Keeping Cities on the Move

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About the author

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About the series 'Books for the Concerned Citizen'

Leveraging the diverse expertise of its members in the subject domains and in publishing, the TERI Alumni Association proposes to publish a series of books on topics related to energy, resources, and the environment. The idea is to share information and, even more important, critical insights and understanding, with citizens who are keen to know more about some of the critical issues facing society and the world today but are lost in the deluge of information.

Our target audience is educated adults who are concerned about topical issues but lack the understanding to make sense of what they read or watch in the mass media—the series aims to equip them with conceptual tools and essential information not only to enrich their understanding but also to encourage them to act and thereby, albeit indirectly, further the UN Sustainable Development Goals.

The topics to be covered in this series and their respective subject-matter-specialist authors are listed below.

- *Your City, Your Impact*: Priyanka Kochhar
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- *Carbon Markets*: Nitu Goel

Keeping Cities on the Move

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CONTENTS

FOREWORD

For several years, urban transport did not receive as much attention as it deserved, despite being at the core of enabling our cities to become the engines of economic growth. Dr O P Agarwal has been involved with this sector for the last 30 years, both in India and across the world. There is no one better to talk about this sector than him. He has seen this sector grow from an embryonic stage in India and has had the opportunity to compare India's systems with those across the world.

In this short write- up, he gives us a basic foundation of what urban transport really comprises, the challenges we face, and the way forward. He has used simple and non-technical language that makes it possible for all of us to understand the issues.

Urban transport is particularly important to all of us who live in cities because it allows us to access our jobs, it allows our children to access their schools, and it allows us to access health care, recreation, and shopping—a day-to-day necessity for all of us. It is for this reason that the Teri Alumni Association decided to bring out this publication, and clearly, OP was the right person to write it for us in a language we all will understand.

Rakesh Kacker
Vice Chairperson, TERI Alumni Association

ABBREVIATIONS

BRT	bus rapid transit
CNG	compressed natural gas
EVs	electric vehicles
GHGs	greenhouse gases
LTA	Land Transport Authority [Singapore]
LRT	light rail transit
MRTS	mass rapid transit system
PHPDT	passengers per hour per direction trips
STIF	Syndicat des Transports d'lle-de-France
TfL	Transport for London
TOD	transit-oriented development
UMTA	unified metropolitan transport authority

What is urban transport and why is it important

Urban transport refers to the facilities and equipment that enable people and goods to move from one place to another within an urban area. Thus, the network of roads, rail tracks, cars, motorbikes, rail coaches, buses, trucks, traffic signals, parking facilities, flyovers, etc. are all part of a given urban transport system.

These systems allow employees to access jobs, employers to access workers, students to access education, patients to access health care, and everyone to access recreational facilities. These systems also enable goods to move from where they are produced to where they are consumed. Similarly, urban transport systems enable the waste generated in a city – whether in households, factories, commercial establishments, office buildings, or hospitals – to be disposed of elsewhere. Urban transport systems are therefore critical to the economic efficiency of cities and to the health and well-being of people living in them.

Quite often, an urban transport system is compared to the circulatory system in the human body: the flow of blood enables nutrients to be moved from the sites at which they are absorbed into the human body to where the nutrients are needed, and waste products from the sites at which they are generated to the points from which they are excreted. We all know that if the circulatory system stops functioning, the person dies. Similarly, if a city's transport system stops functioning, the city will come to a standstill and can effectively be regarded as dead. This is one of the most important reasons that makes its transport system so critical for a city. We cannot really think of a smart city without paying adequate attention to its transport system.

Cities are often referred to as engines of economic growth. If they are, the transport system functions as the wheels of that engine. We all know that if the wheels of an engine do not move, nor does the engine. Therefore, if the urban transport system of a city does not function well, the city cannot be an engine of economic growth. This is yet another reason why urban transport systems are extremely important.

Urban transport systems are also important as they provide a

framework around which cities grow. In earlier times, cities came up along rivers largely because they functioned as transport channels that were extremely important for the city. However, with the advent of the internal combustion engine, transport systems have become more versatile and transport is no longer dependent entirely on rivers. It is for this reason that now cities have grown around railway lines and even around highways. We have several examples of cities that have spread out as soon a ring road or a bypass road is built to avoid congestion in the central part of a city. The ring road or a bypass road offers a transport backbone, which attracts development around it. This is often the negative result of building a ring road or a bypass without adequate thought, and goes only to demonstrate that the transport system provides a backbone around which cities have tended to grow. If a city grows without such a backbone, the growth is haphazard, and meeting the transport needs of such haphazard growth becomes particularly difficult.

Urban transport versus intercity, or long-distance, transport

Urban transport systems differ from intercity transport systems in many significant ways, as shown in Table 1.

Urban transport systems are used nearly every day as employees go to work, children go to school, and people go shopping. In all these instances, it is the traveller who generally pays for these trips: employers seldom pay for the trips their employees make; schools do not pay for the trips made by pupils; hospitals never pay for patients to get there. This is why people always protest strongly whenever fares for public transport are raised.

As against this, intercity systems are used less frequently, and largely to meet business-related needs. Therefore, the cost of such travel is a business expense and generally paid for by the employer and not by the person travelling, although a small proportion of the trips, such as those related to holiday travel or undertaken for personal reasons, are paid for by the travellers.

This is why raising airfares or fares of long-distance trains does not elicit as strong a response as that to raising the fares of urban buses or metro services.

Table 1 Urban transport systems versus intercity transport systems

Feature	Urban Transport (**within** a city)	Intercity transport (**between** two cities)
Frequency of travel	Almost daily	Less frequent
Trip lengths	Short	Relatively long
Who pays	Typically the traveller	Typically the employer or business
Frequency of service needed	Several services in an hour	Only a few services in a day
Pattern of travel	Peak and off-peak periods	Generally uniform and evenly distributed
Price elasticity of demand	Very low	Moderate
Sensitivity of price increase	Very high	Relatively low
Frequency of stops in public transport services	Frequent, often every kilometre	Far less frequent, often every few hundred kilometres
Complexity of planning and operations	Highly complex	Fairly simple

Urban public transport services also need to be more frequent and show a clear difference between peak hours and off-peak hours. Typically, the interval between trips on the metro rail is 10–15 minutes and as short as less than 5 minutes during peak hours – usually 8 to 10 in the mornings and 4 to 7 in the evenings, as people travel to work and then return home – compared to intervals of several hours in the case of intercity services, which is less of a problem given the low demand.

Even short delays in urban transport services can be hugely

disruptive whereas similar delays in intercity services are less disruptive. For example, an hour's delay for a long-distance train or a flight may not cause as much havoc as an hour's delay for a metro trip or a city bus trip. This is because people have to get to work within a narrow window of time and typically return within a narrow window as well. Over the day, any trips that are needed have to be completed within a short period of time and hence higher frequency of service is essential.

Yet another difference is that urban transport systems are complex to design, manage, and operate. Intercity systems are far simpler. Planning intercity transport systems is largely about engineering, whereas intra-city transport systems involve several dimensions that go well beyond engineering and have strong links with land-use planning, economics, finance, social factors, psychological factors, governance, environment, etc.

Because people have to make trips every day, affordability is a very important factor. If urban transport systems are not affordable, people are limited to finding jobs within a limited area, and employers can access only limited labour markets. Therefore, affordability has a major bearing on livelihoods and the economic efficiency of cities. Social image is also important because the status of a person is often determined by how he or she travels to work. Finance is important because most urban transport systems are loss-making ventures and need financing beyond their regular earnings from fares to remain sustainable. Urban transport systems also need to be integrated as multiple modes are often required to move from one point to another.

Thus, the planning, design, and management of urban transport systems involve much more than engineering and probably more of an art than a science.

Forms of transport and their features

Transport systems have many forms and can be classified across multiple dimensions.

Assets: fixed or moveable

Fixed assets are those that are stationary and provide the supporting infrastructure for movement whereas moveable assets are those that are mobile and carry passengers and goods. Thus we have roads, which are fixed assets and enable moveable assets such as cars, buses, and trucks to move on them and carry people and goods. Similarly, we have metro rail tracks that allow metro trains to run on them and rivers that enable ferries and boats to move on them. Parking facilities, on the other hand, are fixed assets, as are signalling systems to regulate the movement of vehicles.

Source of power: animal or machine

Transport modes that use animal power are typically bicycles, cycle rickshaws, pushcarts, horse carriages, and even walking. These modes only use animal energy and do not require any fossil fuels to be burnt. In the current context of climate change and local air pollution, animal-powered modes of transport are becoming increasingly important because they are clean and emit no pollutants. However, there are limits to how far such modes can move people and goods, how much weight they can carry, and how fast they can go.

Machine-powered modes of transport include cars, buses, trains, trucks, and motorboats. They use machines that are driven by some form of energy, typically produced by burning fossil fuels. However, it is desirable to limit their use, primarily to reduce the burning of fossil fuels, which is harmful to the environment.

Ownership and use

Personal motor vehicles are owned by their users; for example, cars and motorbikes are typically used by their owners and are therefore classified as personal motor vehicles. Typically, they are used only for a limited time over the day and remain parked most of the time. Hence, they are considered wasteful of space, which is

always limited in cities. Besides, their use is only a small fraction of their potential capacity: a typical car can carry four people comfortably and yet for most of its trips a car carries only one or two people.

Public transport vehicles, on the other hand, carry goods and people on a commercial basis and are seldom used by their owners for their personal purposes. This category includes public buses, taxis, autorickshaws, metro rail systems, etc. and they charge a fee for carrying people or goods.

Public transport services can be classified into 'fixed route and fixed schedule' services or 'on-demand' services. Public buses and metro rail services represent the first category, and passengers have to use them according to the routes and schedules fixed by the service provider. On-demand services, on the other hand, are run according to the demand of the customer, who decides the time of use, the origin, and the destination of the trip. Taxis and autorickshaws in many cities represent the second category, and have neither fixed schedules nor fixed routes, being governed by the demand of the passenger using them.

Guidance mechanism

Road-based modes of transport such as cars, buses, trucks, and motorbikes are steered by the person driving the vehicle and therefore can change lanes and even roads based on the judgement of the driver whereas rail-based systems are guided by the facilities on which they move—trains are guided by rail tracks and not by the engine driver, who only controls the speed, starts, and stops but cannot steer the train.

Propulsion technology

Most motor vehicles today use petroleum fuels that are burnt in an internal combustion engine to generate the energy that spins the wheels through a complex transmission system. The most common fuels are petrol, diesel, and compressed natural gas (CNG). More recently, there has been a strong move towards motor vehicles that use electricity stored in a battery to drive an electric motor which, in turn, spins the wheels. These are known

as electric vehicles (EVs). They are becoming increasingly popular as they are cleaner and emit fewer pollutants.

Nature of payload

Some motor vehicles carry passengers whereas others carry freight, and are accordingly classified as passenger vehicles or freight vehicles. Cars, buses, and taxis carry passengers; trucks and van carry freight. Metro rail systems carry passengers, but on intercity routes one could also have freight trains.

Mass transit systems

Shared transport forms that carry a large number of people simultaneously are known as mass transit systems or, if they do so at relatively high speeds, as mass *rapid* transit systems (MRTS). Thus, the typical bus systems or trams that still operate in a few cities are not mass transit systems because their payload is light: they do not carry a large number of people on a single trip and do not travel at high speeds. As against this, metro rail BRT (bus rapid transit) systems qualify as MRTS because they not only carry a large number of people on a single trip but also do so at fairly high speeds.

The two main forms of MRTS that are emerging around the world are either metro rail systems or BRT (Box 1) systems. Both have their underground or elevated or even 'at- grade' versions. As the names imply, the underground systems move within special tunnels below the ground; the elevated ones move on special viaducts above the ground; and the at-grade versions move on the ground level.

Metro rail systems are typically either underground or elevated and only rarely at grade.

Some alternatives to the metro and BRT systems include light rail transit (LRT) and monorail: LRT systems are common in many smaller European cities, and monorail systems are used in some cities in Japan. Monorail is also common as a people- mover system in amusement parks and airport terminals.

Each of these mass transit options is unique in terms of its capital and operating costs, carrying capacity, and flexibility of

operations, making each option the most appropriate for a given situation. Metro rail systems are at one extreme, offering very high carrying capacities but at equally high capital cost and virtually no route flexibility; monorail systems are well suited for areas with tall buildings that flank narrow roads, but offer a much lower carrying capacity compared to that of metro rail systems; LRT is a good option for smaller cities in which the demand is not as high as that in larger cities; BRT offers carrying capacities similar to that of light rail and monorail and at much lower capital cost, but needs wider roads if at the ground level and can also use elevated viaducts although the costs go up.

Table 2 gives approximate carrying capacities and capital costs of each of these options. The actual costs and capacities will vary from city to city depending on multiple factors, and the table gives only indicative costs and carrying capacities mainly to serve as a broad guide to choosing the most suitable form of mass transit for a given situation.

Table 2 Key features of different public transport systems

Underground metro	Elevated metro	Light rail	Tram	Monorail	BRT	Trolley bus	Normal bus
Capital (crores of rupees per kilometre)							
500	300	150	100	150	40		
Capacity per trip (passengers per hour per direction)							
80,000	70,000	15,000	7500	7500	25,000	800	800
Route flexibility							
None	None	None		None	Limited	High	High
Speed							
High	High	Medium	Slow	Medium	High	Slow	Slow

As a rule of thumb, linear cities, which have fewer corridors but each carrying high volumes of traffic, are more suited to high-

Box 1 **Bus rapid transit systems**

Bus rapid transit systems are a relatively recent concept, which came up primarily to provide a lower cost alternative to metro rail systems and yet offer carrying capacities much higher than those feasible with normal bus systems, primarily by replicating the features of a metro, but on the road. Typically, they have dedicated lanes on the road (either one way or in both directions) reserved exclusively for buses—no other vehicle can use these lanes. This exclusive road space enables the buses to move much faster, unhindered by any other traffic. In addition, the bus stops have raised platforms that are level with the bus floor so that passengers do not have to negotiate any steps to board or to alight, which makes boarding and alighting faster, thereby shortening the duration of each stop. Yet another feature is offline ticketing: the bus stops are closed systems similar to a metro system; people have to pay beforehand and cannot pay after boarding. In fact, they have to pay not to enter a bus but to enter the bus station. Boarding and alighting – technically known as the 'dwell time' – are made even faster by having wider, multiple, and separate doors for boarding and for alighting.

The first such BRT system came up in the mid-1970s in Curitiba, a mid-sized city in Brazil. The concept received a much stronger push after Bogota, the capital of Colombia, completed a far more sophisticated system in December 2000. The Bogota system, known as TransMilenio and championed by its charismatic mayor, Enrique Penalosa, has become a role model for many such systems around the world. Cities such as Mexico, Guangzhou, Jakarta, and Istanbul have built highly successful BRT systems.

Whereas underground metro systems cost about 50 billion (500 crore) rupees per kilometre and offer carrying capacities up to 80,000 passengers per hour per direction trips (PHPDT), the corresponding figure for TransMilenio is 40,000—and the cost was less than Rs 16 billion (160 crore), or $20 million at the current exchange rate of 90 rupees for a dollar. Other BRT systems around the world have cost much less, although their capacities are also lower, at about 15,000 PHPDT. However, that capacity is enough even for most large cities—only a few megacities need capacities of 80,000 PHPDT.

capacity mass transit systems whereas cities that are more evenly spread out and with a large number of corridors albeit with lower traffic volumes require a wider network served by a low-capacity system. Hence, it is the volume of traffic on a corridor that is a better determinant of the kind of system needed than the overall population of the city.

Issues in urban transport

Urbanization is a worldwide phenomenon. As cities grow and spread, with more and more people moving into them, travel distances continue to become longer. This leads to a greater need for motorized travel and, in turn, that for higher speeds. Further, increasing incomes are also making motor vehicles affordable to a larger number of people. Increased motorization has led to severe congestion, increased air pollution, higher emission of GHGs (greenhouse gases), and an increasing number of deaths due to road accidents. All these trends lower the economic efficiency of cities as also the health and well-being of the people living in them. Figure 1 shows the increase in the number of registered motor vehicles in India between 1951 and 2021.

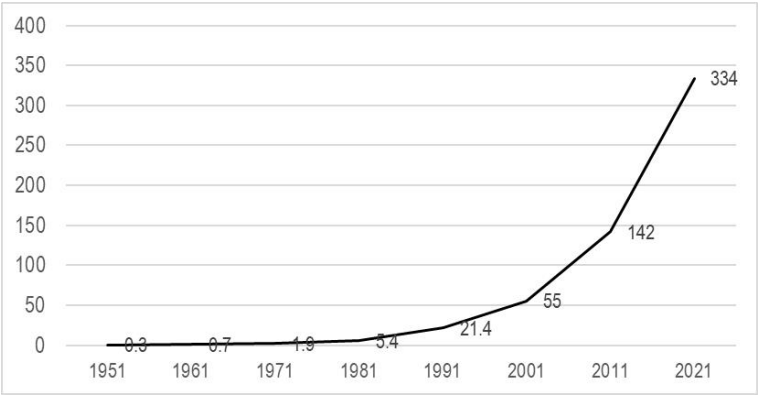

Figure 1 Decadal growth in the number (millions) of registered motor vehicles

As seen from the figure, the number of registered motor vehicles has been growing exponentially, especially after the economic liberalization that began in 1991. The number went up from a mere 0.3 million in 1951 to 334 million in 2021, a thousandfold growth. It is noteworthy that India's population increased only about fourfold over the same period. This is indeed a steep growth, and the resulting congestion is not surprising because the road network could not grow as rapidly as the number of motor vehicles: after all, cities need land for multiple competing purposes and cannot allocate a large share of the land only for roads.

The growth in the number of registered motor vehicles has also seen a sharp change in the profile of the fleet. Before 1991, cars accounted for a large share of the fleet, and buses also had a reasonable share of approximately 11%. However, after 1991, motorbikes showed a steep growth, and currently about 75% of the fleet comprises motorized two-wheelers whereas the share of buses has dwindled to less than 1%. Figure 2 shows the shares of different types of motor vehicles from 1951 to 2021, highlighting the major trend.

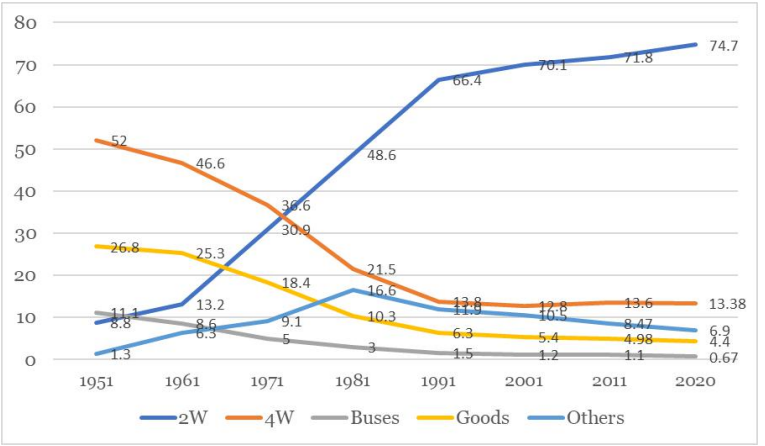

Figure 2 Changes (%) in the share of different types of vehicles: 1951–2021

The economic liberalization permitted several international brands to enter India. Well-known international brands such as Honda, Yamaha, and Kawasaki entered India after tying up with local companies (Hero, Rajdoot, and Bajaj, respectively), resulting in a large number of attractive and fuel-efficient vehicles becoming available at relatively low costs and that too without a long wait. India's youth took to these brands in a big way. Prior to 1991, the most commonly sought-after two-wheeler was the Bajaj scooter: it was affordable and had the reputation of not letting you down if you were careful to not drive recklessly. However, it was not easy to get one. Typically, one had to book the order in advance and then wait for nearly five years. If one was lucky enough to get some US dollars and use them for the initial deposit, it was possible to get the export model 'Bajaj Chetak' in six months. However, post 1991, the attractive and highly fuel-efficient motorbikes became available off the shelf. At the same time, financial institutions began competing among themselves to offer low-cost loans to people to buy these vehicles. All these changes drove India towards two-wheelers, with many switching from public buses to personal motorbikes.

Unfortunately, the problems arising from rapid motorization are not limited to congestion alone. For one, the bill for imported petroleum fuels has risen steeply: in 1981/82, India paid nearly 52 billion rupees (Rs 5189 crore) for imported oil—the corresponding figure for 2023/24 was nearly 560 billion (Rs 55.92 lakh crore). This is a massive thousandfold increase. The amount of petroleum fuels consumed went up from 34.11 million tonnes in 1981/82 to 234 million tonnes in 2023/24, a roughly sevenfold increase. While the consumption increased seven times and the import bill, a thousand times, indicating that higher oil prices and a weaker rupee have indeed impacted India's trade balance in a big way (Petroleum and Natural Gas Statistics, Ministry of Petroleum and Natural Gas, 1985 and 2023).

Because emissions of GHGs are a function of the amount of petroleum fuels consumed, the sevenfold increase in consumption

has led to a similar increase in emissions from the petroleum fuels sector. The bulk of this increase is contributed by road transport, a large share of which is that of urban transport. Therefore, cleaner urban transport systems will also lower India's oil import bill.

The rising oil consumption also increases local air pollution in the form of particulate matter, sulphur oxides, etc., leading to many Indian cities now being amongst the most polluted in the world. The large number of motorized vehicles has also meant an increase in the number of deaths due to road accidents: in 2022, 450,000 road accidents were responsible for 150,000 deaths, and the numbers continue to rise. Overspeeding is by far the largest cause of these deaths, with motorized two-wheeler riders and pedestrians being the most vulnerable. Too many families have lost their near and dear ones, leading to untold misery for them.

Possible solutions

At the core of efforts to find solutions to these problems is encouraging a shift from personal motor vehicles to either shared modes of transport or to non-motorized modes. Such a shift is good for reducing both congestion and emissions. The extent of savings is clearly evident from Table 3, which gives the approximate road space used per passenger travelling 100 km by different modes of transport.

As may be seen from Table 3, walking or using public buses uses road space far more efficiently and consumes very little of petroleum fuels. It is for these reasons that a shift to walking, cycling, or using shared modes of transport has been the fundamental solution used in most countries around the world.

However, although desirable, it is often difficult to bring about such a shift especially in those who can afford a personal motor vehicle: those who cannot, have little choice; to persuade those who can, multiple strategies have to be adopted to nudge them. Some of the strategies are presented here.

Table 3 Road space used and fuel consumed per passenger-kilometre

Metric	Cars	Motorbikes	Buses	Walking
No. of passengers per vehicle	2	1	40	1
Road space per vehicle (m^2)	12	4.5	36	—
Road space per passenger (m^2)	6	4.5	0.9	0.4
Petroleum fuel per 100 km (L)	10	2	20	0
Petroleum fuel per 100 passenger-kilometres	5	2	0.5	0

Building safe and easy-to-use walkways and cycle tracks

Walking or cycling is unsafe if the same road space is also used by fast-moving vehicles such as cars, buses, and trucks. It is for this reason that many do not prefer to walk or cycle although for short distances walking or cycling are the most convenient modes. This drawback can be overcome by building safer and segregated walkways and cycle tracks, a measure known to encourage walking and cycling.

Integrating different modes of transport

Travelling from one place to another in a city using public transport often involves using multiple modes, such as a metro rain and a bus or a bus and a taxi or an autorickshaw. Sometimes, such travel may involve using a personal vehicle up to a point and public transport thereafter. In any case, all trips by public transport necessarily involve walking at both ends of the trip. If transferring from one mode to another is easy, people may be willing to use different modes; if not, those who can afford a personal motor vehicle will prefer to use it. In particular, motorbikes offer a convenient mode of travel in a city, and persuading people to switch to public transport needs good intermodal integration and easy transfers. If multiple modes function as stand-alone systems, transfers between them are

extremely inconvenient, and personal modes become the favoured option.

Mechanisms that help improve integration include a common fare collection system or a common ticket, a common fare structure, convenient transfer stations through which people can move from one mode to the other easily, and an integrated schedule of services that complements different modes. Having common signage across modes is yet another feature that helps create a mental image of a single unified system despite the different modes.

Unfortunately, India has been by and large unsuccessful in such integration, and people have to buy separate tickets for a metro and a bus or other forms of public transport. The schedules of different services are also not integrated, and the separate logos and signage serve only to reinforce the fact that each mode is a different service, poorly coordinated – if at all – with another.

Concentrating residences near transit stations

Creating higher population densities near mass transit stations means more people live close to these stations. This helps easier access to the stations and nudges commuters towards using public transport by making it more convenient. This concept, known as transit-oriented development (TOD,) is gaining importance in many parts of the world, including many cities in India. Singapore, Curitiba, Copenhagen, and Washington, DC (especially the orange line of the Washington Metro), present good examples. The Delhi–Meerut line of the regional rapid transit system has also adopted TOD in a big way. Many large malls are very close to metro stations and in fact offer direct access from them, thereby becoming more attractive destinations. Many office buildings and large residential complexes also offer direct access to metro stations as a way of increasing the property values of those buildings and complexes.

Compact and mixed-use planning

Sprawling cities, which have relatively low population densities, entail longer trips and therefore greater reliance on motorized travel. As against this, cities that are denser and compact ensure shorter trips, many of which can be undertaken by walking or cycling. And even motor vehicles become more sustainable or less polluting given the shorter travel distances.

Planning for mixed use – mixing work places and residential reas within a compact area – can have a powerful impact by shortening trip lengths and thereby making walking or cycling more convenient and feasible. Therefore, planning for mixed use is also a good way of easing the problems arising from the overuse of motorized modes of travel.

The actions needed to curb motorized travel that uses personal vehicles involve both supply-side measures and demand-side measures. Supply-side measures primarily aim at increasing the capacity of the infrastructure so that it can meet the required demand, whereas demand-side measures seek to contain demand so that it can be met by available capacity. This may require either reducing the demand or splitting it across time and space to use the available capacity more efficiently.

Both supply-side measures and demand-side measures can be fiscal or physical. For example, imposing higher taxes on vehicles and fuels or higher parking fees are fiscal measures that seek to reduce demand, especially that met through personal motor vehicles. Higher taxes at the time of buying a new vehicle can lower the demand for personal vehicles at source whereas higher taxes on fuel reduce the use of such vehicles. Limiting the spaces available for parking space and restricting the road space available to personal vehicles are physical measures to reduce the demands on personal motor vehicles. Thus, the demand for parking can be curtailed either through high parking fees or through limiting the parking space available or through both. A choice of such instruments depends on local conditions, and the same measure may not be the best everywhere. Singapore, for

example, imposes severe fiscal and physical restraints on ownership, whereas Japan depends more on relatively narrow roads and limited space for parking.

Supply-side measures typically involve investing on widening roads, building flyovers, expanding bus fleet, or building more metro lines. These are physical instruments to expand the supply of infrastructure to enable it meet demand.

All these are important approaches to reducing the problems of congestion and air pollution in cities. However implementing them is difficult, which is why only a few cities have really been able to solve these problems. Singapore and Seoul are two cities that have made significant progress and have also demonstrated that supply-side or demand-side measures alone are not enough: they must be used in combination if we really want to solve the problems of congestion and deteriorating air quality.

Integrated systems

Different parts of a city have different levels of traffic. Core areas of any city attract high levels of traffic whereas fringe areas witness limited traffic. Sprawling cities typically have lower levels of traffic on any given corridor compared to those seen in compact and dense cities. Therefore, some parts of a city need high-capacity systems such as metro rail or BRT whereas others need low-capacity systems such as normal bus services or even minibus services or paratransit systems. This is analogous to the circulatory system of a human body: some parts of the body need a lot of blood and are therefore served by larger arteries and veins whereas other parts need less blood, and capillaries alone are enough for them. Just as this network of blood vessels of different carrying capacities ensures a smooth flow of blood throughout the body, with neither excess capacity nor inadequate capacity, a city needs a network of integrated transport systems with varying capacities to cater to different volumes of traffic. As is erroneously believed, merely building a metro alone will not solve the problems of congestion: metro systems need to be connected

to, or integrated with, smaller-capacity systems to be able to carry people to all nooks and corners of a city and cannot do that by themselves.

Unfortunately, such an integrated network of transport systems in a city has been a difficult proposition mainly because each form of transport is managed by a different agency of the state. These agencies rarely talk to each other, and this lack of a dialogue makes integration particularly difficult. In cities with better integration across transport systems, a lead agency is responsible for all forms of transport. Cities that have such lead agencies have achieved better coordination than those that lack such lead agency. Among some praiseworthy examples of such lead agencies around the world are Transport for London (TfL), the Land Transport Authority (LTA) in Singapore, the Syndicat des Transports d'lle-de-France (STIF) in the Paris region, and the Translink in Vancouver. Setting up such an entity provides the required leadership to ensure coordination across different modes of transport and thereby offers a city a well-functioning and integrated transport network.

Several cities in India have set up such lead agencies, which go under the name of unified metropolitan transport authorities (UMTA). In some cases, the authorities have been set up through legislation. However, none has managed to be active and effective.

Emerging paradigms

The last few years have witnessed major changes in how urban transport systems are planned, designed, managed, and financed. These new paradigms have made a big difference and seem to be here to stay. A few of these changes are highlighted here.

The **first** change is the availability of greater options for the mode of travel. For example, earlier the options were limited to a personal motor vehicle, a bicycle, a bus, or a black-and-yellow taxi. If one wanted a taxi, it was necessary to walk to a busy street to look for one or to go to a taxi rank. In many cities, taxis were hard to find. However, today metro rail systems have come up in many cities in addition to the traditional bus services. Besides, there is a large variety of paratransit 'aggregator' services such as

Uber, Ola, and Rapido. In addition, one can call a radio taxi and board it at one's doorstep instead of stepping out to look for one. Such radio taxi services include Meru and Mega. The availability of shared modes of transport has also expanded in a very big way, hopefully leading to decreased need for personal motor vehicles. The fact that these services can be booked and paid for through an app on a mobile telephone makes these services extremely convenient: the taxis (or even autorickshaws) arrive at the chosen point, and the app not only estimates the time by which the taxi will arrive and eventually reach the destination but also calculates the exact fare—which can also be paid through the app, avoiding any argument over the fare or the route with the driver or the need to have exact change to pay the fare. Thus, greater options have decreased the dependence on personal vehicles.

The **second** change, given the convenience of such shared modes of transport as aggregator services such as Uber, is that it is no longer necessary to own a car to meet a given travel need. In many cases, people prefer not to drive through congested streets and then to struggle to find a parking space at the destination, and instead prefer the convenience of a taxi.

The **third** change is the move towards a system in which all beneficiaries and not just the users pay for public transport. Earlier, the prime sources of income for any public transport operator were either the fares or any subsidies paid by the state. However, it is being increasingly recognized that there are many who may not use public transport but benefit from it. As an example, anyone who owns property close to a metro station will benefit from the value of that property going up several times because of the improved metro connectivity even without being a user. Similarly, all those who use cars are beneficiaries of public transport because of the lower congestion. Such beneficiaries are typically made to pay for the benefits through higher property taxes or higher taxes on petroleum fuels—funds that are then diverted to operators of public transport, thereby contributing to its financial viability.

The **fourth** change is the emerging paradigm in public transport planning of going beyond designing public transport systems along major corridors to look at a wider area to ensure greater connectivity across it. Accordingly, mass transit systems such as metro rails and BRT are built not only along a single corridor but expanded to form a network of feeder systems serving a wider area. These feeder services could include smaller buses, park-and-ride facilities, or even broad footpaths and convenient overhead walkways. An areawide approach has become important primarily to ensure better accessibility to mass transit systems and enhance the captive area for such systems.

The **fifth** change is the shift from the internal combustion engine to EVs. Increasing concerns about climate change, local air pollution, and rising oil import bills have led to a marked preference for EVs, which are seen to be cleaner. The shift has also benefitted considerably from the declining prices of batteries, making EVs cheaper. At the same time, the energy density of these batteries has increased, making it possible for EVs to cover longer distances on a single charge. Both these developments have made EVs a much more feasible option.

The **sixth** change is the moving away of transport systems from being stand-alone systems to increasingly interconnected systems. For example, earlier bus systems and metro rail systems functioned as two independent systems. However, the emphasis around the world today is on integrating them so that they are perceived as a single system that serves their entire travel needs. Such integration is facilitated primarily by integrated fares across all modes, a single system for collecting the fares, integrated schedules of operations, convenient interchange stations for seamless transfer between different modes, and common signage that reinforces the perception of a unified system comprising different modes of transport rather than that of separate stand-alone systems for each mode of transport.

The future of urban transport

Based on the emerging paradigms discussed here, experts believe that the future of urban transport will largely be a combination of EVs, shared systems, and interconnected systems. Personal motor vehicles may not be relevant for too long, particularly because the increasing congestion makes it increasingly difficult to drive as also to find parking space. Competing demands on land in any city will make additional land for road construction or road widening increasingly hard to find. Shared modes of transport, therefore, appear to be the promising option in many countries around the world. Electric vehicles make eminent sense for such transport systems because those vehicles are more cost effective and cleaner.

Summary

Mobility systems are extremely important for any city because they connect people to jobs, students to education, patients to health care, and goods to markets. Urban mobility systems are to a city what the circulatory system is to the human body and also serve as a framework for future growth of the city. However, today these systems face serious problems of congestion, air pollution, increasing amounts of emissions of GHGs, and increasing road accidents. Nudging users from personal motor vehicles towards public transport and non-motorized modes of transport has been the traditional approach to dealing with these problems. Unfortunately, despite significant investments in high-capacity mass rapid transit systems as well as in the more traditional bus systems, the growth of personal motorized transport continues to accelerate instead of slowing down. This trend calls for more stringent measures that go beyond the more traditional measures. A combination of supply-side measures and demand-side measures has helped some cities, which have been able to deal with the problems mentioned above more effectively. Several emerging paradigms, which are changing the way people

travel and the way urban transport systems are planned and financed, have the potential to deal with the current problems. The preference for personal motor vehicles has also led to inefficient use of land resources because these vehicles remain parked for over 95% of the day while occupying valuable urban land. This is a major waste that needs to be curbed. The new paradigms seem to offer solutions that could tackle this problem by facilitating the sharing of motor vehicles. Advances in information technology have been, and will be, of immense help in moving towards more sustainable urban mobility systems.

Keeping Cities on the Move explains the importance of urban transport in the context of our economic development goals. It highlights its key differences between urban, or intracity, transport systems and intercity transport systems. It dwells on the complexities of urban transport, especially in terms of its much-needed integration with multiple other disciplines, such as land-use planning, environment, finance, governance, etc. Finally, the book highlights the challenges faced by the sector in the form of increasing congestion, worsening air pollution, increasing emissions of greenhouse gases, a rising oil import bill and increasing incidence of fatalities in road accidents. *Keeping Cities on the Move* also highlights the measures currently adopted to deal with the forementioned challenges as well as the measures needed in the years ahead.

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