Mumbai has over 3.6 million registered vehicles.

### Two-Wheelers



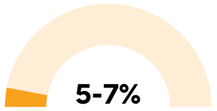

Predominantly, two-wheelers account for **60-65%** of Mumbai's vehicles, favoured for affordability, fuel efficiency, and manoeuvrability in traffic.

### Four-Wheelers



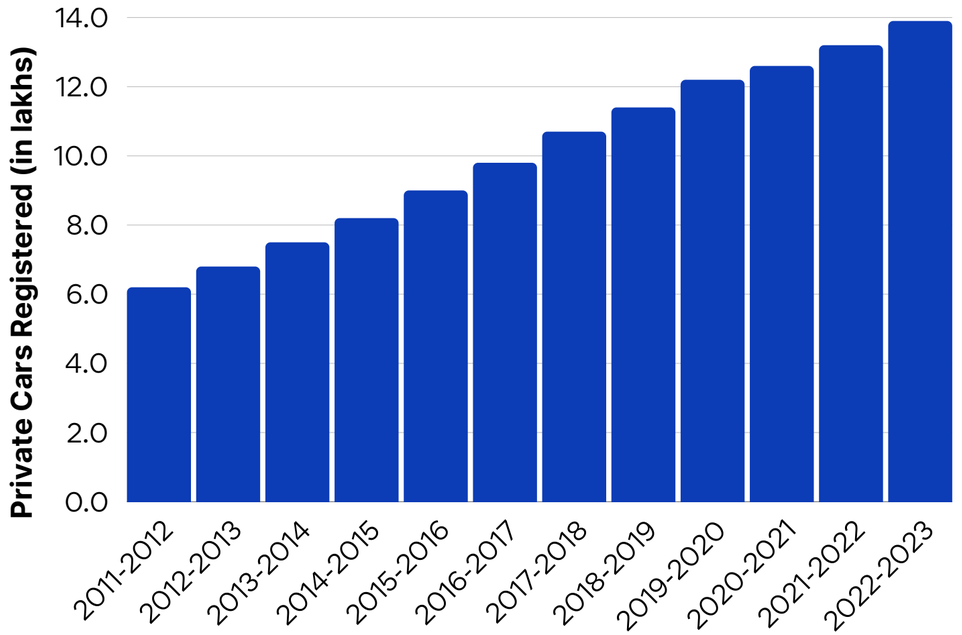

Cars and SUVs constitute **30-35%** of vehicles, reflecting increased middle-class demand and accessible financing options.

### Commercial Vehicles




Taxis, trucks, and buses make up **5-7%** of vehicles, growing slower than private vehicles.

**Graph showing the number of private cars registered (in lakhs) over the years in Mumbai**




## Factors Driving Private Vehicle Ownership

**Economic Growth**

Mumbai's economic expansion has raised disposable incomes, enabling more residents to afford private vehicles.

**Public Transport Shortcomings**

Public transit remains inadequate and unreliable, pushing many towards private vehicles.

**Urban Expansion**

Mumbai's sprawling urban areas have lengthened commutes, promoting private vehicle use for convenience.

**Cultural Factors**

Owning a vehicle signifies status and independence, influencing cultural preferences.

**Financial Accessibility**

Easy credit and financing options facilitate private vehicle purchases.

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# Policy and Governance Issues

## Government Policy Issues

**Lack of Congestion Pricing**
The lack of congestion pricing in Greater Mumbai exacerbates traffic congestion by failing to regulate road use effectively

**Poor Urban Planning & Road Design**
Haphazard development, inefficient zoning policies, and inadequate integration of residential, commercial, and industrial areas.

**Deficient Public Transport Infrastructure**
Mumbai's public transport infrastructure, particularly buses and suburban trains, has not seen adequate investment and modernization.

**Fragmented Governance of Transportation**
Multiple agencies with overlapping responsibilities and poor coordination result in delayed infrastructure projects, inadequate enforcement of traffic regulations, and inefficient use of resources.

**Inefficient Parking Management**
Inadequate parking facilities, illegal parking, and encroachments reduce available road space, causing obstruction in traffic flow.

## Implementation Gaps

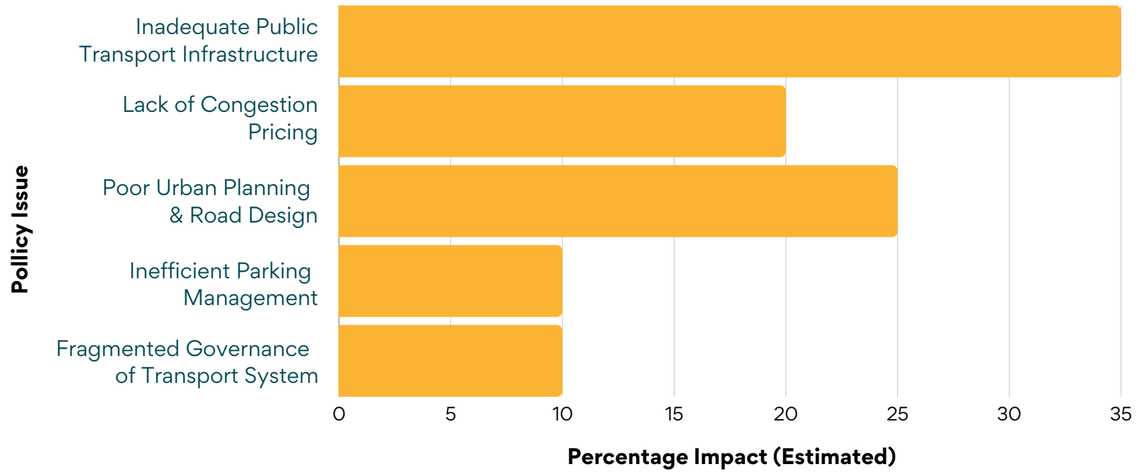
**Integrated Ticketing System**
Without a unified system, commuters face inconvenience and inefficiency when switching between different modes of public transport, leading many to prefer private vehicles.

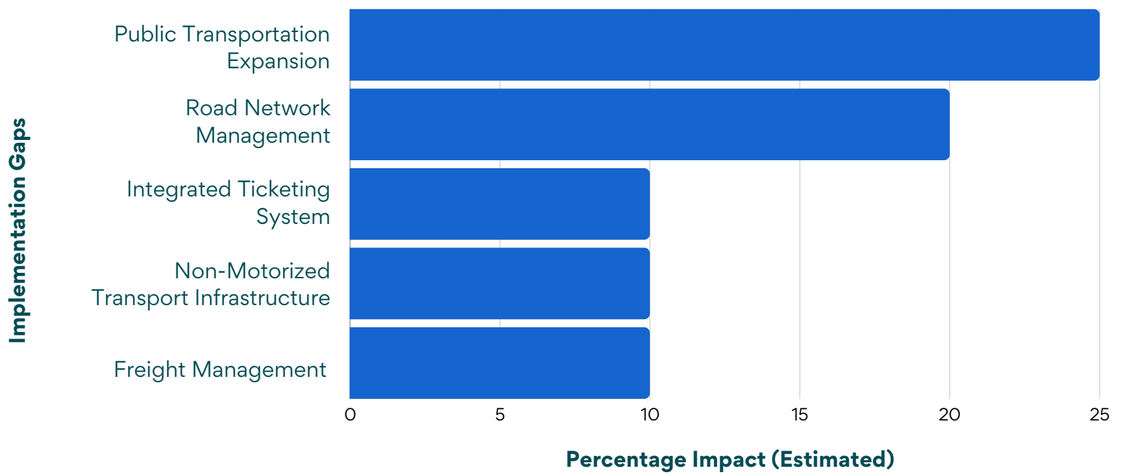
**Non-Motorized Transport Infrastructure**
Insufficient facilities such as dedicated bicycle lanes, pedestrian pathways, and safe crossings discourage walking and cycling as viable transportation options

**Road Network Management**
Poor maintenance, lack of real-time traffic monitoring, and inadequate incident response exacerbate traffic delays and bottlenecks

**Public Transportation Expansion**
Insufficient investment in modernizing and expanding the public transport network leads to overcrowded trains and buses, pushing more commuters to rely on private vehicles.

**Freight Management**
Inefficient logistics and distribution networks lead to increased congestion on roads as trucks and commercial vehicles struggle to navigate the city



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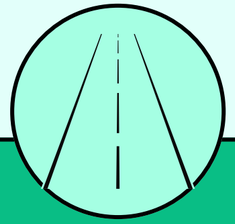
# Existing Traffic Management Strategies

The current traffic management of Greater Mumbai involves a multi-faceted approach aimed at addressing the city's complex and dense traffic environment.

## Public Transportation Enhancement

- **Suburban Railway Network:** Expansion and improvement of the suburban railway network, which is the lifeline of Mumbai's public transport system.
- **Metro Rail System:** Development of the Mumbai Metro.
- **Bus Rapid Transit System (BRTS):** Introduction of dedicated lanes for buse.



## Road Infrastructure Improvements

- **Widening and Maintenance:** Efforts are made to widen key roads and ensure their maintenance.
- **Flyovers and Underpasses:** Construction of flyovers, underpasses, and elevated roads.
- **Expressways and Highways:** Development of expressways such as the Eastern Freeway and the Mumbai-Pune Expressway.

## Non-Motorized Transport Initiatives

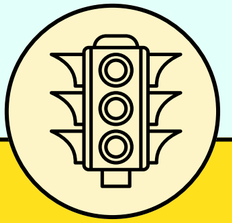
- **Pedestrian Infrastructure:** Development of pedestrian-friendly infrastructure including sidewalks, foot overbridges, and pedestrian signals.
- **Bicycle Lanes:** Promotion of cycling by developing dedicated bicycle lanes and bike-sharing programs.

## Parking Management

- **Public Parking Spaces:** Development of multi-level parking facilities and designated parking zones to reduce illegal parking on streets.
- **Parking Regulations:** Enforcement of strict parking regulations to ensure free flow of traffic on busy roads.

## Traffic Law Enforcement

- **Automated Enforcement:** Use of cameras and automated systems to monitor and enforce traffic violations such as speeding, red-light jumping, and unauthorized parking.
- **Increased** Fines and Penalties: Implementation of stringent fines and penalties for traffic violations.



## Traffic Signal Management

- **Intelligent Traffic Management Systems (ITMS):** Implementation of adaptive traffic signal systems that adjust signal timings based on real-time traffic conditions.
- **Synchronization:** Synchronizing traffic signals along major corridors.

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# Infrastructure Projects

## On-going

### Mumbai Urban Transport Project Phases III and IV

- **MUTP III:** Involves the extension of suburban rail corridors, addition of new trains, and improvement of railway infrastructure.
- **MUTP IV:** Focuses on further expansions, including additional rail lines and capacity enhancement projects.

### Virar-Alibaug Multi-Modal Corridor

- **Length and Connectivity:** A 126 km corridor connecting the northern (Virar) and southern (Alibaug) parts of the Mumbai Metropolitan Region.
- **Key Benefits:** Reduces travel time by over 50%, facilitates efficient movement of goods and passengers, and boosts the region's GDP by up to 2%.

### Mumbai Coastal Road Extension

- **Extending Northward to Reduce Congestion:** Future plans to extend the coastal road further north to cover more areas, aiming to alleviate congestion in additional neighbourhoods.

### Goregaon-Mulund Link Road

- **Enhancing East-West Connectivity:** A 12.7 km road project to connect the western suburb of Goregaon with the eastern suburb of Mulund, intended to ease congestion on the current east-west routes.

## Planned

### Mumbai Metro Expansion

- **Mumbai Metro Lines:**
- **Line 2:** Dahisar to Mankhurd
- **Line 3:** Colaba-Bandra-SEEPZ
- **Line 4:** Wadala-Thane-Kasarvadavali
- **Line 5:** (Thane-Bhiwandi-Kalyan)
- **Line 6:** (Swami Samarth Nagar-Vikhroli)

### Mumbai Trans Harbour Link (MTHL)

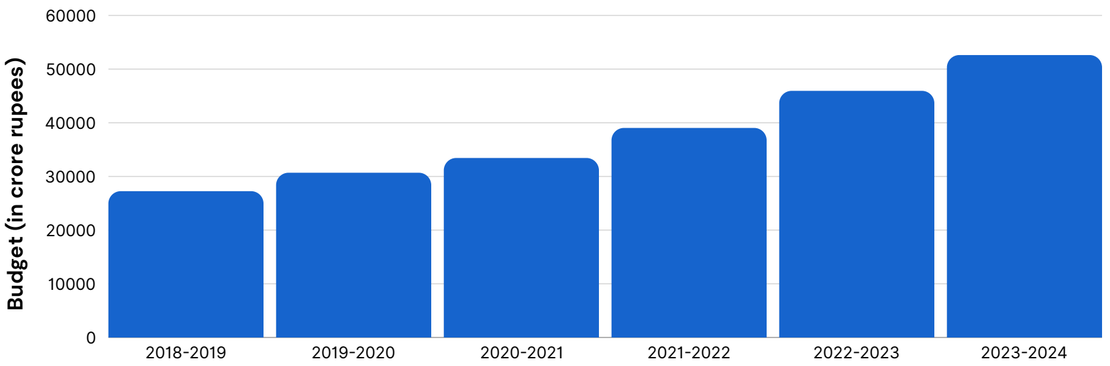
- **Atal Setu, India's Longest Sea Bridge:** A 21.8 km sea bridge connecting Mumbai with Navi Mumbai, aimed at reducing travel time and decongesting existing roadways.

### Coastal Road Project

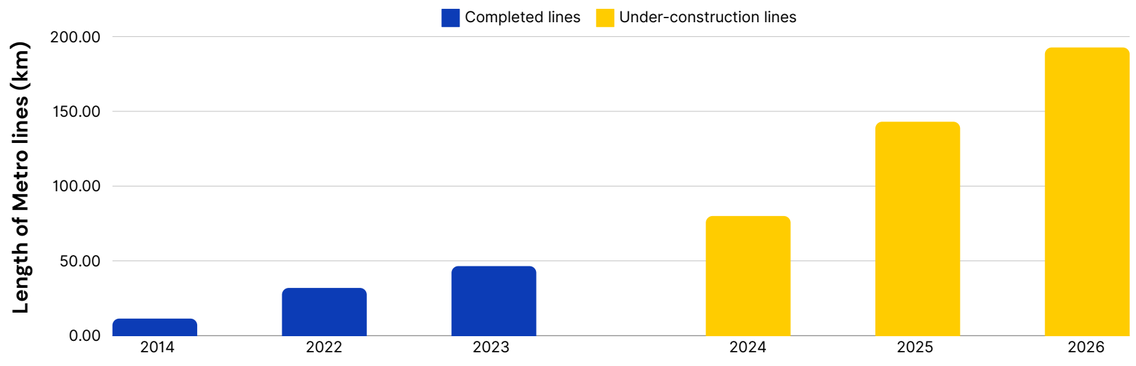
- **Mumbai's Coastal Lifeline:** An 8-lane, 29.2 km road running along Mumbai's western coastline from Marine Lines to Kandivali, designed to reduce congestion on the Western Express Highway.

### Sewri-Worli Elevated Corridor

- **Elevated Roads to Slash Commute Times:** An elevated road to improve connectivity between the eastern and western parts of the city, reducing congestion on the existing routes.

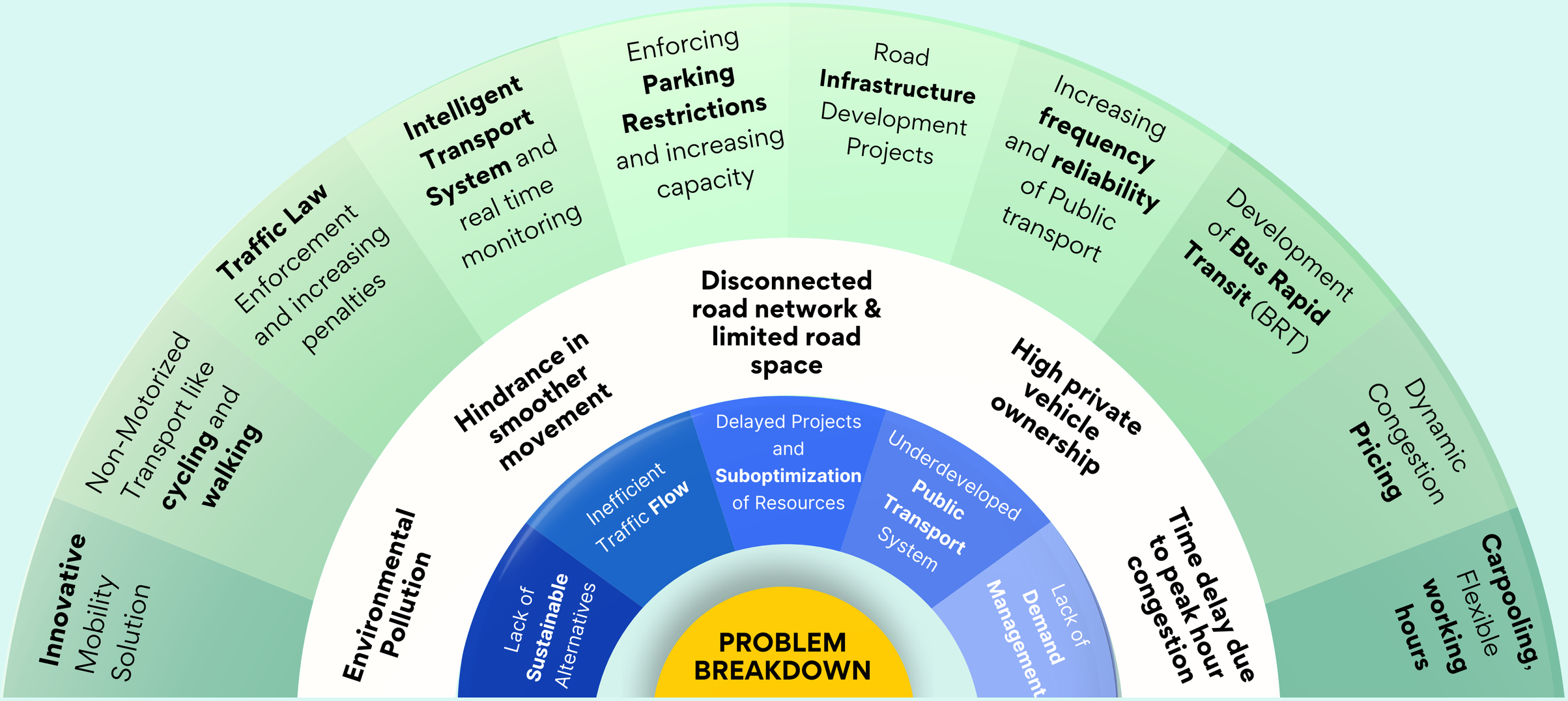



Graph showing the budget of MCGM over the years




Graph showing the expansion of Mumbai Metro over the years

# Overview of Solutions



# Technological Innovations

## Intelligent Transport System (ITS)

ITS refers to the application of advanced **information and communication technologies** to transportation systems for improving efficiency and safety.

### GPS based methods

Using in-vehicle GPS systems for position reading and computing vehicle speed and other data

### Unified Smart Cards

Passengers benefit from using a single card for multiple public transport modes, enabling automatic fare deduction and promoting equitable access while potentially cutting operational costs.

### Floating cellular data

The accelerometer data from smartphones is used to monitor traffic speed and road quality, while audio data and GPS tagging help identify traffic density and potential jams.

### Live Traffic Data

Mobile phone data is used to gather real-time traffic information. This data helps suggest alternate routes, improving traffic flow and reducing emissions.

### Radio Frequency Identification

Readers installed at strategic points (checkpoints, depots) track the location and movement of vehicles in real-time. The existing FASTag system uses this technology

### Passenger Information System

Electronic displays and mobile apps provide real-time information on arrival times, reducing passenger uncertainty and wait times. This system can also generate revenue through advertising.

### Collaborating with ITS India Forum

A non-profit organization in India promoting the development of ITS to enhance efficiency, safety, and sustainability in transportation through this technology.

### Real time monitoring

Provide accurate real-time data from multiple sources such as sensors, GPS, smart cameras, dynamic message signs, traffic lights and road weather information systems.

***Mumbai's transport planning has historically favoured private vehicles**, leading to a reliance on cars and limited investment in public transport. Enhancing public transport would encourage more people to opt for them, reducing traffic congestion and creating a more sustainable city.*

# Enhancement to Public Transport

### Increased Frequency

Increase public transport services during peak and off-peak hours to reduce waiting times, improve connections, enhance reliability, and support high-ridership transit systems.

### Improving Existing Infrastructure

Ensuring proper maintenance and cleanliness of the public transports to provide commuters a safe and comfortable journey.

### Improved Reliability

Monitor and manage fleet schedules and run maintenance programs to prevent delay and breakdowns. Also, collection of Automatic Vehicle Location (AVL) and Automatic Passenger Counting (APC) Data and conduction of surveys should be done to understand user needs and cater accordingly.

### Integrating Last-Mile Connectivity

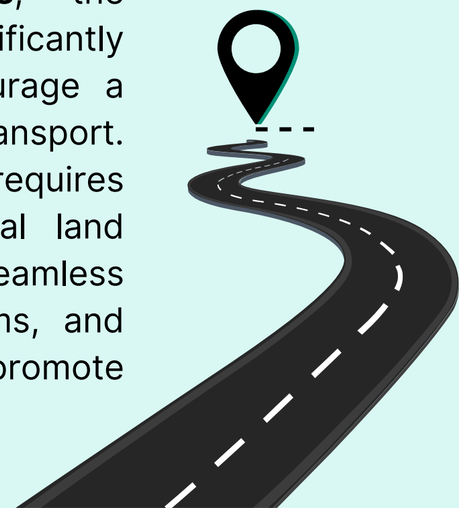
The authority would prioritize the development and integration of last-mile connectivity options to make public transport more accessible and convenient.

### Fare Integration and Discounts

Offering discounts for frequent riders, students, seniors, and low-income individuals to make public transport more affordable and encourage ridership.

## Long Term plans: Bus Rapid Transit (BRT) system

By offering features like **dedicated lanes, faster boarding stations, and modern high-capacity buses**, the existing BRT system can significantly reduce travel times and encourage a shift towards public transport. Successful implementation requires careful route planning, potential land acquisition for lanes, seamless integration with existing systems, and public awareness campaigns to promote its benefits.



# Promoting Non-Motorized Transport

*Non-motorized transport, including **walking and cycling**, offers a sustainable and healthy alternative to motorized vehicles. Promoting these modes of transport can significantly reduce traffic congestion, improve air quality, and enhance the overall quality of urban life in Greater Mumbai.*

## Infrastructure Development

- **Pedestrian Zones:** Establish car-free areas with benches, shade, and lighting for public use.
- **Cycle Tracks and Parking:** Develop dedicated bike lanes linking key locations and transit hubs.

## Policy Measures

- **Incentives for Active Commuters:** Subsidize bikes, offer tax benefits, and provide transit discounts for cyclists.
- **Awareness Campaigns:** Promote walking and cycling through public campaigns highlighting health and environmental benefits.

## Safety Enhancements

- **Traffic Calming Measures:** Implement speed bumps and reduced speed limits.
- **Safety Education:** Educate pedestrians and cyclists on road safety rules.

## Community Engagement

- **Community Feedback:** Conduct public consultations for community feedback on infrastructure needs.
- ·**Active Partnership:** Foster partnerships with schools and businesses to promote walking and cycling events.

## Integrated Planning and Investment

- **Multimodal Connectivity**: Integrate paths with public transit hubs for seamless travel.
- **Sustainable Funding:** Secure continuous funding for infrastructure development and maintenance.

# Demand Management Strategies

## Carpooling

Encouraging multiple passengers to share a single vehicle for commuting.

## Flexible Working Hours

Allowing employees to have staggered start and end times to avoid peak traffic hours.


- Reduced emission
- Decreased cost
- Extended Vehicle Lifespan
- Social Connections

**Save per year per commuter** by adjusting their travel habits (for a 10 km commute in Mumbai?


One day of working from home (Friday)

39 hrs 199kg

Three days of working from home (Friday, Tuesdays and wednesday)

120 hrs 600kg

**Public Awareness Campaigns**

Promote carpooling and flexible work hours through **media and community outreach.**

**Corporate Engagement**

**Partner with businesses** for carpooling programs and flexible work policies.

**Incentive Programs**

Offer **financial incentives** for adopting carpooling and flexible work practices.

**Technology Integration**

Support **carpooling apps** to coordinate commuters efficiently.

**Policy Support**

Advocate for **local government policies** and incentives supporting carpooling and flexible work hours.

# Road Infrastructure Development

## Expected Impact

By implementing these road infrastructure developments, Greater Mumbai aims to create a more efficient, reliable, and sustainable transportation network, significantly **reducing traffic congestion and improving the quality of life for its residents.**

### Mumbai Trans Harbour Link (MTHL)

The sea bridge will facilitate **quicker travel between Mumbai and Navi Mumbai**, decongesting existing routes like the Eastern Express Highway.

### Coastal Road Project

This project will provide an **additional route along the western coast**, reducing the burden on the Western Express Highway and other arterial roads.

### Western and Eastern Express Highway Upgrades

Widening and the addition of flyovers and underpasses will **reduce bottlenecks and improve traffic flow on these key highways.**

### Virar-Alibaug Multi-Modal Corridor

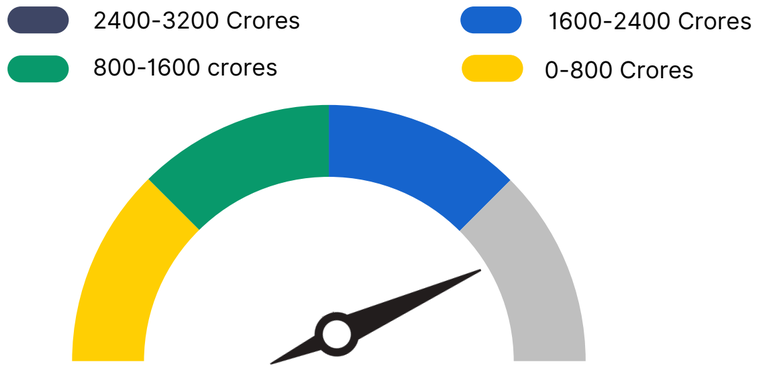
This corridor will **enhance connectivity between the northern and southern parts of the region**, facilitating smoother movement of goods and people.

### Goregaon-Mulund Link Road

This new link road will **ease congestion on existing east-west routes**, providing an alternative for commuters traveling between these suburbs.

## Budget for Road Development

Greater Mumbai has undertaken several road infrastructure development projects aimed at tackling road congestion. These projects include the **construction of new roads, expansion and upgrading of existing roads, and the implementation of intelligent traffic management systems**.




A total of **Rs. 2825 Crores** were allocated for traffic operations and road projects.

## Overall Expected Impact

These projects will enhance mobility, reduce congestion, shorten commutes, lower pollution, boost the economy, and improve quality of life.

# Dynamic Congestion Pricing

## Concept

- **Variable Pricing:** Adjust toll rates based on traffic flow to manage congestion efficiently.
- **Real-Time Data:** Use live traffic data to dynamically set toll prices.
- **Technology Integration**: Implement seamless toll collection using advanced systems and mobile apps.

| Dynamic Pricing | Cordon Pricing | Time-of-Day Pricing |
|---|---|---|
| Real-time toll adjustments based on current traffic conditions. | Charges for entering specific zones during peak hours. | Variable toll rates based on time of travel. |

## Aim

- **Manage road congestion** by adjusting prices based on real-time traffic conditions.
- **Optimize use of roads**, particularly during peak hours.
- **Encourage alternative transport modes** by varying road usage costs.

## Benefits

- **Reduced Traffic Congestion**
- **Improved Travel Times**
- **Environmental Benefits**

**Infrastructure Setup**

- Install ERP Gantries
- Equip Vehicles with IUs

**Technology Integration**

- Develop ERP System
- Implement Payment Solutions

**Data Collection and Analysis**

- Gather Traffic Data
- Analyze Patterns.

**Dynamic Pricing Implementation**

- Set Initial Rates
- Adjust Rates Quarterly

**Public Communication and Monitoring**

- Launch Public Awareness Campaign
- Monitor and Optimize

## Case Study: Singapore's Electronic Road Pricing (ERP) System

### Background

- In the early 1970s, Singapore introduced the **Area Licensing Scheme (ALS)** as a manual congestion pricing system.
- By 1998, advancements in technology and growing traffic demands led Singapore to replace ALS with the **Electronic Road Pricing (ERP)** system.

### Overview

- Singapore's ERP system uses technology and **dynamic pricing** to effectively manage urban traffic congestion.
- It has **reduced congestion**, improved travel speeds, and enhanced transportation network efficiency.
- The case shows that with **planning, public engagement, and adaptation**, cities globally can benefit from Dynamic Congestion Pricing.

## Implementation in Greater Mumbai

- **Pilot projects** on key corridors like Western and Eastern Express Highways to assess effectiveness and gather data.
- **Integrate** pricing models with **Metro and public transport** to enhance connectivity and promote usage.
- **Implement Dynamic Congestion Pricing** to manage congestion, improve travel, reduce emissions, and generate revenue for infrastructure.

# Innovative Mobility Solutions

| | | | |
|---|---|---|---|
| **New Mobility Options** | **Micro-Mobility Solutions**<br>**Electric scooters, bicycles** for short trips, reducing congestion and emissions. | **On-Demand Public Transport**<br>**Flexible bus services** adjusting routes based on real-time demand, enhancing public transit efficiency. | **Mobility-as-a-Service (MaaS)**<br>**Integrates public transit, ride-sharing, and bike-sharing** into one platform for easier journey planning and reduced private vehicle use. |
| **Autonomous Vehicles** | **Self-Driving Cars**<br>**Vehicles with AI** for autonomous driving, enhancing traffic flow and accessibility but facing cost, safety, and regulatory hurdles. | **Autonomous Public Transport**<br>**Self-driving buses** offering reliable service and traffic management benefits, needing infrastructure and public acceptance. | **Platooning**<br>**Grouped autonomous vehicles** for fuel efficiency and safety, requiring industry coordination, infrastructure upgrades, and regulatory approval. |
| **Electric Vehicle Infrastructure** | **Charging Stations**<br>**Public EV charging points** promote EV adoption, reduce fossil fuel reliance, and cut emissions. | **Battery Swapping Stations**<br>**Quick battery swaps** decrease EV downtime, enhance convenience, and improve efficiency. | **Smart Grid Integration**<br>**EVs linked to a smart grid** optimize energy use, support renewables, and reduce carbon footprint. |

## Considerations for Implementation

- **Public and Private Sector Collaboration:** Collaboration between public and private sectors is essential for implementing innovative mobility solutions, balancing regulatory support with safety and fairness.
- **Public Acceptance and Adaptation**: Educating the public on the benefits and usage of new mobility options, addressing concerns like privacy and job impacts, is crucial for widespread adoption of technologies like autonomous vehicles and EVs.
- **Environmental and Economic Impact**: Implementing mobility solutions must consider both environmental benefits and economic impacts, including infrastructure costs and industry disruptions.

# Traffic Law Enforcement

## Automated Enforcement

### Expand Red Light Cameras

To reduce congestion, install red light cameras at major intersections, particularly where violations are common, to **deter drivers from running red lights.**

### Implement Speed Cameras

Deploy **speed cameras on key arterial roads and highways** to enforce speed limits. This would not only improve safety but also help regulate traffic flow.

### License Plate Recognition for Parking Violations

Use license plate recognition technology to **automatically detect and fine vehicles** parked illegally. This would free up parking spaces and improve traffic flow

### RFID-based Traffic Management

Explore the use of RFID tags on vehicles to track their movement and **optimize traffic signal timing.** This could help create **"green waves"** and reduce delays at intersections.

### Smart Traffic Signal Systems

Implement **intelligent traffic signal systems** that use sensors to monitor traffic flow and adjust signal timing in real-time. This would help optimize traffic flow and reduce congestion.

## Increased Fines and Penalties

### Higher Fines for Traffic Violations

**Increase fines** for common traffic violations like running red lights, speeding, and illegal parking. This would act as **a stronger deterrent** for drivers.

### Point System for Repeat Offenders

Implement a point system where **repeat offenders accumulate points** for violations. Reaching a certain threshold could result in license suspension or other penalties.

### Stricter Enforcement of No-Parking Zones

Enforce no-parking zones more rigorously, using automated enforcement systems and increased fines. This would **free up valuable road space**.

### Penalties for Blocking Traffic

Impose hefty fines for vehicles blocking traffic, such as **double-parking or stopping in the middle** of the road. This would discourage drivers from obstructing traffic flow.

### Penalties for Using Mobile Phones While Driving

Increase fines for using **mobile phones while driving**, as this is a major distraction and contributes to **accidents and congestion.**

# Parking Managements

## Public Parking Spaces

### Increase Public Parking Capacity

Expand the availability of public parking spaces, particularly in high-demand areas like commercial districts, shopping malls, and entertainment zones

- **Developing Multi-Level Parking Garages**: Constructing multi-level parking garages to maximize space utilization in densely populated areas.
- **Utilizing Underutilized Spaces**: Converting underutilized spaces like rooftops, basements, and vacant land into parking facilities.
- **Encouraging Private Parking Lot Sharing**: Incentivize private parking lot owners to share their spaces during off-peak hours or through a shared parking platform.

### Improve Parking Infrastructure

Enhance the infrastructure of existing public parking spaces to make them more user-friendly and efficient

- **Clear Signage and Wayfinding:** Provide clear signage and wayfinding systems to guide drivers to available parking spaces.
- **Adequate Lighting and Security:** Ensure adequate lighting and security measures in parking areas to enhance safety and deter crime.
- **Accessible Parking:** Designate and maintain accessible parking spaces for people with disabilities.

### Promote Park-and-Ride Facilities

Enhance public parking by creating park-and-ride facilities at city outskirts to encourage public transport use, improving usability and efficiency.

## Parking Regulations

### Enforce Parking Restrictions

- **No-Parking Zones:** Clearly designate and enforce no-parking zones, especially in areas where parking obstructs traffic flow.
- **Time Limits:** Implement time limits for parking in specific areas to prevent vehicles from occupying spaces for extended periods.
- **Permit-Based Parking:** Introduce permit-based parking systems in residential areas to restrict parking to residents and visitors.

### UtilisingTechnology

- **Parking Guidance Systems:** Install parking guidance systems that display real-time availability of parking spaces in public garages and lots.
- **Mobile Parking Apps:** Develop and promote mobile parking apps that allow drivers to reserve parking spaces, pay for parking, and receive notifications about parking violations

### Alternative Parking Options

- **Bike Parking:** Provide secure and convenient bike parking facilities to encourage cycling.
- **Ride-Sharing and Taxis:** Promote ride-sharing services and taxis as alternatives to driving personal vehicles

### Dynamic Pricing for Parking

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# PESTEL Analysis

| | Intelligent Traffic System | Enhancing Public Transport | Non- Motorized Transport | Demand Management Strategies | Dynamic Congestion Pricing | Road Infrastructure Improvement | Traffic Law Enforcement | Parking Management | Innovative Mobility Solutions |
|---|---|---|---|---|---|---|---|---|---|
| **Political** | Requires government support and policy changes for **widespread implementation.** | Government support for public transport **funding**. | Policy support for non-motorized transport **initiatives**. | **Government incentives** for carpooling and flexible work policies. | Requires **legislative approval** and public buy-in. | Government support and **funding allocation**. | Strong **government backing** for stricter enforcement. | Support from **local authorities** for parking regulations. | **Supportive policies** for sustainable mobility solutions. |
| **Economic** | **Initial investment** in technology, but **potential cost savings** from reduced congestion. | Investment in infrastructure and **operational costs**; economic benefits from reduced congestion. | Relatively **low cost**; potential health cost savings. | Low implementation cost; **savings from reduced fuel** consumption. | **Revenue** generation **from tolls**; **costs** of implementing and **maintaining** the system. | High initial investment; long-term economic **benefits from improved connectivity.** | Costs of enforcement technology; potential **revenue from fines**. | Revenue from **parking fees**; **costs of developing** parking infrastructure. | Investment in infrastructure; potential **new revenue streams.** |
| **Social** | Acceptance by the public; **potential privacy concerns.** | **Improved public transport experience**; potential initial inconvenience during implementation. | Increased **public health** and reduced traffic; **cultural shift** towards non-motorized transport. | Improved **work-life balance**; potential resistance from employers. | Potential public resistance; **equity concerns** for lower-income drivers. | **Temporary disruption** during construction; long-term travel time savings. | Improved road safety; public perception of **increased surveillance.** | Improved **parking availability**; potential resistance to new regulations. | Increased mobility options; potential **safety concerns**. |
| **Technological** | **Dependence** on advanced technology and data analytics. | **Upgrades** to existing transport infrastructure. | **Minimal** technological **requirements.** | **Integration** of carpooling **platforms** and scheduling **tools.** | **Advanced toll collection** and data analysis systems. | Engineering and **construction technology**. | Deployment of **automated enforcement** systems. | Development of **smart parking** solutions. | Integration of advanced **mobility technologies.** |
| **Environmental** | Potential **reduction in emissions** due to improved traffic flow. | **Lower carbon footprint** due to increased public transport use. | Significant **reduction in emissions.** | **Reduction in emissions** from fewer vehicles on the road. | Incentivizes reduced car usage, **lowering emissions.** | **Potential environmental impact** during construction; long-term benefits from reduced congestion. | **Reduced accidents** and smoother traffic flow, leading to lower emissions. | **Reduced congestion** from cars searching for parking. | **Lower emissions** from increased use of electric and shared mobility options. |
| **Legal** | Data **privacy laws** and regulations. | Compliance with transport and **safety regulations.** | Development of safe infrastructure and compliance with **urban planning regulations.** | Compliance with **labor laws and data privacy** regulations. | Implementation of **legal frameworks for tolling** and data use. | Compliance with **environmental and urban planning** regulations. | Enforcement of existing traffic laws and **potential need for new regulations.** | Implementation of **parking laws and regulations.** | Regulation of new mobility services and **safety standards.** |

2024

# Short-Term Measures

| Intelligent Transport System | Public Transport Improvement | Carpooling, Flexible Hours | Traffic Law Enforcement | Parking Management |
|---|---|---|---|---|
| Pilot testing | Increase Frequency | Awareness Campaigns | Review Policies | Policy Review |
| Initial Implementation | Enhance Reliability | Incentive Programs | Technology Implementation | Initial Implementation |
| Full Rollout | Infrastructure Upgrades | Expansion | Enforcement | Expansion |
| Optimization | Continuous Improvement | Continuous Promotion | Continuous Monitoring | Continuous Enforcement |

## Timeline

- Q1-Q2 (Year 1)
- Q3-Q4 (Year 1)
- Year 2
- Year 3

2024

# Long-Term Strategies

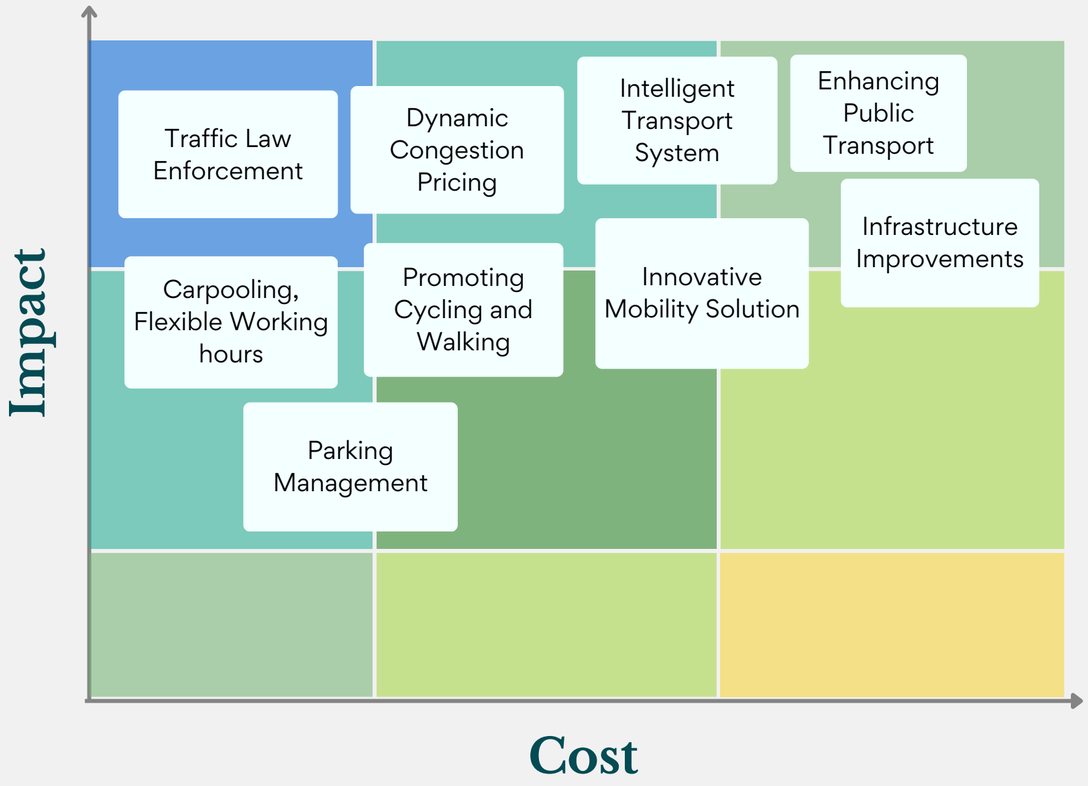
| | YEAR 3 | YEAR 4 | YEAR 5 | YEAR 5+ |
|---|---|---|---|---|
| Bus Rapid Transit System | Planning | Pilot Projects | Initial Implementation | Expansion |
| Dynamic Congestion Pricing | Feasibility Study | Planning | Initial Implementation | Expansion |
| Road Infrastructure Improvements | Detailed Study | Initial Projects | Major Projects | Completion and Optimization |
| Innovative Mobility Solutions | Pilot Projects | Initial Implementation | Expansion | Continuous Improvement |

## Timeline

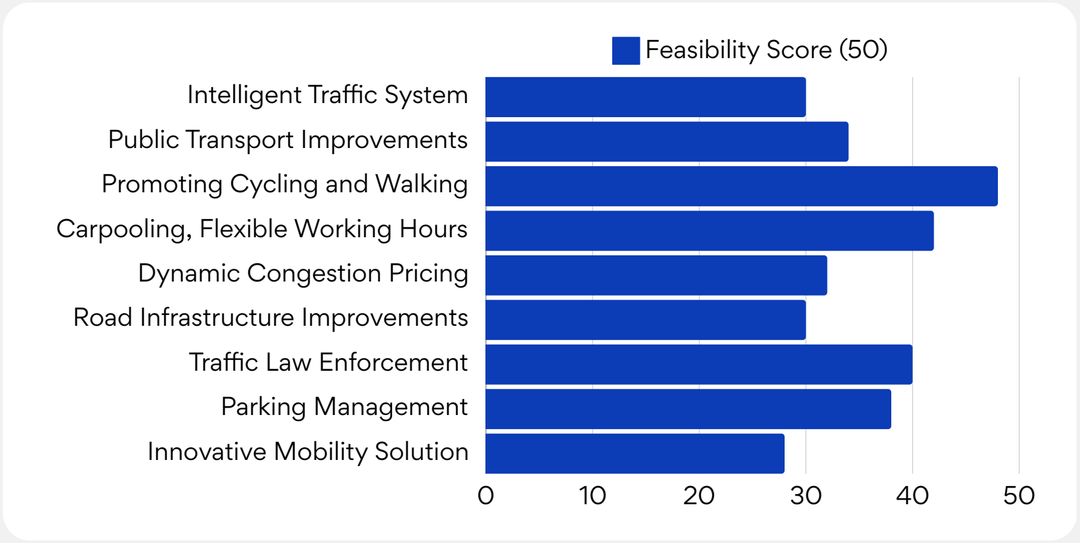
2024

# Multi-Criterion Decision Analysis (MCDA)

## Cost vs Impact Analysis




## Feasibility Analysis




**Criteria:**

- Cost (C)
- Time to Implement (T)
- Technology Readiness (TR)
- Political Support (PS)
- Public Acceptance (PA)

**Calculation:**

- Feasibility Score= (C+T+TR+PS+PA)/ 5

2024

# Potential Risk and Mitigation Strategy

**Mobility-as-a-Service (MaaS)**

Integrates public transit, ride-sharing, and bike-sharing into one platform for easier journey planning and reduced private vehicle use.

| Potential Risk | | Mitigation Strategy |
|---|---|---|
| **High implementation costs can strain budgets.** | Intelligent Transport System | **Secure funding through public-private partnerships and phased implementation.** |
| **Low Adoption Rates and resistance to switch** | Promoting Cycling and Walking | **Launch awareness campaigns highlighting health, environmental, and economic benefits** |
| **Lack of Last mile connectivity** | Enhancing Public Transport | **Develop and integrate shuttle services, bike-sharing programs, and pedestrian pathways to ensure seamless connectivity** |
| **Low participation rates.** | Carpooling, Flexible Working hours | **Provide incentives such as tax benefits and promote corporate partnerships.** |
| **Public opposition to new charges.** | Dynamic Congestion Pricing | **Educate the public on benefits and offer exemptions for low-income drivers.** |
| **Long Construction Periods** | Infrastructure Improvements | **Plan projects in phases and use advanced construction techniques to minimize duration.** |
| **Public backlash against stricter enforcement.** | Traffic Law Enforcement | **Ensure fair and transparent enforcement and educate the public on safety benefits.** |
| **Insufficient infrastructure for new parking regulations.** | Parking Management | **Invest in building adequate parking facilities and smart management technologies.** |
| **Regulatory hurdles may delay implementation.** | Innovative Mobility Solution | **Work closely with regulatory bodies to streamline approvals and ensure compliance.** |

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# Key Performance Indicator

## Intelligent Transport System

**Reduction in average travel time during peak hours.**

Measure: Percentage decrease in commute duration compared to baseline data.

## Carpooling, Flexible Working hours

**Reduction in peak-hour vehicle density.**

Measure: Decrease in the number of single-occupancy vehicles during peak periods.

## Traffic Law Enforcement

**Compliance with traffic regulations.**

Measure: Percentage change in traffic violation tickets issued.

## Promoting Cycling and Walking

**Percentage Increase in Cycling and Walking Trips**

Measure: Track daily cycling and walking trips before and after implementation using surveys, traffic counts, or transportation data.

## Dynamic Congestion Pricing

**Reduction in peak-hour traffic volume.**

Measure: Decrease in the number of vehicles entering congestion-prone areas during peak times.

## Parking Management

**Increase in parking space utilization efficiency.**

Measure: Percentage of time parking spaces are occupied versus available.

## Bus Rapid Transit System

**Increase in BRT ridership.**

Measure: Percentage growth in daily BRT passengers compared to previous years.

## Infrastructure Improvements

**Improvement in traffic flow.**

Measure: Average speed increase on improved road sections.

## Innovative Mobility Solution

**Adoption rate of sustainable mobility options.**

Measure: Percentage increase in the use of electric vehicles and micro-mobility services.

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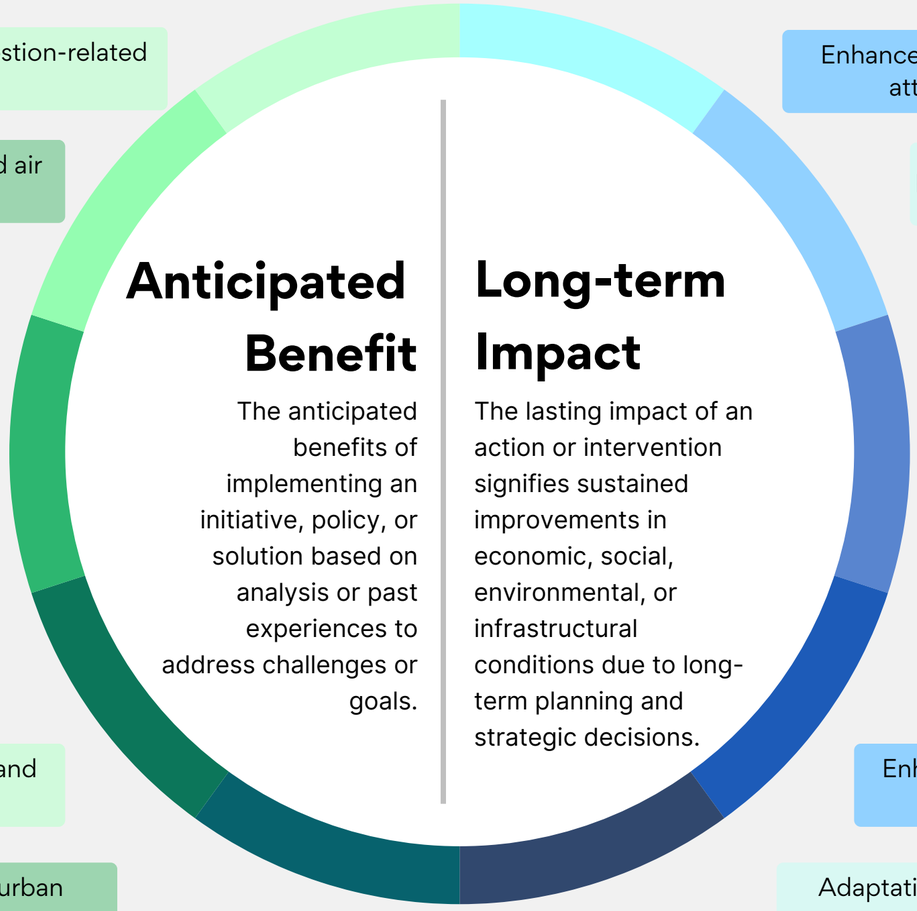
# Anticipated benefits and Long-term impact



## Anticipated Benefit

The anticipated benefits of implementing an initiative, policy, or solution based on analysis or past experiences to address challenges or goals.

## Long-term Impact

The lasting impact of an action or intervention signifies sustained improvements in economic, social, environmental, or infrastructural conditions due to long-term planning and strategic decisions.

- Improved mobility and accessibility across the city.
- Reduced travel times and congestion-related delays.
- Enhanced public health due to decreased air pollution.
- Increased economic productivity and efficiency.
- Promotion of sustainable transport modes and reduced carbon footprint.
- Enhanced safety and reduced traffic-related accidents.
- Improved quality of life for residents through better urban livability.
- Optimized use of existing infrastructure and resources.
- Strengthened resilience to future urban mobility challenges.
- Enhanced public perception and trust in urban governance and planning.
- Sustainable development and resilience to population growth.
- Enhanced economic competitiveness and attractiveness for investment.
- Reduced dependency on private vehicle usage.
- Improved integration and connectivity across different neighborhoods and communities.
- Preservation of natural resources and reduction of environmental degradation.
- Continued innovation and advancement in urban transport technologies.
- Greater equity in access to transportation services and opportunities.
- Enhanced community well-being and social cohesion.
- Adaptation to future transport trends and technological advancements.
- Long-lasting improvements in urban infrastructure and public services.

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# Cumulative Impact

## Economic Growth

- **Boosts Productivity:** Reducing traffic congestion directly boosts productivity by cutting travel times, allowing residents to spend more time at work and less time commuting.
- **Smoother Operations**: Efficient movement of goods and services fosters smoother business operations and supply chains, enhancing economic efficiency.
- **Business Friendly Environment**: Infrastructure improvements and the adoption of Intelligent Transport Systems (ITS) attract investments, creating a favourable environment for businesses, especially in technology and logistics. These projects generate employment opportunities within the transport sector and related industries.
- **Revenue Utilization:** Revenue from dynamic congestion pricing can be reinvested into transport infrastructure, creating a sustainable cycle of growth.

## Improved Public Health

- **Improved Air Quality:** Fewer vehicles on the road mean lower emissions of greenhouse gases and pollutants, improving air quality and reducing respiratory issues among residents
- **Better Commutes**: Commutes become quicker and more predictable, decreasing stress levels and positively impacting mental health.
- **Improved Physical Wellness**: Promoting walking and cycling encourages physical activity, contributing to better overall health transport sector and related industries.
- **Healthy & Safe Cities:** Improved traffic management and public transport reliability reduce the incidence of traffic accidents, making the city safer. A healthier, less stressed population enjoys a better quality of life and is more productive.

## Increased Liveability

- **Increased Appeal:** Enhanced road and transport infrastructure make the city more visually appealing and enjoyable to live in. Developing green spaces and pedestrian-friendly areas improves the city’s aesthetics and provides recreational spaces.
- **Better Mobility & Bonding:** An efficient and interconnected public transport network increases accessibility and mobility for all residents. Initiatives like carpooling and shared mobility foster community engagement and social cohesion.
- **Sustainable Development:** Embracing eco-friendly practices and resilient urban planning supports sustainable development, ensuring Mumbai can adapt to future challenges.
- **Increased Quality of Life:** Reduced congestion leads to more time for personal and leisure activities, enhancing residents' quality of life and making the city more attractive to both residents and visitors.

# Appendix


- https://trafficindex.org/mumbai/
- https://www.ceicdata.com/en/india/traffic-congestion-index-average-by-cities/traffic-congestion-index-average-india-mumbai
- https://www.hindustantimes.com/cities/mumbai-news/mumbai-was-india-s-most-congested-city-in-2021-101644471450502.html
- https://www.tomtom.com/traffic-index/mumbai-traffic/
- https://www.hindustantimes.com/cities/mumbai-news/71-of-mumbai-s-greenhouse-gas-emissions-due-to-electricity-usage-study-101630087951470.html
- https://www.linkedin.com/pulse/how-ruin-indias-best-city-kavali-rajesh/
- https://databank.worldbank.org/source/world-development-indicators
- https://www.sciencedirect.com/science/article/pii/S2352146517305896
- https://www.researchgate.net/figure/1-Noise-Levels-in-dB-Noise-Climate-and-Noise-Pollution-Levels-in-the-study_tbl1_279861861
- https://airquality.cpcb.gov.in/ccr/#/caaqm-dashboard-all/caaqm-landing
- https://www.livemint.com/news/india/traffic-volumes-on-mumbai-s-arterial-roads-analysis-11675023634029.html
- https://timesofindia.indiatimes.com/city/mumbai/mumbai-commute-times-a-detailed-survey/articleshow/98472654.cms
- https://www.mid-day.com/mumbai-news/article/traffic-congestion-in-south-mumbai-key-areas-affected-23155642
- https://www.cseindia.org/mumbai-traffic-speed-analysis
- https://www.itsindiaforum.com/
- https://www.mcgm.gov.in/irj/portal/anonymous/qlbcircular2021
- https://portal.mcgm.gov.in/irj/portal/anonymous?NavigationTarget=navurl://096135a3643bc6c5a7f39e693d487a10
- https://www.mcgm.gov.in/irj/portal/anonymous/qlbudEsti2122
- https://www.mcgm.gov.in/irj/portal/anonymous/qlbudEsti2223
- https://www.mcgm.gov.in/irj/portal/anonymous?NavigationTarget=navurl://33e726072ebb67906360a03dd45472bd
- https://en.wikipedia.org/wiki/Mumbai_Metro#

# Thank You

Summer Projects ‘24

Shriyansh Raj

Ishika Mandal

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