



# Evolution of Urban Transportation Policies in India: A Review and Analysis

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## Abstract

India's rising population and vehicular ownership have led to problems such as traffic congestion, pollution, and road accidents. The transportation sector is a crucial player in the country's economy, but at the same time, it is also a significant contributor to climate change. Since climate change is a global threat, most transportation policies eventually lead to solving the climate change problem to achieve sustainable transportation. Despite commitments from various countries, the carbon emissions are still to come down and require the implementation of ambitious policies. Globally, countries are increasingly putting more effort towards sustainable transportation through various policy initiatives, and so does India. Given the growing transport-related externalities, the policy stance of India towards urban transportation is also gradually shifting to a systems approach from supply-oriented to demand-oriented policies. This paper highlights the significant transportation problems faced in India and how the Government of India's transportation sector policy interventions for cities have evolved since its independence. The challenges and gaps in the existing policies are discussed, and possible ways to frame the policies are presented. This study finds that most government policy initiatives are still to see the intended level of success. This is majorly due to lack of monitoring, complex institutional capacities and urban governance, irregular zoning of land and inefficient comprehensive development and mobility plans.

**Keywords** India · Urban transportation · Transport policies · Sustainability · Developing economies

## Introduction

The rapidly growing Indian population, when coupled with increasing economic levels, leads to substantial vehicular growth. Currently, India stands sixth among the world's largest vehicle producers. The per capita vehicle ownership puts India in the middle spectrum of global countries [1]. Therefore, any rapid growth in income levels and the absence of an appropriate public transportation system boosts vehicular

growth in India. It is predicted that the passenger vehicles' annual sales are likely to strike 10 million by 2030 [2]. The sudden vehicular growth causes various issues such as traffic congestion, fossil fuel consumption and air pollution. The transportation sector is considered to be a critical component in the economy of a nation. The rapidly growing Indian transportation sector heavily relies on fossil fuels and contributes to 6.5% of the nation's gross domestic product (GDP). India stands third among the global greenhouse gas emitter after China and the United States of America [3]. Due to its significance, the global transportation sector shares about 24% of the global CO<sub>2</sub> emissions, with the majority contribution from road transportation [4].

Transportation is one of the leading contributors to climate change. Climate change is one of the biggest threats to humankind, and therefore, most transport policies are formulated around it. Globally, efforts are being put to reduce the emissions from all the sources, including the transportation sector. The Paris agreement in 2015 is a legally binding international treaty on climate change. About 196 countries participated in this treaty and pledged to contain

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global warming from reaching 1.5 °C from the pre-industrial levels. Despite the pledges and targets, emissions kept rising, and target emissions reduction has increased fivefold [5]. To address these issues, India launched many initiatives in recent years. These initiatives are a shift from the traditional supply-centric to demand-centric policies and planning. Post-independence, the Indian transportation system focused on connecting rural areas to urban areas as most people resided in rural areas [6]. In this regard, significant infrastructure development has taken place in constructing roads, railways, flyovers and underpasses. However, the increasing vehicular ownership presented India with new challenges such as traffic congestion, longer travel times, climate change and road accidents. This led to a shift in the policy approach of the Indian government. The ninth planning commission suggested that an extensive mass transportation system solves the growing transportation problems [7]. Since then, many initiatives have been in place to address the transportation problem in India with the broad goal of attaining a sustainable transportation system.

This study aims to present the evolution of the urban passenger transport policies in India. The policy interventions considered in this study are from the post-independence period and restricted to urban road passenger transportation. While policies on other transport sectors are equally important to investigate, covering them in one paper may compromise the in-depth review required and is, therefore, suggested as the future scope of this paper. The objectives of the current study are as follows:

- (a) To review and highlight various transportation-related problems and externalities across the world and in India.
- (b) To review and discuss various policy interventions by the Government of India (GOI) to address the rising urban transportation problems.
- (c) To identify the challenges and gaps in the existing transport policies.
- (d) To propose possible ways to maneuver through the existing challenges and address the problems at hand.

## Evolution of Transportation System in India

A highly competitive transportation system is critical to a country's economic growth. India urbanized slowly before Independence but steadily afterwards, particularly after economic reforms in the 1990s. The urban population has increased from 11.4% in 1901 to 28.53% in 2001 and 31.16% in 2011 [8]. By 2036, urban areas are expected to house approximately 38.6% of the country's population [9]. India's transportation system is a mix of public, private, and intermediate transport modes. Urban transport can be roughly

divided into pre-independence and post-independence eras. Before Independence, the predominant modes of transport were a bicycle, steam engine, rail, and tram. The onset of diesel engines happened in 1920, leading to the production of cars and buses. After Independence, cars have become the dominant mode of travel for the rich in the country. Buses and intermediate transport modes such as cabs and auto-rickshaws were widely used by the middle- and low-income groups. The first metro started operating in 1984, in Kolkata and the first high-quality BRTS (Bus Rapid Transit System) started in 2009 in Ahmedabad [10]. Therefore, the current public transportation modes include bus, metro, suburban and monorail. The private modes in use include two-wheelers and cars, and intermediate modes include cycle rickshaws, autos, and cabs.

Even though traffic in India is diverse, personalized transport vehicles such as two-wheelers (including motorcycles, scooters, and mopeds) and cars (including jeeps) account for more than 80% of the vehicle population in most major Indian cities. Cities in India have lower vehicle ownership as compared to the cities in developed economies. Still, they suffer more from traffic congestion, longer travel times, pollution, and accidents [11]. The significant contribution to these is by the private transport modes. The growth of the registered two-wheelers and cars has increased by 164% and 192%, respectively, from 2001 to 2011 [12]. Similarly, in some major cities, the mode share of public transport has decreased by 20%, from 1994 to 2007 [13]. There are several reasons stated in the literature for the increase in private modes, such as easy availability of vehicle loans, improved productivity of automobile industries and improved socio-economic status due to increased Gross Domestic Product (GDP). Other important reasons for the shift to private transport modes discussed in the literature are public transport modes' inefficiency and poor quality [14]. These factors incentivize people to shift to private modes.

Connectivity within the cities through intra-bus transport service is good in major cities of India, which are run mainly by the State Transport Undertakings (STUs). 62% of the total trips are being made through intra-bus transport service in India compared to 21, 11, and 15% in Beijing, Chicago, and London, respectively [15, 16]. Despite this demand, the bus operators in most cities in India face enormous economic loss [17]. Some of the reasons reported in the literature are the inadequate number of buses compared to the demand, inappropriate route selection, lack of optimized mechanisms to strike a balance between service and revenue generation, and so on [18–20]. Furthermore, metro and suburban rail services are being operated in 13 and 9 cities, respectively. Similarly, BRT service is being operated in 13 cities.

## Problems with the Current Transportation System

### Developed Economies

Since the second industrial revolution in the 1860s the transportation system has metamorphosed significantly to become a crucial component in every country's economy. For many years, the transportation industry thrived solely on fossil fuels, a limited supply. It played a significant role in influencing and shaping people's lives through effective and efficient transport [21]. Alongside the development made in this field, many predicaments have emerged. The expanded urbanization and income levels resulted in increased vehicle ownership, congestion, accidents, air and noise pollution, and fossil fuel resources depletion. Most of the prosperous economies are car-dependent. For example, the United States (US) government spends a lot of money on public transportation. However, despite heavy subsidies, the public transportation system ridership is nowhere near optimum in most US cities. The reason is because of the fewer service hours and longer interchange times. In addition, the US policymakers and public sees it as a social welfare program rather than a critical public utility [22].

Like the US, many other developed economies are primarily car-dependent. Although some countries have sound public transportation systems, the growing population and limited space availability make it difficult to accommodate new infrastructure, causing congestion and pollution. For example, Germany's per capita annual public transportation trips are six times higher than the US. Still, the high car ownership of Germany is one of the main reasons for congestion and increasing air pollution [23]. Munich, one of the biggest cities in Germany, is also called the 'traffic capital of Germany' due to the longest queuing [24]. A similar trend is observed in Hamburg and Berlin. In other major European cities such as Madrid, Rome, and Spain, average travel times under normal traffic conditions are significantly lower than the average travel time due to congestion [25]. Efforts are underway to move people away from personal vehicles, improve vehicle and fuel technology to solve these problems. The developed countries are improving public transportation systems, introducing shared mobility services, Mobility as a Service (MaaS) [26]. However, unregulated usage of any of these modes of transport leads to congestion and does not solve the problem. Therefore, having a safe NMT infrastructure will decelerate personal vehicle growth.

As discussed above, Germany has an excellent public transportation system as well as car ownership. Therefore, Germany shifted its attention towards improving the

NMT infrastructure. For example, decades of investments in public transportation and NMT in Freiberg resulted in reduced car ownership [27]. Further, the shared bike services in Europe were successful for a while in reducing congestion and pollution. However, many reported theft and damage cases eventually bankrupted the companies [26]. For example, congestion and air pollution in China have become one of the biggest environmental concerns threatening human health and the environment [28–31]. This can be attributed to various reasons such as economic boom, population growth, motorized vehicular growth and topography [32].

### India

India is one of the fastest growing economies globally and the second most populous country, with over 1.38 billion people in 2021. In comparison with the US and China, the land area of India is approximately 3.5 times smaller. However, the population density is 13 times more than that of the US and 3 times more than China [33]. The population density of India increased from 154 persons/sq.km in 1961 to 455 persons/sq.km in 2018 [34]. Over one-third of the residents live in urban areas, and more will be created by 2050 due to rapid growth in the population [35]. A country's economic activities cannot thrive without an infrastructure base. Due to its extensive infrastructure usage, the transportation sector plays a crucial role in the economy [36]. For developing economies such as India, it is a challenge to address the issues related to transportation while maintaining economic growth. The increased economic activity along with the enormous population growth led to increased vehicular ownership in India.

In 1951, the total number of registered motorized vehicles in India was 0.3 million, and the number rose to 253 million in 2017 [37]. The compound annual growth rate (CAGR) of the total vehicles registered is 10.11% from 2007 to 2017. The highest CAGR of 14.8% occurred from 1981 to 1991 [37]. The population growth alone has a minimal impact on vehicular growth. The other significant factors contributing to vehicular growth are urban development and economic growth [38]. India also faces severe traffic congestion problems, air and noise pollution, and road accidents. Many studies have attempted to solve these problems through various methods. [39] studied the mobility characteristics across 154 cities in India. It is reported that the mean travel speed in India, as seen from 154 cities, is 24.4 kmph. The mean speed for the slowest city is 16.2 kmph, and the fastest city is 34.9 kmph. This paper also found that Kolkata is the slowest city, and Bengaluru is the most traffic-congested city in India. The higher levels of traffic congestion are resulting in more commuting times between two places. In Central Delhi, the mean travel time spent commuting during peak hours

increases by almost 40% [39]. Due to increased income levels and inadequate public transportation facilities, people are resorting to personal vehicles. The vehicular composition in India shows that about 70% are two-wheelers. On the other hand, cars, jeeps, taxis, and auto-rickshaws account for 25%, and public transportation vehicles are only 0.7% [40].

Congestion often leads to air pollution. The level of exposure to these emissions is high as vehicles come to a gridlock. In Delhi, it is observed that as the average morning peak hour speeds dropped from 28 to 23 kmph, the nitrogen dioxide levels increased by 38% [41]. India stands third in CO<sub>2</sub> emissions after the US, with the leading emissions from China [3] and out of the world's top 20 most polluted cities, 13 are from India [42]. In addition, 75% of GHG emissions from the transportation sector are from road transport [43, 44]. About 99.9% of the Indian population resides in areas exceeding the air quality permissible limits set by the World Health Organization (WHO) [45, 46]. The air quality studies in India projected the PM<sub>2.5</sub> concentration to increase, resulting in premature mortality by 2050 even under the business-as-usual scenario [42, 47–52]. This indicates that unless aggressive air pollution mitigation policies are in place, severe consequences are inevitable.

India is vulnerable to climate change impacts such as extreme weather events, sea-level rise and shifts in precipitation due to climate change [53]. The observed trends in the extreme precipitation in India show that the frequency of such events will be on the rise in the coming decades [54]. The transportation sector is one among many sectors that are affected due to climate change effects. It is constantly under threat from various turbulent events such as urban flooding [55, 56]. The occurrence of floods in India in the recent decades resulted in colossal damages in terms of economy and lives [55, 57–62]. Due to improper drainage management, excessive encroachment, and concretization of natural land, urban flooding in cities is common even under normal rainfall conditions [56, 63]. Cities in India are already crawling during peak hours, and urban flooding further diminishes the level of service on the roads, making it a nightmare for the commuters.

Road accidents are another major epidemic of the world and a significant cause of morbidity and mortality. The broad roads, high-speed vehicles and low discipline are the primary reasons for the accidents. Globally, 2.1% of the mortality is due to road accidents and ranks 4th among the leading causes of death. India shares about 10% of the fatalities due to accidents worldwide [64]. Since two-wheelers are more in India, they account for a significant share of accidents. It was also observed that the accidents in India are high during May–June and December–January, highlight the significance of extreme weather to accidents [17]. India has a mixed road traffic condition. Pedestrians and cyclists are also responsible for road accidents. Damaged footpaths and Hawker's

force pedestrians to walk on the roads in some of the busiest streets leading to accidents.

While there is significant growth of urban dimensions, the land area available for a country remains the same. Therefore, it requires meticulous urban planning to utilize and allocate the available space to various sectors. The central, State and City's planning authorities should design and implement appropriate policies to tackle the problems discussed above. The following section highlights how the transportation policies in India came into existence after India's independence.

## Evolution of Transportation Policies in India

India is a country that is in a transition phase from a developing economy to a developed economy. The immense economic growth would not have been possible without industry and service sectors, primarily concentrated in the urban areas. Therefore, the economic growth of a metropolitan area is strongly correlated with the overall economic growth of India. However, economic development is paralleled with increased transportation and environmental problems, as discussed in “[Developed Economies](#)”. Post-Independence, India had put various efforts through multiple policy interventions to address multiple issues related to transportation. Some of the main policies are listed and described in the following sub-sections.

### Metro Railways (Construction of Works), 1978 Act and Amendment Act in 1982

The Indian Railways played a crucial role in transporting goods and people across major cities in India after the independence. Therefore, intending to develop the railway transportation system within the metropolitan cities in India, the Government of India (GOI) had proposed the metro railways act in the year 1978. The act intended to construct the metro railways in the metropolitan cities of India. This act was primarily enacted to create metro railways in Calcutta, India. The act also states that it can be applied to the national capital region and other metropolitan cities upon consultation and agreement of the state governments. Further, the act was amended in 1982 and was called the Metro Railways (Construction of Works) amendment act, 1982.

### The Air (Prevention and Control of Pollution) Act, 1981

The industrial revolution has led to increased industries and automobiles. Consequently, air pollution became one of the significant concerns by the late 1950s and early 1970s [65]. The impact was evident through severe smog



incidents in the US and England. Due to the intensity and danger posed by air pollution, countries assembled for the first United Nations Conference on the Environment, Stockholm, Sweden, in 1972. India engaged in the conference and vouched to take suitable measures to enhance quality and control pollution. This paved way to create the Air (Prevention and Control of Pollution) Act in 1981, amended in 1987. According to this act, the responsibility of setting and tracking the vehicle emissions standards lies with the State Pollution Control Board (SPCB) under the guidance of the Central Pollution Control Board (CPCB).

### **The Environment (Protection) Act, 1986**

This Act can be considered an extension of the air pollution act based on India's commitments at Stockholm in 1972. In 1986, the GOI implemented the Environment (Protection) Act to protect and improve the environment and the associated matters. Similar to the Air pollution act, the SPCB and CPCB are the responsible authorities.

### **The Motor Vehicles Act, 1988**

The increased vehicular population led to increased accidents. Therefore, to enhance traffic safety on the roads and minimize road accidents, the GOI drafted the Motor Vehicles Act in 1988 and implemented it in 1989. This act aims to consolidate and amend the laws related to motor vehicles in India. This act provides licenses to drivers, vehicle registration, traffic regulations and permits to control motor vehicles. Further, it also provides for penalizing the violations, if any.

### **Integrated Transport Policy, 2001**

Due to steady economic growth in India, the earlier dominant modes of transport such as train and bus are now being shared by cars, two-wheelers, and other intermediate modes of transport. The liberalized Indian economy needs an efficient transportation system providing adequate and reliable transport infrastructure. For better policy planning, the transportation sector should be seen as an integrated structure with all the modes of transport interacting with one another by maintaining healthy competition. Therefore, it is critical to have an overall and integrated policy to encourage competitive pricing and coordination between different modes. In this regard, the Planning Commission provided the Integrated Transport Policy framework, 2001. The main objective of this policy was to foster the development of various transport modes for a safe, sustainable, efficient, and regionally balanced transportation system. Each of these transport modes should operate within its range of economy

and usefulness, maintaining the competitiveness which helps in the overall development of transportation infrastructure.

### **National Auto Fuel Policy, 2003**

The transportation sector is one of the most significant contributors to air pollution because of its dependency on fossil fuels. The growing concerns for environmental degradation led the government to focus on improving the fuel standards in India. In this regard, the GOI mandated the National Auto Fuel policy in 2003 under the Ministry of Petroleum and Natural Gas. This policy covered various aspects such as vehicular emission norms, quality of fuel, strategies to reduce emissions through vehicle and fuel technology [66]. Currently, the fuel standards in major cities in India are updated from Bharat Stage (BS) IV to Bharat Stage (BS) VI, equivalent to Euro 6 standards. The urgency and importance of emissions reduction have led to skipping BS V standards.

### **Jawaharlal Nehru National Urban Renewal Mission (JNNURM), 2005**

The Jawaharlal Nehru Urban Renewal Mission (JNNURM) was set up in 2005 under the Ministry of Urban Development. Under this mission, the cities were provided with funds by the central government to modernize the existing urban infrastructure. The main objective of this mission was to empower the Urban Local Bodies (ULBs) to manage the local urban issues (7) successfully. Through JNNURM, the GOI aimed at creating sustainable transportation with a focus on improving the public transportation system across major cities [67]. Further, JNNURM mandated cities to prepare Comprehensive Development Plans (CDPs) and Comprehensive Mobility Plans (CMPs), highlighting the significance of land use and transport planning. Since then, the Central government has actively participated in urban transport by forming the National Urban Transport Policy (NUTP), 2006.

### **National Urban Transport Policy (NUTP), 2006**

Under the Ministry of Urban Development (MoUD), the central government introduced the National Urban Transport Policy (NUTP) in 2006. The vision of this policy is to move people rather than vehicles. NUTP aims to provide safe, affordable, quick, comfortable and sustainable access to all the facilities. In line with its vision, this policy addresses congestion and pollution problems by providing more road space to public transportation, improving traffic performance through traffic management instruments, mitigating private vehicle growth, and improving vehicle and fuel technology to reduce air pollution. Further, NUTP advocates

establishing the Unified Metropolitan Transport Authority (UMTA) in cities with over a million inhabitants [68].

### **National Action Plan on Climate Change, 2009**

Due to the growing concerns of climate change and India being in an economic transition state, keeping the emissions under control is critical. The Indian government recognized the importance of tackling climate change. It hosted the United Nations Framework for Climate Change Convention (UNFCCC) in 2002. The Delhi Ministerial Declaration was adopted here, and it calls for the developed economies to share the technology with the developing economies to confront climate change. Few years down the line, in 2009, the first-ever National Action Plan on Climate Change (NAPCC) was introduced to address the climate change problem. The NAPCC has eight missions, and among them, the National Mission on Sustainable Habitat focuses on transport sector emissions reduction through a modal shift towards public transportation, using alternative fuels and good urban planning to achieve a low carbon transportation system.

### **National Road Safety Policy, 2010**

The rapid vehicular growth combined with faster and broader roads led to a steady increase in road fatalities in India. The GOI identified that a bulk of the road accident victims are poor people. Due to the increasing road accidents, it is recognized as a public health issue. Therefore, the GOI has drafted the National Road Safety Policy in 2007 and approved it in 2010. The policy aims to ensure safer roads by reviewing and upgrading the road infrastructure standards with international best practices. In addition, the policy focuses on licensing safe drivers by enhancing the licensing procedure, improve vehicle safety from the design, manufacturing, usage and maintenance perspective [69].

### **National Electric Mobility Mission Plan (NEMMP) 2013**

The National Electric Mobility Mission Plan (NEMMP) was adopted in 2013 with the deadlines as 2020. This plan highlights the significance of adopting electric vehicles (EVs). The NEMMP presented a framework for the early adoption of EVs and hybrid vehicles. Further, the Faster Adoption and Manufacturing of Hybrid and EV (FAME) was introduced in 2015 to reduce the initial purchasing costs and early adoption of EVs and hybrid vehicles.

### **India Transport Report: Moving India to 2032 (2014)**

As discussed in “[Developed Economies](#)”, the transportation system plays a crucial in boosting the country’s economy.

The per capita income should double for every 10 years to achieve a sustainable middle-income status. However, the desired target demands an adequate transportation system with appropriate quality and quantity. In this light, the GOI in 2010 constituted the National Transport Development Policy Committee (NTDPC). This policy aims to provide a safe, comfortable, and long-term sustainable transport policy. The committee submitted its findings and solutions in the year 2014 to the GOI. The study considers the long-term timeline as 2032 when India should be ready to adopt multimodal transportation facilities.

### **Intended Nationally Determined Contribution (INDC), 2015**

India had offered its Intended Nationally Determined Contribution (INDC) to the Secretary of UNFCCC prior to the Conference of Parties (COP) on Climate Change in 2015. As per the INDC, from the 2005 levels, India vowed to subdue the emissions intensity of its GDP by 33–35% by 2030. To reach this target, India is resolute in upholding and enhancing the existing policies by promoting renewable energy usage, boosting the alternate fuels’ share in the overall fuel mix, and mitigating emissions from the transportation sector.

### **Smart Cities Mission, 2015**

The GOI under the MoHUA launched the Smart Cities Mission in 2015. The mission’s main objective is to improve the quality of life in the cities by promoting a sustainable environment and smart solutions. From the transportation sector perspective, the smart cities missions focus on providing for efficient urban mobility, smart public transport, and a sustainable environment. The three main areas for efficient urban mobility highlighted in this mission are smart parking and intelligent and multimodal transportation systems. For the cities to acquire funds for urban transportation under the smart city project, the infrastructure improvement scheme should comply with the NUTP guidelines.

### **Green Urban Mobility Scheme, 2017**

India took another step to achieve its Intended Nationally Determined Contributions (INDCs) targets of reducing greenhouse gas emissions by unveiling the Green Urban Mobility Scheme in 2017. This scheme is initially launched across 103 cities with over 0.5 million population to make the transportation sector more sustainable. This scheme promotes hybrid/electric vehicles and alternate fuels for public transport, resulting in a drastic reduction in emissions. In addition, the scheme promotes the non-motorized transportation system by developing the walking and cycling infrastructure, serving as the first and last-mile connectivity. In

addition, significant importance is given to the Bus Rapid Transit System (BRTS) and Intelligent Transport System (ITS).

### **National Policy on Transit-Oriented Development, 2017**

In 2017, MoHUA introduced the National Policy on Transit-Oriented Development (TOD). This policy aims to integrate land use with mass transit systems. The influence area of the mass transit system mentioned in this policy is 500–800 m. This policy allows for a high-density development within the influence range to reduce the extra miles traveled using the private mode of transport. By providing adequate non-motorized transportation infrastructure and a bicycle sharing system, this policy aids in reducing congestion and emissions by a significant amount.

### **Metro Rail Policy 2017**

The Metro Rail Policy came into existence in 2017. This policy highlights the demand for a high-quality public transportation system to cater to the rapidly growing urban population. The policy also presents the need for a framework to implement metro rail projects. One of the crucial aspects highlighted by the policy is that the multimodal transportation system will be the future, for which the metro rail system should be the backbone. In addition, the policy also advises the cities to develop a CMP under the statutory body UMTA. The importance of TOD and feeder buses within the catchment area of the metro are also highlighted.

### **National E-Mobility Programme, 2018**

The National E-Mobility Programme was launched by the Ministry of Energy in 2018. This programme focuses on the long-term growth of the EV industry. This is done by subsidizing the vehicle manufacturers, fleet operators and charging infrastructure providers. This policy advocates for public procurement of EVs as part of their fleet to make EVs more attractive and boost public attention.

### **National Policy on Biofuels, 2018**

The National Policy on Biofuels was initially implemented in 2009, aiming to blend biofuels with conventional fuels. However, India failed at reaching the targets with a significant amount. This policy is an updated version of the earlier one, aiming to blend 20% ethanol in petrol and 5% biofuel in diesel by 2030 [70].

### **Motor Vehicles Act (Amendment Bill, 2019)**

The Motor Vehicles Act (Amendment Bill) is an updated version of the Motor Vehicle Act, 1988. The penalty for violations is significantly high compared to the previous Act. As per this Act, the traffic violators and the environment degrading vehicles and the manufacturers will receive stricter punishments. Further, this Act also focuses on improving land use transport planning to make the transportation system more sustainable and cities more livable.

The following section discusses the challenges and gaps with policies described in this section.

## **Challenges and Gaps in Policies**

### **Mobility and Infrastructure**

In spite of multiple efforts by the GOI, traffic congestion and vehicular emissions are still on the rise in India. Most of the policies that exist today have been in place for 4 decades and have evolved. However, the evolved policies fail to address the transportation needs of the rapidly growing population. The Motor Vehicles Act (1988) addresses the need to improve the licensing system and reduce accidents. Policies such as these have been introduced when the vehicle density on the roads was very sparse and income levels are significantly low compared to current times. With substantial economic development and increased urbanization, this policy fails to address the congestion and pollution problems. The weak penalties proposed in this policy and inefficient enforcement contribute to a significant share of users flouting the transport rules and regulations. However, the recently updated Motor Vehicle Act (Amendment Bill, 2019) has revised the penalties. The impact is yet to be understood. The national transportation sector gained specific attention through JNNURM and NUTP policies. These policies aim to improve the safe, accessible, comfortable, and affordable public transportation system, reduce vehicle growth, encourage hybrid/electric vehicles and air pollution. These policies suggest that the Urban Local Bodies of the major cities should prepare Comprehensive Mobility Plans to manage the local transportation issues. These CMP's are supposed to be the future guiding books for developing the transportation system. The CMP's discuss the emissions reductions plans in a vague manner. They discuss the targets but do not present the measures to reach the targets. For instance, a typical CMP assumes an increase in the modal share of public transportation by a certain percentage. However, how public transportation should achieve high mode shares are not discussed. This lack of comprehensive policy preparation and evaluation creates a gap in knowledge about achieving the desired target. This is one of the reasons why the CMP's do

not significantly impact reducing transportation problems, and private vehicles continue to grow.

Policies such as Transit-Oriented Development take a long time from the amendment phase to implementation, leading to a significant rise in land prices. Therefore, it is challenging to acquire the private land for developing the NMT infrastructure, which acts as feeders to transit hubs. Most of the major cities in India are yet to improve their feeder services and NMT infrastructure significantly. This might result in low ridership of the metro services and increased vehicular growth due to increased economic activity near the transit hubs. Therefore, all the players of the LUB's should come under one hood and design appropriate land use transport policies such as the Integrated Transport Policy that also favors the TOD policy.

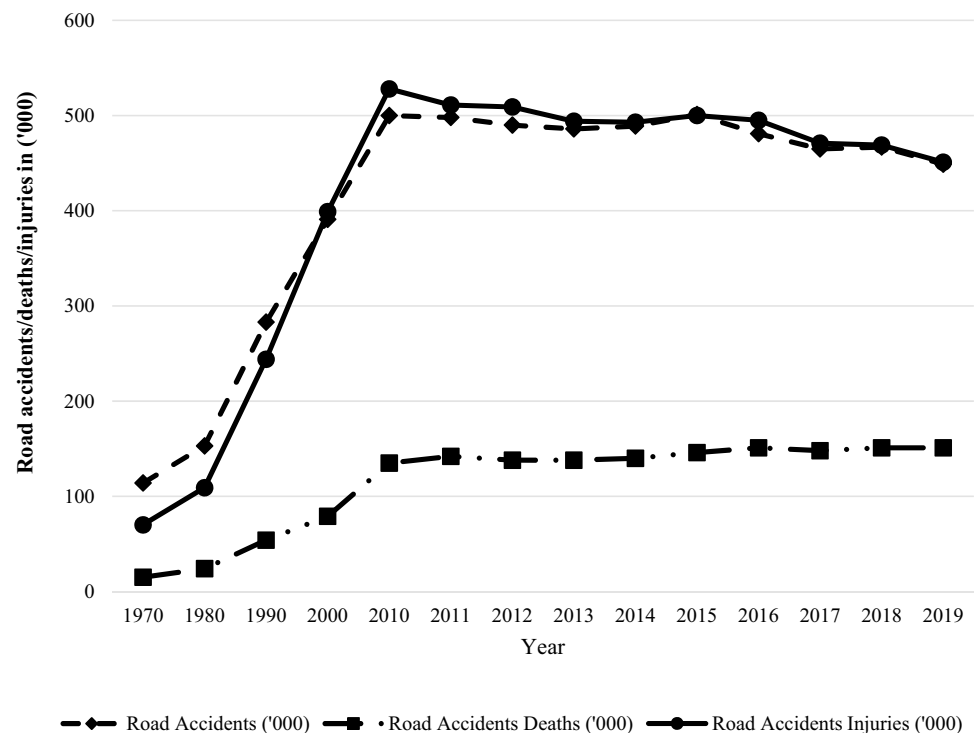
## Road Safety

One other area the government policies thrust upon is road safety. In this regard, the National Road Safety policy was introduced in 2010. This policy aims to improve road safety through infrastructure improvements. This policy impacted reducing the growth rate of the accidents occurring in India. A time-series graph of road fatalities in India from 1970 to 2010 is shown in Fig. 1, which shows that the road accidents/deaths/injuries were increasing from 1970 to 2010. The National Road Safety policy intervention in 2010 has helped reduce the growth in road accidents/deaths/injuries and has been almost constant from 2010 to 2019.

However, comparing mode-wise deaths for 2017, 2018 and 2019, shows that the total accident deaths have increased for some of the modes from 2017 to 2019, as seen in Fig. 2. India has a heterogeneous traffic system where all modes share the same space without any specific lane allotment. Due to increased motorized traffic and the absence of efficient non-motorized transport infrastructure, the NMT deaths due to accidents have increased.

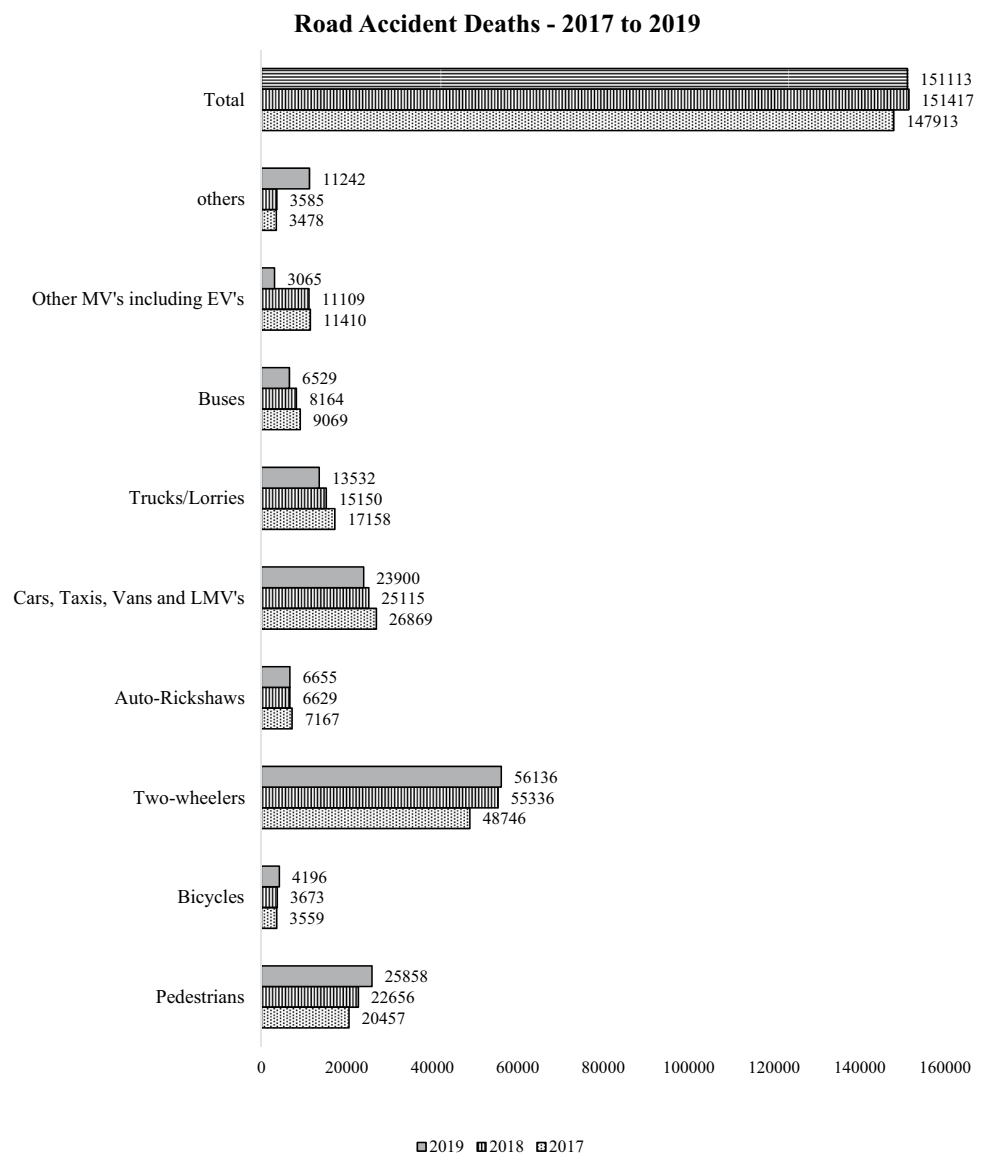
From Fig. 2, it can be seen that bicycles, pedestrians, and others (animal-drawn vehicles, cycle rickshaws) have shown increased deaths from 2017 to 2019. In contrast, motorized traffic showed reduced accident deaths over the same years. It is evident from these numbers that despite government framing policies on improving sustainable transportation, these policies are failing at the implementation level. Therefore, it is crucial to effectively utilize the available space in providing a safe and secure infrastructure for NMT users. The high land acquisition costs and the lengthy process make it a critical barrier for designing land use transport policies. A significant part of the infrastructure development is delayed due to this reason [71]. The land markets are heavily distorted due to zoning and development. The complex zoning system makes it difficult during land acquisition. In addition, the zoning system creates a scarcity of available land for infrastructure development. The local planning bodies have created well-planned pockets of townships outside the city limits. The idea is to decongest the city by diverting some development areas to the city's periphery. However, this has led to various issues such as urban sprawl, vehicular

**Fig. 1** Annual road accidents/deaths/injuries from 1970 to 2019. Source: [93]





**Fig. 2** Mode-wise road accidents comparison 2017–2019. Source: [93]



growth, and accessibility. Due to scarcity in the supply of transportation infrastructure to these farther areas, vehicular ownership has increased. The development of the new townships has increased the land value, and the commercial complexes started coming up, leading to urban sprawl. In addition, these areas have low density, and providing an excellent public transportation system is a challenge.

**Social Equity**

Globally, social equity is one of the crucial components that is often neglected in transportation policies. The rural areas in the US and European countries still face low public transportation facilities [72, 73]. This situation is more concerning in developing economies, perhaps due to a lack of financial resources to maintain and upgrade the existing public

transportation system. Until recently, the public transportation and NMT system in both urban and rural areas were neglected. In urban areas, the zoning system has distorted land prices. Due to higher land prices at specific locations, the low-income people who cannot afford such costly locations are forced to move to a relatively less costly location. Studies have shown that the lower income group primarily depend on public transportation for commuting [74, 75]. Due to inefficient land use transport policies, low-income groups are often deprived of basic public transportation facilities, making it challenging to commute [76]. Therefore, they rely on personal vehicles, which makes their trip costlier than public transportation and restricts them to travel far in search of better opportunities. In addition, men travel more than women and contribute more towards congestion and emissions. The high-income groups use more personal

vehicles and contribute more to emissions and congestion, but a significant share of impacts is borne by the low-income groups [77, 78]. However, the transportation policies implemented in India to date does not include equity in its planning framework. The UN SDG Target 11.2 states that by 2030 “countries should provide access to safe, affordable, accessible and sustainable transport systems for all, with special attention to the needs of those in vulnerable situations—women, children, persons with disabilities and older persons” [79]. Most of the transportation policies realized the importance in the transportation sector and are advocating for it. Therefore, maintaining equity in transportation policies helps in reducing personal vehicle growth. If sustainable cities and communities are to be achieved, it is essential to address the requirements of every section of the community.

### Fuel and Vehicle Technology

The GOI has also focused on improving fuel and vehicle technology, apart from improving mobility and infrastructure changes in the transportation system. The policies National Auto Fuel Policy (2003), National Electric Mobility Mission Plan (2013), National Policy on Biofuels (2018), and National E-Mobility Programme (2018) are the policies focused on improving fuel and vehicle technology. The National Auto fuel policy is strictly monitored across the major cities in India. It is currently on track and comparable with euro standards. The National Policy on Biofuels was initially implemented in 2009. Due to the low supply of biofuels in India, the desirable blending targets of biofuels with petrol and diesel were not achieved. Therefore, the GOI released the revised policy with new targets in 2019. According to the proposed targets for 2030, India requires to produce 22% more biofuel. However, the annual production growth between 2019 and 2025 shows the production falls short by 86% [80]. The GOI’s electric mobility-related plans and policies will help shift energy usage away from fossil fuels. But the critical question that should be addressed is will it solve the emissions problem? Currently, the energy mix in India is 74% non-renewable and 26% renewable sources. Therefore, electricity generated under this energy mix leads to a significant increase in vehicular emissions [81]. Consequently, it is crucial to shift the energy sources from non-renewable to renewable before expanding these policies to a large scale.

### Urban Governance and Institutional Arrangement

Governance in urban transport is a multifaceted method where various players influence the overall quality and quantity of transportation infrastructure and its service provision [82]. Governance plays a pivotal role in implementing urban

transport policies [83]. A healthy operating institutional framework is decisive for victorious policy implementation. The policy implementation draws multiple agencies under one hood to reach desired targets [84]. Due to multiple actors in the policy implementation, it is challenging to make these arrangements run effectively and require imaginative and flexible solutions.

Urban development is primarily a state government’s responsibility as per the seventh schedule (Article 246) of the Indian constitution. The central nodal agency for urban transport-related matters is the Ministry of Housing and Urban Affairs (MoHUA). The state government implements the central government’s initiatives through their Urban Local Bodies (ULB’s). Although the central government sets the guidelines, it is not mandatory for the state government to formally bind to these directives. They are allowed to formulate their own norms. The primary role of urban development is allotted to the state or local governments according to the 74th Constitutional Amendment Act of 1992, making the lower level public administration an essential player in urban development [85]. In addition, the local governments are provided with administrative and fiscal decentralization. However, the reliance of local governments on the higher government levels for funding hindered the progress. They lack the power to gather additional revenue, and if this situation persists, cities will not be able to improve their infrastructure. Therefore, the ULB’s must be empowered to operate as an independent body to accumulate funds needed for the infrastructure development projects. By doing this, the LUB’s can expand the infrastructure base, improve the quality of sustainability services to their residents, and provide for the accelerated growth of the Indian economy.

As per the GOI guidelines (Oct 2010) for Smart Cities for sustainable development, one of the essential pillars is Institutional infrastructure that includes governance. Activities that are related to planning and managing an urban system are often referred to as institutional infrastructure. Therefore, institutional infrastructure, which includes governance, is one of the essentials pillars for smart cities’ sustainable development. The main goal of the smart city initiative includes providing smart and sustainable transport with smart governance. In this regard, the MoHUA in 2018 invested a significant amount across 99 Indian cities. The Special Purpose Vehicle (SPV) set up at the city level under the Companies Act, 2013 implements the smart cities mission. The State/UT and the ULB’s jointly promote these missions, acting as equal shareholders. Looking at the highest investments made in this mission, it is crucial to understand that not much investment is in setting up a suitable institutional framework with appropriate technical skills. Therefore, it is imperative to strengthen the institutional capacity to implement the policies and utilization of funds properly. Nevertheless, the LUB’s across India used only 4% of the

total funds, showcasing the inadequate institutional capacity and inefficient policy implementation process [86].

### Way Forward

Traditionally, India’s urban transportation and urbanization policies have been supply centric. Till early 2000, the primary focus was given to connectivity between the rural and urban areas. It was during this time where many investments went into transportation infrastructure development [6]. This trend has been observed from the first five-year plan to the ninth five-year plan. In the ninth five-year plan, the government realized that one of the solutions to the growing transportation problem is to shift focus from supply-centric to demand-centric policies and planning. Under a demand-centric transportation system, the aim is to move more passengers for a given transport supply. However, India is still struggling to shift completely towards the demand-centric transportation system. We are still focused on widening roads and building flyovers and underpasses rather than creating extensive public transportation and NMT systems. As per the Paris agreement, countries pledged in 2005 to reduce the emissions to mitigate the global surface temperature rise from reaching 1.5 °C. But the emissions kept increasing, and currently, India and other countries should cut their emissions by 15% every year [87]. Therefore, supply-centric policies and planning are no longer the solutions for India to reach these challenging targets. India must invest in infrastructure that moves a significant amount of passengers for a given infrastructure supply. At the same time, it should also be noted that economic constraints play a significant role in project implementation. Therefore, the government should consider the passengers using a mode of transport for the investment made per kilometer. The authors calculated a comparison of various modes of transport and the return on investment for Bengaluru, which is presented in Table 1.

From Table 1, it can be seen that the metro carries more passengers than any other mode of transport. However, the investment to create a metro network is also significantly high. Comparing metro and Bus Rapid Transit System (BRTS), it can be seen that investments for metro infrastructure are almost 40 times that of the BRTS. However, the number of passengers transported per hour per direction is more by just four times. One of the main variables that should be used to measure the success of any infrastructure project is passengers transported per crore of investment made per kilometer besides other vital parameters such as travel demand on the corridors. From Table 1, it can be seen that at grade, BRTS gives the best returns on investment by carrying 3750 passengers per crore investment per kilometer.

In addition, the COVID-19 pandemic has posed a new challenge to the transportation industry. The fear of moving with crowds might reduce mass transportation system usage and increased personal vehicle growth. Therefore, the GOI and the ULB’s should incentivize the public transportation system and provide a safe, secure, comfortable, and reliable public transportation system. NMT, also known as the active transportation system, is a reliable solution for the post-COVID-19 scenario. It helps maintain social distance norms and keeps people active and healthy, essential under pandemic circumstances. Therefore, significant investments should go into these sustainable transport modes before a surge in vehicular growth.

The European Union (EU) is at the forefront in reducing emissions from the transportation sector. EU’s ambitious policies aim to reduce the emissions from the transportation sector by 90% by 2050. The EU focuses on improving the public transportation system, investing, incentivizing electric vehicles and the charging infrastructure, improving the non-motorized transportation system to achieve those targets. A significant percentage of the vehicle fleet will be replaced with low/zero-emission vehicles soon [88]. Apart from these strategies, the focus is on restricting vehicular movement through effective traffic management strategies

**Table 1** Comparison of return on investment for various transportation modes

Particular	At grade			Elevated	
	POD taxi	BRTS (at grade)	Metro (single track per direction)	Elevated Metro corridor (assuming 2 lanes per direction)	Elevated corridor (BRTS only)
Investment in crores (10 million) of INR (per Km)	50	4	150	166	166
Carrying capacity (persons/hr/direction)	9030	15,000	69,000	3600 (138,000 capacity by 2-track metro/direction on the same width)	15,000
Passengers transported/crore/Km	181	3750	460	22 (831 for a 2-track metro per direction for the same width)	90

such as congestion pricing, shared mobility, and Mobility as a Service (MaaS) [26, 73]. Congestion pricing is one of the best policies in reducing congestion and pollution [89]. In Europe, it is widely used in London, Stockholm, and Oslo. In England, the implementation of congestion pricing has reduced the central business district's volume by 20% [90]. Apart from the EU, congestion pricing is a popular traffic regulatory measure in Singapore. However, congestion pricing is not fancied in many countries, including India. The possible reasons for this could be rejection from political parties, local business vendors, the public that resides around the periphery of the cordon and infrastructure challenges. Therefore, advertising this policy positively garners more attention and demand than showing it as a regulatory measure. For instance, instead of promoting congestion pricing as the penalty paid by the user for causing congestion, it can be advertised as the premium paid by the user to access less congested roads. In addition, providing subsidies and safe and secure NMT infrastructure reduces congestion and pollution and improve sustainability [91]. The Heavy Occupancy Toll (HOT) lanes are also potential solutions to address the transportation problems [92]. It is widely used in the United States, and the most prominent HOT lane is in Israel. Unlike congestion pricing, HOT lanes allow the high occupancy vehicles such as buses to use separate lanes. To increase the usage of HOT lanes, personal vehicles with more than the average occupancy levels are allowed through HOT lanes with a subsidized price. This measure aids in reducing the number of vehicle kilometers traveled due to increased occupancy levels.

Shared mobility services and Mobility as a Service (MaaS) are other policies gaining significant attention in European countries [73]. These two policies aid in reducing personal vehicular growth, thereby reducing congestion, pollution, and increased road safety. Shared mobility is a service where more than one person uses a common mobility service. In recent times, this service has been identified as a potential way to reduce transport sector emissions, specifically from urban areas. However, this service will not solve congestion or pollution due to low occupancy levels in the long run. Therefore, effectively using this service requires at least medium occupancy vehicles to reduce the passenger kilometers traveled. It should also be noted that the flexibility offered by the shared mobility services might disrupt the locations where public transportation and NMT systems are heavily used. Therefore, the government should use shared mobility services to complement public transportation rather than make it mainstream. However, in a location where public transportation is absent, shared mobility services can be used as feeder services to the nearest public transportation hub.

MaaS is based on the idea of using multiple mobility services such as public transportation, NMT and share mobility

using a single platform such as a mobile phone. Among the United Nations' Sustainable Development Goals (SDGs), SDG 3, SDG 11 and SDG 13 focus on urban mobility. The overall aim of these SDG's is to make cities safe, secure, inclusive, resilient, sustainable, ensure healthy lives and promote well-being. The public transportation system plays a vital role in achieving these goals. Public transportation is an effective mode of transport for low and medium-income people for medium-distance transport. Due to its high occupancy levels, it generates fewer passenger kilometers, reduces congestion and pollution and thus favoring the environment. Therefore, MaaS should be developed as a service where public transportation is at the system's core, and other services should act as feeders to serve the last and first mile. This system should also ensure that there is a fewer number of interchanges between the services. Because the higher the number of interchanges, the higher is the waiting time and overall travel time, thereby reducing the utility of MaaS. In the distant future, autonomous vehicles will also share the road space, and necessary infrastructure should be in place to act as feeders to public transportation. In the near horizon, the new mobility services such as ride-hailing are an example of how such mobility services can help solve the core transportation issues such as accessibility.

Although many acts and missions mention sustainable transportation, the ways to achieve it are not clearly discussed. The strategies presented above are widely used in the developed economies to address the overall transportation problems. They can be adopted in developing economies such as India, which can significantly reduce the transportation problems which have been in place for many years. Due to the massive population and increasing economic and vehicular growth, the above-discussed policies are crucial to reduce congestion and pollution in Indian cities. Subsequently, coupling congestion pricing and HOT lanes policies with subsidies to public transportation systems can significantly cause a shift from personal vehicles to public transportation.

## Conclusions

The urban passenger transportation sector plays a crucial role in everyone's day to day life. It is considered a backbone for any country's economy and a significant contributor to air pollution. The contributions of the urban transportation sector to climate change have gained prominence in recent decades. The scientific shreds of evidence have shown that global warming of 1.5 °C from its pre-industrial era will have devastating effects on humans and the natural environment. Despite the effort being made, the current global temperatures have reached 1.19 °C. This makes the commitments made at the Paris agreement fall short of the climate

goals of containing global temperature to 1.5 °C. This demands aggressive emissions mitigating policy interventions required at the local, national, and global levels. Apart from these issues, accessibility and road accidents are also significant issues in the transportation system. This study attempts to identify the common transportation problems at the global and the national (India) levels. This study's focus is restricted to the urban passenger transportation sector due to the vastness of the subject. Further, to address these transportation problems, the various GOI initiatives that have evolved are presented.

Urban mobility is the result of a combination of multidimensional policies, operations, and gaps in operations. The GOI has implemented initiatives to address every aspect of the transportation problems from mobility, safety, and environmental perspectives. However, the initiatives were not found to be working as they were intended to. The main reason for these ineffective results is the lack of strict monitoring and coordination between various institutions/ministries. The Indian transportation system evolved to provide connectivity between the rural and urban areas. In this process of building infrastructure, the volume carried for the given capacity has been ignored. A significant amount of the early investments went into the widening and construction of roads, flyovers, and underpasses. But not much attention was paid to improve sustainable transport modes such as public transportation and NMT. In addition, the complexities involved in the zoning of the urban areas have made it very difficult in land acquisition and infrastructure development, thus delayed sustainable transport projects. Through JNNURM and NUTP, the urban transportation system has gained significant attention from the GOI. These policies thrust upon achieving sustainable transportation and preparation of a CMP report. The CMP's lack in specifying the comprehensive set of strategies required to achieve sustainable transportation. This is one of the critical missing components in CMP's. The local planning authorities should invest in the human resources required to simulate various sustainable transport scenarios. This will provide the authorities with a broad spectrum of sustainable transport strategies which can be implemented to achieve sustainable and livable cities. Since NUTP in 2006, many initiatives taken up by the GOI have broadly focused on creating a safe, secure and affordable sustainable transportation system through various means.

It is vital to understand that urban mobility is a derived demand. People travel to various destinations using various modes of transport to fulfill their needs, be it social or economic. Among various passenger trips made every day, the work trips take a significant share. The COVID-19 pandemic lockdown in India brought the passenger transportation system to a halt. The work from home culture has proven to be a key solution to achieve sustainable cities and communities.

Further, the need to travel can be reduced by developing compact city forms and mixed communities. The compact city forms bring the activity areas closer to each other. By providing an efficient NMT and affordable public transport system, motorized vehicular travel can be reduced and make cities safer and more livable. In addition to these solutions, the GOI should also make aggressive moves in adopting the best practices across the developed economies such as HOT lanes, congestion pricing, shared mobility, MaaS, autonomous vehicles, low and zero-emission vehicles. The GOI should also understand the impacts of the electric vehicle fleet before the infrastructure is ready. India's current energy mix has a majority share of non-renewable sources. Therefore, pushing electric vehicles into the market before shifting to renewable energy sources increases the emissions from the base level scenario. Overall, the best practices in developed economies revolve around the public transportation system, making it the core of urban transportation. It is high time that India invests more into building extensive mass transportation networks aided with an efficient NMT system, making cities pedestrian and bi-cycle-friendly. This makes cities less congested, less polluted, and less dangerous.

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