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Toward Sustainable and Energy Efficient Urban Transport

Energy Efficient Cities

MAYORAL GUIDANCE NOTE #4

For more information related to energy efficiency in cities, please visit ESMAP's website at: www.esmap.org/Energy_Efficient_Cities.

For more information on sustainable and energy efficient transport, please see:
World Bank and ESMAP. 2014. *Formulating an Urban Transport Policy: Choosing between Options*. Written by O. P. Agarwal, Gouthami Padam, and Cholpon Ibraimova. Washington, DC: Energy Sector Management Assistance Program, The World Bank.

ADDITIONAL RESOURCES

For online training, "Integrated Urban Transport Planning," offered through The World Bank e-Institute, deals with many of the issues explored in this Guidance Note: http://einstitute.worldbank.org/ei/course/integrated-urban-transport-planning-0.

For more information on developing an energy efficient urban transport planning strategy, download "Developing an Energy Efficient Urban Transport Plan for Zarqa City Downtown Area (vols. 1 & 2)" at: http://www.esmap.org/node/1291.

For detailed and practical recommendations on how cities can plan and implement enhancements to their bus fleets without significant capital investments, download "Guidance Note: Best Operational and Maintenance Practices for City Bus Fleets to Maximize Fuel Economy" (ESMAP Briefing Note 010/11) at:
http://www.esmap.org/sites/esmap.org/files/FINAL_EECI-BusGuideNote_BN010-11.pdf.

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VENTE DE TICKET

EXECUTIVE SUMMARY

Many cities of developing countries are experiencing rapid growth of motorized transportation. This is leading to severe congestion, which, in turn, is reducing productivity. Road accidents have been increasing. Transport emissions have become a major contributor to severe air pollution and greenhouse gas emissions. The main cause of these problems has been the increasing preference for personal motor vehicles for commuting to work and getting around the city. In many countries, urban development practices have worked in favor of such preference, leading to urban sprawl. Thus, remedial measures have to focus on reversing the preference for such modes of travel, shifting to public transport, cycling, or walking, and building and retrofitting cities to minimize the need for private automobiles.

The **Avoid–Shift–Improve** principles are the most widely adopted approach to manage traffic demand in modern cities. "**Avoid**" actions seek to reduce the need to travel, for example, through online shopping and facilities for telecommuting. Good land-use planning, focused on developing compact cities and mixed land use, have contributed to reducing the need for motorized travel and the length of the trips that need to be made.

"**Shift**" actions seek to persuade people to move away from their personal motor vehicles to public transport and non-motorized modes, which are more efficient in terms of the urban space they occupy, the amount of fuel they consume, and the amount of pollutants they emit. Therefore, investments in high quality public transport and safer infrastructure for non-motorized modes are necessary. To complement these, it is important to discourage personal motor vehicles ownership and use. Some deterrent measures include: increasing fuel taxes and parking fees, limiting the number of parking spaces available in a city, increasing vehicle registration fees, and even constraining the ability to buy personal motor vehicles.

"**Improve**" actions seek to reduce the negative effects of whatever motor vehicle use inevitably occurs. Improving traffic flow, fuel efficiency of motor vehicles, and the quality of fuel used, helps to reduce the negative impacts of motorization.

There are several cross-cutting issues that need to be addressed in promoting a modal shift. The governance of urban transport is often fragmented across several agencies and there is a need for good coordination. Additionally, urban transport requires significant investments and public budgets are generally inadequate to support them. As such, innovative measures to finance these investments are called for. Taking advantage of the commercial value of prime urban land offers opportunities to raise additional resources. Another option is to tax fuel used by personal motor vehicle users to generate resources for public transport.

Unfortunately, piecemeal efforts do not produce the desired outcomes. It is therefore essential to take a comprehensive and holistic approach that encompasses the entire range of Avoid-Shift-Improve actions. Developing a strategic vision, appropriate policies that align with this vision, and the right institutions to implement the policies are necessary to make cities both livable and true engines of sustainable growth. This needs champions—champions who have an understanding of the right things to do as well as the influence to do them. This guidance note seeks to outline the right actions that the city leaders may like to consider.


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TOWARD SUSTAINABLE TRANSPORT

The quality of urban transport systems is an important determinant of cities' livability and economic efficiency and, unfortunately, these systems are encountering several challenges. Severe congestion, deteriorating air quality, increased greenhouse gas emissions, increased incidence of road accidents, and increased fuel costs are threatening the health and well-being of residents as well as the economic efficiency of cities. Air pollution is estimated to cause 800,000 deaths in urban areas every year and transport accounts for around 14 percent of human-created greenhouse gas emissions. The transport sector's share of petroleum consumption went up from 45 percent of the world's oil production in 1973 to 61 percent in 2007. Road transportation accounted for 81 percent of this consumption. International crude oil prices fluctuated significantly in the past, impacting the balance of payments of oil importing countries. From 2000 to 2013, inflation-adjusted average crude oil prices increased 2.5 times. In addition, road crashes caused 1.2 million deaths worldwide annually, making road accident deaths among the highest causes of death in the world.

The most important factor contributing to the above problems has been the rapid increase in the use of private motor vehicles. For instance, in the six largest cities in India, the population doubled between 1981 and 2001, but the number of motor vehicles increased eight times over the same period. Between 2000 and 2013, car ownership in China increased more than six times. Similar trends are seen in other fast growing economies. Increased income levels and the availability of cheaper personal vehicles, coupled with increased travel distances and inadequate public transport systems, have made the personal motorcar an increasingly attractive travel option.

Figure 1 | Traffic Snarls

Photo | S. McCourtie / ©World Bank.

Efforts to deal with the problems associated with increasing travel demand have tended to largely focus on expanding the capacity of roads and public transport. Unfortunately, this has not been enough. Increasing road capacity may help alleviate the problem in the short term, but, over the long term, as long as the number of motor vehicles continues to increase, roads will not only remain congested—there will be even more traffic. This is not the solution, nor is increasing the capacity of public transport by adding more vehicles, as this does not necessarily encourage a shift from personal motor vehicles. Energy efficient cities require a paradigm shift in urban land use and transport planning.[1]

THE OPPORTUNITIES

The objective of this guidance note is to present a systematic, practical, and comprehensive approach to dealing with the problems of urban transport.[2] It outlines a framework of possible interventions and demonstrates how such interventions relate to the overall objectives of improving mobility and energy efficiency as well as reducing air pollution and road accidents. Thereafter, it highlights a range of cross-cutting issues that need to be addressed and also suggests steps to create an enabling environment to move towards a sustainable urban transport system. Its target audience is the city-level leadership and key decision makers responsible for sustainable urban mobility.

PART I: A SYSTEMATIC APPROACH TO SUSTAINABLE URBAN MOBILITY

Since the rapid increase in the use of personal motor vehicles has been the prime contributor to the problems of transport in cities, the focus of remedial measures has to be in reducing such use as well as on reducing the negative impacts of whatever motor vehicle use is inevitable. These efforts have popularly come to be known as the "Avoid–Shift–Improve" (ASI) approach. **Avoid** actions seek to reduce the need for travel, both in terms of the number of trips that people make and the length of each of these trips. **Shift** actions seek to get people to move from less sustainable modes of travel—like personal motor vehicles—to more sustainable modes, like public transport and non-motorized modes. **Improve** actions seek to reduce the negative impacts of the motorized travel that inevitably continues to take place despite the avoid and shift measures.

AVOID ACTIONS

"Avoid" actions seek to reduce the need for travel. Travel demand is the average number of trips that people make, multiplied by the average length of each trip. Therefore, travel demand can be reduced by decreasing the average number of trips that people need to make or by shortening the average length per trip or a combination of the two.

Reducing the Average Number of Trips per Person

Most working people and students make two trips in a day to and from work and school. In some cases, there are other trips to meet shopping needs, for recreation, etc. Initiatives such as telecommuting and online shopping, which allows people to work and shop from home (respectively), reduce the average number of trips that people need to make.

Reducing the Average Length per Trip

The length of a trip is generally determined by the size of the city and the manner in which residential, commercial, educational, work, and recreational centers are laid out in a city. Sprawling cities generate longer trips, whereas more compact cities have shorter trip lengths. Further, cities that adopt mixed land-use policies—meaning that different forms of land use are closely interspersed rather than separated—tend to have shorter trip lengths. Thus, by closely integrating the processes of land-use and transport planning, cities can be developed in ways that help improve accessibility and shorten trip lengths. This integration happens through a process that takes into account the concentrations of where people live and work while designing transport systems. Similarly, it takes into account the alignments of existing transport networks when land-use plans are developed to reduce the distance people have to travel and also encourage greater use of public transport or non-motorized modes of travel.

Unfortunately, such integration does not happen under normal circumstances as the responsibilities for land-use planning and transport planning rest with different agencies of the government that rarely coordinate their actions. Yet, there are several examples where the existence of an agreed spatial vision for a region, developed upfront, helps align transport and land-use plans to a common vision. Ahmedabad, Curitiba, and Singapore present examples of such a regional vision enabling the effective integration of land-use and transport plans (Suzuki et al. 2013).

Chandigarh, a medium-sized city in India, has used the principles of mixed land use in ensuring that every sector has residential and shopping areas. Washington, DC, has a well interspersed business, residential, and commercial land-use pattern, making it possible for people to walk to work within a relatively short span of time. Curitiba, Brazil, integrated land-use plans with its plans for a trunk bus rapid transit (BRT) network in such a manner that a large number of people could easily access the BRT and access trips are of a very short length. Such mixed land-use planning allows people to live closer to where they work or shop and this helps reduce trip length times.

There are two instruments that can be used to foster the development of a compact city through permitting a more intensive use of the land. One is by increasing the Floor Area Ratio (FAR),[3] the other is limiting holding sizes.

However, it needs to be recognized that with some kinds of economic activities, such as manufacturing, it is often necessary to segregate the manufacturing centers from the residential centers. Still, it is possible to mix educational, shopping, and entertainment areas with residential areas in order to reduce the length of trips. Good public transport connectivity between residential and manufacturing locations can facilitate that a large share of the trips are undertaken on public transport.

Box 1 | Land Use and Transport Integration in Curitiba

The city of Curitiba in Brazil (population 3 million) is internationally renowned as one of the world's most sustainable, well-planned cities, in large part because of its success at integrating BRT investments and urban development. Early in the planning process, Curitiba's leaders adopted a master plan that sought to channel growth along designated corridors, mix land uses, intensify land development at key BRT stations, and introduce high-quality urban designs that encouraged pedestrian access to the BRT corridor. Curitiba has evolved along well-defined radial axes that are intensively served by dedicated busways. Along some corridors, streams of double-articulated buses haul 16,000 passengers an hour. The city's system of 390 routes served by 2,000 vehicles carries 2.1 million passengers a day.

To ensure a transit-oriented built form, Curitiba's government mandates that all medium- and large-scale urban development be sited along a BRT corridor. Orchestrating regional growth is the Institute for Research and Urban Planning (IPPUC), an independent entity charged with ensuring integration of all elements of urban growth.

Curitiba is one of Brazil's wealthiest cities, yet, it averages considerably more transit trips per capita than Rio de Janeiro and São Paulo, which are much larger. Its share of motorized trips by transit (45 percent) is the highest in Latin America. High transit use has appreciably shrunk the city's environmental footprint. Curitiba's annual congestion cost per capita of US$0.67 is a fraction of São Paulo's (US$7.34). The city also boasts the cleanest air of any Brazilian city with more than one million inhabitants, despite being a provincial capital with a sizable industrial sector. The strong, workable nexus that exists between Curitiba's bus-based transit system and its mixed-use linear settlement pattern deserves most of the credit.

Sustained political commitment has been an important part of Curitiba's success. The harmonization of transit and land use took place over 40 years of political continuity, marked by a progression of forward-looking, like-minded mayors who built on the work of their predecessors. A cogent long-term vision and the presence of a politically insulated regional planning organization, the IPUCC, to implement the vision have been crucial in allowing the city to chart a sustainable urban pathway.

Source | Suzuki et al. 2013

SHIFT ACTIONS

"Shift" actions seek to persuade people to move from personal motor vehicles to public transport or non-motorized modes. Such a shift is desirable because public transport and non-motorized modes occupy less road space, emit less pollutants, and consume less fuel than personal motor vehicles, on a per passenger/km basis. Figure 2 shows the extent of road space occupied by 50 people using cars, bicycles, or buses. It demonstrates that cars use an unnecessary amount of precious urban space.

A bus carrying about 60 people uses only about 2.5 times the space occupied by a car carrying only about two people. Further, it is almost 10 times as fuel efficient as cars in terms of the person/kms generated for the same amount of fuel. It is also less polluting in the same ratio. Such shifts can be brought about through measures that make public transport and non-motorized modes more attractive to use compared to personal motor vehicles. These are best undertaken through a mix of supply-side measures and demand-management measures.

Figure 2 | Comparing the Use of Space in Personal Vehicles, Non-Motorized Transport, and Buses

Source | City of Muenster Planning Office, in GTZ, 2005.

Supply-Side Measures

Supply-side measures seek to provide adequate public transport capacity to meet the demand. They also seek to enhance the convenience and attractiveness of public transport. The objective is to persuade people who have other options for travel to prefer this mode. Construction of mass transit systems, like metro rail and BRT, or enhancing the supply of buses contributes to enhancing public transport capacity.

It is for this reason that several cities have invested heavily in improving their public transport systems rather than on the road systems alone. New Delhi has a 189-km metro rail network and has added thousands of buses to its streets. Beijing has a nearly 400-km metro rail network and almost 20,000 buses. Several other cities in China are building metro rail systems. Cities around the world are looking at Bus Rapid Systems as a lower cost mass transit system that uses existing road space to accord priority to public transport. Ahmedabad, Bogota, Curitiba, Guangzhou, Leon, Mexico City, and Pereira are some of the cities that have built high quality BRT systems as a means of encouraging a shift from personal motor vehicles to public transport.

A host of other initiatives also work towards making public transport convenient to use. Some examples are the following:

- **Construction of high-density commercial and residential complexes close to mass transit stations** so that people have easy access to mass transit and do not have to walk long distances to reach stations. This kind of development is generally known as Transit-Oriented Development or TOD. Curitiba presents an excellent example of how these land-use policies integrate well with the alignment of the BRT system, allowing higher densities along the BRT lines. Similarly, Arlington county in Virginia (US) presents an excellent example of high-density mixed use around stations on the Blue, Orange, and Silver lines of the Washington, DC, metro system.
- **Common fare cards and fare collection systems** across different modes so that people do not have to pay multiple fares or go through the inconvenience of repeatedly

purchasing travel tickets. This is known as fare integration. Seoul's T-money and Singapore's EZ Link are examples of such common fare collection systems that work across operators and across modes of transport in the city. India has been attempting to put in place a common mobility card that would be valid for travel payments across all cities in the country.

- **Improved integration of different modes of transport,** so that people who need to transfer from one mode to another can do so easily and quickly. This needs well-designed interchange facilities, and good feeder systems to mass transit and other facilities, such as parking close to and a good pedestrian environment around mass transit stations, providing safe walking access to public transit systems. Having too many transfers or difficult interchanges can be a deterrent to shifting from personal motor vehicle use. Singapore and Seoul present some of the best examples of such intermodal integration, through well-designed interchange stations. Transmilenio in Bogota is a good example of such integration between the trunk and feeder services. Park and Ride facilities in several cities of the United States are examples of integration between public transport and personal motor vehicles.

One of the major reasons people have veered from non-motorized modes has been the lack of safe infrastructure for their use. It is in this context that good quality infrastructure is needed. Supply-side measures for encouraging the use of non-motorized modes primarily comprise the construction of safe and convenient sidewalks and bicycle lanes along all roads. Proper lighting, pedestrian crossing facilities, planting trees, bike sharing/renting arrangements, and minimal interfacing with motorized traffic help improve the environment for the use of non-motorized modes. In its latest Land Transport Master Plan of 2013, Singapore announced plans to develop a 700-km island-wide cycle track network by 2030, complemented with adequate bicycle parking racks.

Demand-Side Management Measures

Demand-side measures primarily focus on reducing the use and/or discouraging the ownership of personal motor vehicles. Fiscal and physical measures to discourage use include:

- Increasing the fuel tax so that gasoline becomes more expensive
- Levying a road user fee or a congestion charge for using personal motor vehicles in certain parts of a city
- Increasing parking charges for personal motor vehicles
- Reducing the number of parking spaces available, thus deterring the use of personal vehicles
- Reducing road capacity by allocating preferential road space to public transport and non-motorized modes
- Implementing car-free days when people are not allowed to use cars in certain parts of a city
- Designating some core city areas as "pedestrian zones" so that people are discouraged from using their personal vehicles

Measures to discourage ownership include:

- Increasing vehicle registration charges significantly to increase the cost of ownership

- Limiting the right to purchase a car by requiring a permit to buy a personal motor vehicle, such as the "Certificate of Entitlement" scheme in Singapore
- Increasing the purchase tax of a personal motor vehicle so that the cost of the vehicle goes up
- Requiring the demonstration of an owned parking space before a person can buy a car

Singapore has one of the most comprehensive demand management policies in the world. It has strong restraints on both the ownership and use of personal motor vehicles. The need to purchase a "Certificate of Entitlement" at fortnightly auctions and a high vehicle registration fee discourage the ownership of personal motor vehicles. A road pricing scheme also discourages use in the central parts of the city. London has deployed a congestion charge that requires personal motor vehicles to pay £8 (approximately US$13.50) to enter central parts of the city.

Demand-management measures can also distribute road loads across the entire day—discouraging use of road space during peak times and encouraging road use during off-peak times. Levying a road usage fee that is higher during peak times and lower during the latter persuades people to choose off-peak times for some of their travel needs. In Singapore, the road usage fee, known as Electronic Road Pricing, charges a fee that varies with the time of the day.

IMPROVE ACTIONS

Improve actions seek to reduce the negative impacts of whatever motor vehicle use is inevitable. There are two types of actions that can be taken: (i) management measures and (ii) technological measures.

Management Measures

Management measures primarily seek to improve traffic flow along heavy demand corridors so that time and fuel are not lost in idling. A series of measures can be adopted to improve traffic flow:

- Improve the quality of the road surface as poor roads lead to slow movement at suboptimal speeds
- Improve road and intersection design so that vehicles move smoothly with few barriers
- Use synchronized traffic light signaling to reduce vehicle idling at intersections along a corridor
- Segregate slow and fast moving vehicles into separate lanes so that slower vehicles do not adversely impact the faster moving ones (e.g., separate lanes for cycles and public transport systems, good sidewalks)

BRT systems, wherever implemented, have segregated buses from other vehicles, smoothening the flow of traffic. In many cases, separate lanes for bicycles have been created and pedestrian walkways have been improved as a means to segregate fast and slow moving modes, as well as enhance safety. In several cities, comprehensive corridor improvement measures have resulted in improved intersection design and synchronization of traffic lights along a corridor. These have generally been accompanied by improvements in the road surface and removal of other barriers that impede traffic flow. As an example, New Delhi implemented corridor improvement measures along its inner

and outer ring roads and Cairo proposes similar measures along a 20-km stretch as a pilot initiative before extending it to other corridors.

Technological Measures

Technological measures work to improve fuel and vehicle efficiency, meaning that a vehicle consumes less fuel for the same distance travelled or emits less pollutants for the same amount of fuel consumed.

The automotive industry has improved design techniques to make vehicle bodies more aerodynamic and the use of lighter materials reduces fuel consumption. In addition, a number of steps have been taken to impose stringent emissions standards for cleaner fuel, such as the removal of lead from gasoline and the reduction of sulfur levels in diesel. Also, the use of cleaner fuels has gained momentum in many cities. An emphasis on Compressed Natural Gas (CNG) as a motor vehicle fuel and the use of electric vehicles are both important steps in this direction.

However, bringing about technological improvements in fuel quality or vehicle efficiency is difficult to undertake within a single city. Such improvements require national-level changes in current standards for fuel efficiency and emissions. For instance, New Delhi modified its complete public transport and para-transit fleet from diesel to CNG-fuel vehicles. However, this was only possible due to a national program that encouraged the use of CNG and supported the establishment of an adequate number of CNG dispensing stations. Similarly, several cities in China have been promoting electric vehicles through a nationally supported program.

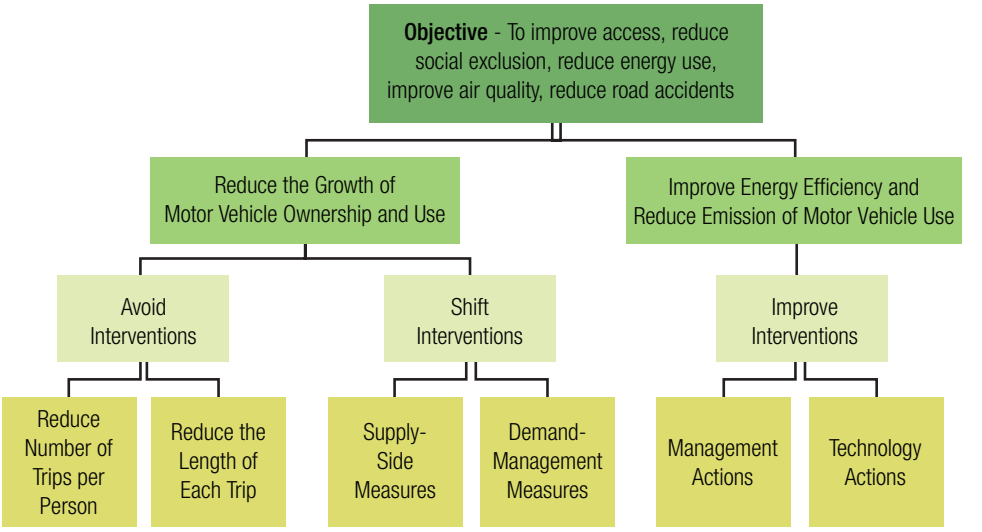
Sound operational and maintenance practices can increase the efficiency of vehicles. At the same time, these practices can decrease down time, mitigate negative environmental impacts, and improve road safety. This is particularly relevant for bus fleets, where fuel costs represent a large fraction of total operational costs (ESMAP 2011).

COMPREHENSIVE APPROACH

While the above are a series of initiatives that can be undertaken singularly, they are in fact a well-aligned and integrated set of initiatives which work towards sustainable mobility. Figure 3 below depicts how these initiatives are interlinked.

Experience has shown that isolated initiatives that focus on single measures, such as widening roads, are suboptimal. It is a larger, programmatic vision—backed by a comprehensive set of measures—that produce the best results. It is necessary to take a comprehensive and holistic approach that combines supply-side measures with demand-side management to integrate transport planning with land-use planning, environmental planning, energy planning, and a host of other dimensions, as well as to accommodate the needs of a variety of people who live in a city, such as women, children, the aged, and the physically disabled.

Figure 3 | Comprehensive Framework of Avoid-Shift-Improve Interventions



Source | Author

Box 2 | Comprehensive Set of Policies Adopted in Singapore

Singapore presents one of the best examples of a comprehensive approach to urban transport planning. Land-use and transport planning have been linked very effectively through a participatory process of developing a long-range concept plan for the city, which is then broken down in shorter term investment plans. Transit-oriented development has enabled higher densities close to metro stations so that easy access to mass transit is available for a large share of the population. The city has an excellent public transport system, comprising 178 km of metro rail and 4,212 buses. In addition, there are over 28,000 taxis that offer services at a modest price. Fare card systems allow integration between modes and transfers are convenient and easy. The private sector has significantly contributed to the efficient operation of public transportation. The latest transport master plan released in October 2013, proposes to extend the metro network to reach 360 km in the next 20 years, as well as to add another 800 buses to the existing fleet.

To complement the high quality public transport system, there are stringent restraints both on the ownership and use of personal motor vehicles. Ownership is constrained by the requirement that anyone desiring to buy a car needs to first acquire a Certificate of Entitlement through an auction process that often results in additional costs equal to the price of a car. In addition, there are road user charges that vary between peak and off-peak times.

It is this combination of high quality public transport, the effective integration of land-use and transport plans, and the imposition of stringent demand-restraint measures that has helped Singapore manage its transport problems in an efficient manner.

Source | Author

PART II: CROSS CUTTING ISSUES

If implemented in a coordinated manner, the comprehensive set of initiatives presented in this guidance note can produce the desired results. However, there is a range of cross-cutting issues that also need attention if these initiatives are to succeed. Governance, financing, role of the private sector, and technology choices for mass transit are among the issues that often come up while planning urban transport improvement actions. Let us look at each of them more closely.

GOVERNANCE

The governance of urban transport tends to be very fragmented. Multiple institutions are involved and coordination tends to suffer. A good urban transport system has specialized entities that take the lead in coordinating the multiple dimensions and service providers that make for an efficient transport system.

There are several issues that need to be decided upon when setting up such institutions:

1 | Governance. The entity can be set up through dedicated legislation through a special law, under a general law for commercial entities as applicable in the country, or an executive order.

2 | Jurisdiction. Whether the entity will preside over a single city or a larger jurisdiction encompassing several municipalities depends on the size of the municipality and

the nature of travel patterns (i.e., whether most travel happens within a municipality or tends to cut across multiple jurisdictions).

3 | Function. It must be clear if the entity is responsible only for public transport or a wider set of responsibilities that encompasses roads, parking, etc.

4 | Financing. The entity's financial source and strength determines its ability to exercise influence over other agencies and effectively coordinate between them.

Several cities have set up successful lead agencies to plan for and oversee transport-related services. The Land Transport Authority of Singapore, TransLink in Vancouver, and Transport for London are examples of lead agencies that could be models for replication.

FINANCING

Significant investments are required in urban transport, which can be classified as either capital or operating expenses:

- **Capital expenses.** These are one-time expenses needed to either build something or get it started. Although typically incurred over a short period and involve large amounts, these one-time investments sustain for several years. Examples: the cost of building a road or a flyover; the cost of constructing a metro or BRT system.
- **Operating expenses.** These are recurring expenses that are needed to keep facilities in a state of good repair and services functional. Examples: the cost of maintaining roads; the cost of operating a metro or bus system.

There are two types of facilities and services that need to be provided:

1 | Those that are not generally paid for by users—for example, the use of sidewalks, pedestrian under-bridges, and, in most cases, city roads.

2 | Those that are normally paid for by users—for example the use of parking facilities and public transport systems (even if the full costs are not recovered from such charges).

A key question that arises with regard to the investments/expenses for urban transport is how they should be financed. We will look at capital investments and recurring costs separately.

Capital Investments

Typically, investments in public infrastructure are made from the public budget. At times, the public sector puts in a share of the required capital and obtains the rest as a loan from financial institutions. An increasingly popular trend has been to attract private sector financing for these investments, either partially, by way of public private partnerships, or entirely, through privatization.

Thus, there are four broad options that are available. Table 1 outlines the main features of each option, the expectations for returns, and gives some examples of the kinds of projects that can be financed through each measure. Typically, the public sector plays a very important role in determining the services required whereas private sector efficiencies are tapped for operations.

Table 1 | Options for Financing Urban Transport Capital Investments

Financing Option	Principal Features	Important Expectations	Types of Projects
Fully funded by the public budget through taxes and other public revenue sources	The entire expenditure is met by the government; no loans taken; no private sector investment required	Economic viability, even if financial viability is not possible	Urban roads, sidewalks, pedestrian walkways, cycle tracks
Partially funded from the public budget and partly by loans from financial institutions	Part of the investment comes from the public budget (25–35%) with the remaining investment as loans that must be repaid, along with interest	Public value for the public investment and an associated earning or revenue stream that can be used for repaying the loan, with interest	High-cost mass transit systems, with limited potential for profits, such as metro rail systems
Partially funded by the public and private sectors, and loans from financial institutions	There is some investment from the public budget and some from a private partner (30-35%); the rest comes by way of loans	Public value, repayment of the loan(s), plus the private sector will expect to earn some profits or some kind of return on their investment (15–20%)	Mass transit systems that have a lower cost than metro rail and have a reasonable expectation of profit, such as light rail systems, BRT systems, parking facilities, public transport terminals, etc.
Partly funded by the private sector and loans from financial institutions	The entire funding comes from the private sector and from loans; no public funding	The profits are adequate for the private sector to be interested and the public value is not so much as to warrant public investment	Facilities that have a clear expectation of profits, such as parking in core city areas, bus operations, etc.

Source | Author

Operating and Maintenance Expenses

These are expenses required to keep a facility in a state of good repair or to keep it operational. In some cases, the expenses may be limited to the cost of maintenance alone, such as for roads, bridges, and sidewalks. In other cases, it would include the cost of running a service, such as public transport.

Generally, transport systems can earn an income by charging fares, fees, or tolls. Public buses and metro rail systems charge a fare. Parking facilities can charge fees and urban roads can, in some cases, charge a toll. In charging for such services, a balance needs to be struck between commercial viability and affordability. There also needs to be a balance between the profit motive of a private operator and the public good value of urban public transport. Therefore, public transport fares need to be kept affordable,

especially since this is the only mode of mass transit for the poor, who cannot afford private transportation. Low fares, however, mean that public transport systems may not recover their cost of operations and needed investments in bus replacement schemes, for example, do not take place. Similarly, it is difficult to charge for urban roads, except along limited stretches. Maintenance of such facilities requires public funds. Parking is perhaps one service that can possibly recover all its costs from fees, but this is also difficult in some cases, as there may not be enough demand in some places to cover all costs. In short, urban transport facilities often need public funds to meet the gap between the revenues and expenditures in keeping public transport systems in good repair and functional.

This funding gap raises two questions: (i) How can funds be found to meet these gaps? and (ii) Are there possible sources of revenue beyond the fares and fees mentioned above? Table 2 gives some examples of possible sources to tap.

Table 2 | Possible Sources for Financing Urban Transport Investments

Possible Source for Additional Resources	Explanation	Contexts for Use	Examples Of Use
Congestion/Road User Fee	Fees for the use of roads in the core part of the city	Generally possible, if a good alternative is in place, such as a mass transit system, along a clearly delineated area	London levies a congestion charge and Singapore has a road user fee
High Parking Fee	Parking fees are levied at a high rate, especially in core city areas	In all situations, but are good to use for areas where alternative modes of travel are available	Most cities levy a higher parking fee in core city areas than in other areas
Land Value Capture	A higher land value is levied on properties that benefit from mass transit investments	If it is possible to clearly delineate the areas that benefit from the investment and also assess, in a fair manner, the extent to which each property benefits	Hong Kong, Tokyo, Bogota
Employment Tax	Levy a tax on employers who benefit from improved access by their employees	In any situation where mass transit systems are operational and used by employees	Paris
Commercial Exploitation of Land	Property in prime areas is developed and used for sale or rental income	Land should be available to the public agency at prime locations and it has the resources to invest in new development on this land	Hong Kong, Singapore, Delhi

Source | Author

ROLE OF THE PRIVATE SECTOR

The private sector can bring in efficiencies that reduce the cost of transport services. Often it brings in financial resources that public budgets may not be able to afford and, thus, should be offered a role in urban transport services. However, the private sector is generally only interested if there are profits to be made. As such, win–win opportunities need to be structured whereby the private sector makes profits and the public sector secures a "public good."

Transport services in cities around the world are provided by a variety of players. For example, public transport services in China, Russia, the US, and several other countries are provided by state-owned entities, whereas in much of Africa, Latin America, and the Philippines they are provided by a large number of private operators. Most other countries have a mix of public entities and private operators providing these services.

Some considerations that are important in choosing between these options at a broader policy level are:

- **The political and economic ideology.** In some countries, the political and economic ideology favors a larger role for the public sector in providing basic services to its citizens. The first attempts are for the public sector to take on this responsibility. In other countries, there is a more favorable climate for the private sector, so the focus is on creating the right incentives and environment to encourage private sector participation.
- **Historical factors.** There are situations in which services were started by the private sector, but for various reasons the public sector stepped in to fill a gap and then stayed on.

Given the above, the options and factors that could be taken into account are shown in Table 3:

Table 3 | Options and Factors for Private Sector Participation in Urban Transport

Options	Factors/Situations/ Scenarios	Examples
Completely in the public sector	Very high public good value Low profitability Large operational losses likely High degree of monopoly power High investments and very long gestation period Very complex regulation	Metro rail system
Capital investment by the public sector but operations by the private sector (management contract/ service contract)	High public value Possibility of profit from operations but not on capital investment Potential for market competition Somewhat complex regulation	Management contracts for LRT/BRT operations

(continues on next page)

Table 3 | Options and Factors for Private Sector Participation in Urban Transport (*continued*)

Options	Factors/Situations/ Scenarios	Examples
Capital investment and operations by the private sector, but for a limited period (BOT)	High public value Possibility of returns on capital investments Simpler regulation Some competition exists	Parking facilities, terminals, some LRT systems
Completely in the private sector, but with tight regulation (routes, schedules, fares, level of service, safety, emissions, etc.)	High public value Potential for abuse of monopoly power Perfect market does not exist Limited market competition Some economies of scale Good possibility of profits Simple regulation	Citywide bus services
Completely in the private sector, but with medium regulation (fares/fees and safety)	High public value Some potential for abuse of monopoly power Reasonable market competition No economies of scale Good possibility of profits Simple regulation	Parking facilities Bus operations in some areas
Completely in the private sector, with very light regulation only (regulation of safety)	Some public value Limited potential for abuse of monopoly power Adequate market competition No negative effects of competition (e.g., oversupply leading to congestion or unsafe practices) No economies of scale Good possibility of profits Simple regulation	Parking facilities in core areas

Source | Author

TECHNOLOGY CHOICES FOR PUBLIC TRANSPORT

There are several technologies that can help make public transport more sustainable. At one end of the spectrum, buses are operating on a shared right of way. At the other end, there are heavy underground metro rail systems. While buses on a shared right of way cost the least and have a high degree of flexibility in the routes they serve, they have only

a limited carrying capacity. Underground metro rail systems have a very high carrying capacity but no flexibility with regard to the routes they serve. They also cost many times more than bus systems. Within these extremes are a range of technologies with varying carrying capacities, costs, and route flexibility characteristics. A choice between these options is often very difficult. The choice depends on the likely demand on the corridor to be served, the shape and size of the city, the terrain, the weather, investment capacity, users' ability to pay, and ease and speed of construction of the different transport options considered.

Cities that are linear and have relatively long travel distances, with limited alternative roads, may prefer metro rail systems that have a high capacity. However, sprawling cities may need a larger public transport network, consisting of several moderate capacity components. In such cases, bus-based systems would be better. Cities with an aesthetic appeal may prefer systems that do not create visual clutter with overhead wires or elevated viaducts. In these cases, underground systems or bus systems would be preferable. Cities with difficult terrain, especially those with severe gradients, would prefer bus systems, as rail systems would have difficulty in negotiating steep grades. Cities with tall building bylines and narrow streets would prefer underground systems or monorail systems, as the right of way on many roads would be a constraint. Thus, a choice between the options is a complex task, where several variables need to be considered together.

Following are some of the key policy issues that can help in limiting the choice between options:

- **Preferred fuel.** For cities in countries that import a large part of their petroleum fuel, a reduced import burden may require a preference for electrical energy. Countries with considerable amounts of hydroelectric power would prefer electrical energy, as well. However, those countries with significant petroleum of their own may prefer the traditional fuel, namely diesel.
- **Environmental sensitivity.** Areas that are environmentally sensitive may prefer electrical energy to petroleum fuels for reduced emissions.
- **Land-use policies.** Cities that are willing to adopt land-use policies that promote densification along pre-identified corridors would prefer high capacity systems along such corridors. Conversely, those who adopt policies favoring a more uniform density across a larger area would prefer low/medium capacity systems with greater route flexibility.
- **Growth projections.** Cities that are expecting a high level of growth may prefer to invest in systems that offer sufficient capacity for future demand, such as high capacity systems, whereas those with lower growth projections may prefer lower capacity systems.

THE WAY AHEAD

Going forward, it is important to adopt a systematic and comprehensive approach. The first action is to develop a clear vision for the kind of city desired. Is it to be a sprawling city with a huge network of highways and plenty of space for every household or is to be a more compact city where people have easy access to most places, but may not have huge backyards? This is a first decision that every city must take. In large cities, these policies are difficult to implement. However, developing multiple nodes—where each node is compact and self-contained—is an approach to consider.

Secondly, it is important to develop policies that can set the framework to guide more detailed planning to include a series of individual, but interrelated projects, which together seek to achieve the vision that the city has set for itself. Examples of policy issues that need to be covered would be those relating to:

- Land-use policies that promote mixed use and allow short trip lengths or that are segregated and require longer trip lengths
- Densification and FAR requirements
- Discouraging the ownership and use of personal motor vehicles
- Balancing supply-side measures with demand-side measures
- Technology choices, pricing, and industry structure for public transport

Thirdly, these policies have to be in alignment with the policies and aimed at achieving the long-term vision in 20 to 25 years. Shorter term investment projects and regulatory action plans need to be developed with specific timelines for implementation and identified sources of funding—public or private. A review of the plan's overall progress would be desirable every two to four years to allow for periodical corrections. Thus, it is important to set up the right institutional mechanisms to oversee the planning process and the subsequent implementation of the plans.

Fourth and lastly, institutions that can implement these plans should be established in a coordinated and well integrated manner. They need to be able to coordinate all aspects of urban transport and take full responsibility for an extremely complex task. Institutions that can focus on planning, contracting, and oversight, rather than on operations, should be considered. This would help create win-win arrangements in which the public sector can focus on the public good and private sector efficiencies can be applied to operational matters.

Though securing a sustainable urban transport system in any city is a complex task, it can be achieved through the foundation of a clear vision, sound policies, comprehensive plans, and strong institutions. It needs strong champions who not only know what is to be done, but also have the influence and courage to execute their vision.

ENDNOTES

1 ESMAP. 2014. *Planning Energy Efficient and Livable Cities: Mayoral Guidance Note #6* (Knowledge Series 022-14). Written by Serge Salat, Mansha Chen, and Feng Liu. Washington DC: Energy Sector Management Assistance Program.

2 ESMAP. 2014. *Formulating an Urban Transport Policy: Choosing between Options*. Written by O. P. Agarwal, Gouthami Padam, and Cholpon Ibraimova.

3 Floor area ratio (FAR) is the ratio of a building's total floor area to the size of the piece of land upon which it is built. It is also referred to as floor space ratio, floor space index, site ratio and plot ratio.

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ACRONYMS AND ABBREVIATIONS

ASI	Avoid-Shift-Improve approach
BOT	Build, operate, transfer
BRT	Bus rapid transit
CNG	Compressed natural gas
FAR	Floor Area Ratio
km	Kilometers
LRT	Light rail system
Mtoe	Million tonnes of oil equivalent
US / USA	United States of America
US$	United States dollar (currency)

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