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Policies for Sustainable Mobility

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Abstract

Rapid urbanisation and sprawling cities are placing great pressure on the existing transport systems in terms of meeting the mobility needs of people as well as goods. The current transport systems, largely dependent on fossil fuels, bring along with them serious environmental, social and economic costs in terms of heavy congestion, air pollution, GHG emissions, accidents, etc. With growing concerns towards sustainable development and mitigating climate change, it is realised that there is a need to shift from the current unsustainable private vehicle led transport approach to a more sustainable approach that allows movement and transport activity in a way that helps in mitigating the negative impacts of transport and strengthening the process of urbanisation in a sustainable manner.

This working paper aims to suggest policy interventions or measures which can guide the development of urban transport in a sustainable manner. It highlights the Avoid-Shift/Retain-Improve (ASRI) approach which emphasizes the need to reduce or avoid travel, shift or retain the shares of more sustainable modes (public transport and non-motorised transport) and also improve the current ways of travelling by interventions related to clean fuels, clean vehicle technologies and use of information and communication technologies.

The paper brings forward a whole package of possible measures under the ASRI approach that can be adopted in our cities to address the current issues in transportation and promote sustainable mobility. It is important to note that not all measures will be applicable or suitable to all cities. Each city should adopt a combination of these measures based on their context, requirements and the applicability of these measures.

1. Introduction

If cities are the engines of economic growth, transport are the driving wheels.

Availability of mobility options or the lack of it has direct implications on the economic efficiency of our cities and their overall well-being. Increasing rate of urbanisation and sprawling cities places great pressures on the existing transport systems in terms of meeting the mobility needs of people as well as goods. The traditional supply oriented approach of building more and more infrastructure (roads, flyovers, etc.) followed in our cities has not been able to meet the growing demands. The public transport systems are largely inadequate and have been unable to keep pace with the increasing demand to travel.

The current transport systems are largely dependent on fossil fuels, have been accompanied by serious environmental, social and economic costs. In 2004, transport sector was responsible for 23percent of global GHG emissions, with nearly three quarters coming from road vehicles alone1. Therefore, current growth trajectory in urban India directs us on an unsustainable path of private vehicle led development which brings along the related concerns of heavy congestion, high air pollution, high GHG emissions, safety issues, etc.

With growing concerns towards sustainable development and mitigating climate change, it is realised that there is a need to shift from the current unsustainable approach to a more sustainable approach that allows movement and transport activity in a way that helps in mitigating the above issues and strengthen the process of urbanisation in the long run.

This working paper aims to suggest policy interventions or measures which can guide the development in the transport sector on the lines of sustainable development. It brings forward a whole package of possible measures that can be adopted in our cities to address the current issues in transportation.

2. Understanding Sustainable mobility

Many organizations and agencies have defined sustainable transport in their own way. Some of the definitions have been discussed in Box 1.

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[1] Kahn Ribeiro, S., S. Kobayashi, M. Beuthe, J. Gasca, D. Greene, D. S. Lee, Y. Muromachi, P. J. Newton, S. Plotkin, D. Sperling, R. Wit, P. J. Zhou, 2007: Transport and its infrastructure. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Box 1 Definitions of 'sustainable transport' adopted by various organisations

- The WBCSD (World Business Council for Sustainable Development) defines sustainable mobility as 'the ability to meet the needs of society to move freely, gain access, communicate, trade, and establish relationships without sacrificing other essential human or ecological values today or in the future.' (WBCSD 2001)

- According to MOST (Media Oriented Systems Transport), 'The goal of sustainable transportation is to ensure that environment; social and economic considerations are factored into decisions affecting transportation activity.' (MOST 1999)

- EST (environmentally sustainable transportation) is 'transportation that does not endanger public health or ecosystems and meets needs for access consistent with (a) use of renewable resources at below their rates of regeneration, and (b) use of non-renewable resources at below the rates of development of renewable substitutes.'(OECD and BLFUW 1998)

- 'An environmentally sustainable transport system:
    - allows generally accepted objectives for health and environmental quality to be met, for example, those concerning air pollutants and noise proposed by the WHO (World Health Organization);
    - is consistent with ecosystem integrity, for example, it does not contribute to exceeding of critical loads and levels as defined by the WHO for acidification, eutrophication, and ground-level ozone; and
    - does not result in worsening of adverse global phenomena such as climate change and stratospheric ozone depletion.' (OECD and BLFUW 1998)

- A sustainable transport system, as defined by the European Council of Ministers of Transport (ECMT, 2004);
    - allows the basic access and development needs of individuals, companies society to be met safely and in a manner consistent with human and ecosystem health, and promotes equity within and between successive generations
    - is affordable, operates fairly and efficiently, offers a choice of transport mode supports a competitive economy, as well as balanced regional development

    limits emissions and waste within the planet's ability to absorb them, uses renewable resources at or below their rates of generation, and uses non-renewable resources at or below the rates of development of renewable substitutes, while minimizing the impact on the use of land and the generation of noise.

    Source: TERI (2009), An exploration of sustainability in the provision of basic urban services in Indian cities

It is important that the definition adopted for sustainable urban transport in this paper reflects the Indian context. It was found that for the Indian context, the study, "An exploration of sustainability in the provision of basic urban services in Indian cities"[2] defines sustainable

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[2] An exploration of sustainability in the provision of basic urban services in Indian cities, TERI, Arghyam, 2009, TERI Press, New Delhi

urban transport in a comprehensive manner. This definition is based on learning from a range of sustainable transport definitions and concepts available in the international literature. The definition acknowledges that urban transport in India should cater to the social, economic and environmental needs of growing cities. The study defines sustainable transport as

"A transport system where every individual or traveller category in a city is able to fulfil their mobility needs in a quick, affordable, safe, reliable, comfortable, energy efficient and environmentally benign manner" (TERI, 2009).

2.1 Elements of sustainable transport system

The studies by TERI on "An exploration of sustainability in the provision of basic urban services in Indian cities, (2009)" and "Review of Comprehensive Mobility Plans (2011)" have delved deeper on the definition and elements of sustainable urban transport. As per TERI (2011) the following are the elements of sustainable urban transport:

- It provides and improves access to all travel categories (including socially vulnerable groups) and hence promotes equity in terms of opportunities available to individuals, companies, societies for their overall growth. It is a balanced system which provides modal choices to the population i.e. choice to walk, cycle or use a personal vehicle, public transport or an intermediate public transport (IPT) mode.

- It has minimal impact on human health. The negative externalities of a transport system on human health include:
    - diseases caused due to air/noise pollution, ozone depletion due to transport system operations
    - physical injuries/fatalities caused due to accidents

A sustainable transport system should minimize the above listed externalities to the maximum extent possible, which implies that it should be safe and should generate least pollution (air, noise and ozone depletion).

- It has minimal impact on environmental quality, which implies that it limits:
    - air pollutants
    - emissions
    - noise pollution
    - water pollution
    - land pollution
    - waste generation
    - ozone depletion
- It reduces dependence on fossil fuels by various measures like:
- promoting mass transport
    - promoting non-motorized transport (NMT)
    - energy efficiency

- o ensuring smooth movement on roads
- o promoting use of clean fuels like electricity (from renewable energy sources), solar energy, hydrogen, bio-fuels, etc.

- It ensures ecosystem integrity which implies that local (sensitive) ecosystems are not disrupted due to construction/operation of transport infrastructure/activities. It:
  - o should not cause habitat loss (e.g. cutting of huge forest patches)
  - o should not pollute local ecosystems (air and water)
  - o Promotes social cohesion by conscious deigning/planning
  - o Promotes community livability by appropriate neighbourhood design
  - o Enhances and not alters the image of areas that have unique identity/cultural heritage

3. Measures to achieve sustainable mobility

3.1 The A-S/R-I Approach

The rising need to travel, current inefficient ways of travelling, high dependence on private vehicles and use of the highly polluting vehicles have collectively led us on the path of unsustainable development. In context to sustainable transport, the 'Avoid, Shift/Retain, Improve' (ASRI) approach has been gaining global popularity in recent times. This approach includes strategies that help in avoiding/reducing the overall need to travel, shifting or retaining the shares of more sustainable modes like public transport and non-motorized transportation, and improving the efficiency of transport modes (as illustrated in fig 1).
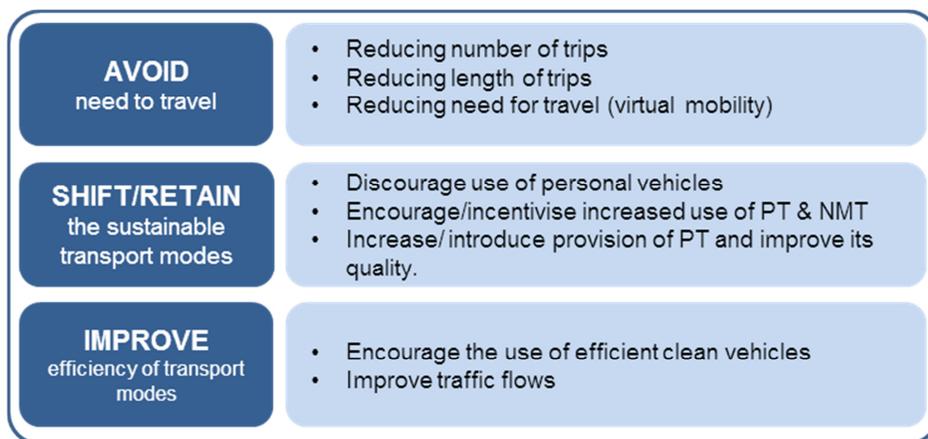
Figure 1: The A-S/R-I Approach

Under the three strategies, several measures have been identified that can help policy makers in making transport related decisions. These measures or the tools to achieve sustainable mobility can fall under different categories including planning, institutional, financial or regulatory in nature. To supplement them, it is also important to generate awareness among the masses and also build capacity of our city officials to implement and monitor these measures in our cities.

I.   *AVOID or reduce the need to travel*

Avoid, the first principle of sustainable mobility seeks to deal with the transport related problems at the root level by altering the overall need to travel. It also includes measures that can help in reducing the number and length of trips. Several measures have been identified to achieve the above and are discussed below:

Table 1 AVOID - Strategies and measures

Strategies	*Measures*	*Type of Measure*
Integrated Land-use-transport planning	Develop integrated plans for compact development of cities	Regulatory
	Promote Transit oriented development to minimise travel distances	Planning
Use of new Information and Communications Technology (ICT) systems	Promote virtual mobility	Planning
	Encourage use of Intelligent Transport Systems (ITS)	Regulatory

A.   Integrated Land use – transport planning

Transport exists because people need to move for work, recreation, education, shopping and other socio economic needs. The spatial arrangement of the various land uses or activities across the city is a very important factor in determining the intra city travel demand. Experiences from other cities like Bogota, Singapore, etc. clearly suggest that integrating and coordinating transport and land use development significantly helps in reducing the number and length of trips. It also increases the available options for people to access their basic needs, thereby leading to an overall improved quality of life.

o *Develop integrated plans for compact development of cities*

In order to address the issue of integrating the two most important components of city planning – land use and transport; it is important that there is a clear understanding of the effects of the existing and proposed land use development on the mobility needs of the people in terms of demand, mode choices and travel patterns in a city. Ideally, the plans after proper assessment of the current and future travel demands should be able to channelize future growth of a city in an integrated manner with minimum travel distances to access employment, housing, and other socio economic needs.

City officials should be encouraged to develop integrated land use transportation plans in a way that serves the entire population as well as considerably reduces the need to travel.

a. *Creation of a single unified agency for transportation*

Currently, there are multiple institutions involved in urban planning and transportation planning and management which include city development authority, town planning department, traffic police, roads and building department, public works department (PWD), etc. It is realized that extensive coordination is required among these various agencies/departments to ensure integration between land use and transport. A single unified body or institution working as an umbrella organisation is the need of the hour that is

responsible for coordination among the various agencies/institutions involved in urban development, delivery of urban services and transport planning.

Or, as suggested in NUTP (2006), all urban development and planning bodies in the States should have in house transport planners as well as representation from transport authorities in their managements.

B. Promote Transit oriented development to minimise travel distances

Transit oriented development (TOD), in recent times, is gaining popularity especially in context to sustainable development. TOD promotes or channelizes the development or growth of a city around a pre-planned transport network. As defined in a study3 conducted by Delhi Metro Rail Corporation (DMRC), TOD is a compact high density mixed-use development designed/clustered around new or existing public transit stations or corridors which provide housing, employment, entertainment and civic functions within walking distances.

The concept of TOD is based on the principle of 5 Ds namely density (high), diversity (mixed land uses), distance to transit (minimum), design (pedestrian friendly streets) and destination accessibility (high). Apart from place making, TOD offers mobility choices and considerably increases access to opportunities.

Globally, several tools have been recognised for achieving TOD. Some of them are discussed below as applicable in the Indian context:

o *Encourage higher densities*

Rapid urbanisation and increasing pressures on the existing infrastructure, has resulted in rapid horizontal spread of the cities. As a result, the travel distances have increased; and also there is an increase in vehicle ownership is increasing; increase in the cost of provision of infrastructure and increasing traffic problems of congestion, air pollution, and a poor quality of life.

Higher density developments can help in addressing the above problems as it helps

- make better use of scarce land resources
- make more efficient use of existing infrastructure
- reduce the need for travel by providing local amenities at shorter distances
- reduce the reliance on car transport by providing a focus for walking, cycling and public transport networks[4].

For effective land use and transport integration, densities should be ideally aligned to the availability of public transport. Allowing higher densities near the mass rapid transit nodes can help increase ridership of the transit systems and decrease overall infrastructure costs5.

To promote densification, the following instruments have been identified:

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[3] Transit Oriented Development (TOD) - Study of Existing Metro Corridor between Chattarpur and Arjangarh of Delhi Metro Project of Phase II. A study conducted by Delhi Metro Rail Corporation (DMRC) and Capita Symonds`

[4] Delivering Successful Higher-Density Housing A Toolkit–Second Edition, by east Thames

[5] Sustainable Urban transport in India –Principles, Standards, Implementation and Best practices, Environmental Planning Collaborative (2012)

a. *Higher FAR/FSI*

Maximising the population holding capacity of an area can be very instrumental in checking the horizontal growth (sprawl). However, the main idea is to promote higher densities and increasing the FAR would not necessarily lead to higher densities. Therefore, it is essential to couple the FAR threshold with a minimum density requirement. Increasing the FAR can be an effective tool in redevelopment of low density or dilapidated neighbourhoods along the public transit nodes.

b. *Transfer of Development Rights (TDR)[6]*

Transfer of Development Rights (TDR) means making available certain amount of additional built up area in lieu of the area relinquished or surrendered by the owner of the land, so that he can use extra built up area either himself or transfer it to another in need of the extra built up area for an agreed sum of money. It is a market-based mechanism that promotes responsible growth, while conserving areas such as working forest, prime agricultural areas and environmentally sensitive lands[7]. TDR can be a very useful tool to the local governments in directing development in specific zones.

c. *Spot Zoning:*

Spot zoning is a provision that can be made in a zoning plan under which a particular parcel of land is granted a certain classification concerning its use that differs from the use of other properties in the immediate area. As it generally benefits a single or a small group of land parcels in a larger zoned area and is often linked to favouritism, it is not favoured in practice.

Densification of the existing developments would require changes in the existing development control regulations as well as building byelaws. These may vary from case to case as per the holding capacity of an area.

With increased densities, the basic other service needs in terms of water supply, electricity, sewerage system, road infrastructure, etc. also increases proportionately. Therefore, the city officials must ensure that the supporting infrastructure will be able to support the new proposed higher densities, or else, it should be upgraded accordingly to meet the new demands. However, the per capita cost of infrastructure (in terms of new pipe lengths and physical infrastructure) reduces significantly with increase in densities.

With increase in density along the public transport nodes, it is important to strengthen walking and cycling infrastructure so as to ensure last mile connectivity and better accessibility to PT.

o **Encourage mixed use development**

Land use planning should be done in a way that best supports the socio-economic activities of the resident population in an area and hence reduces the overall travel needs. A balanced mix of uses should be enabled so as to ensure availability of services or basic needs within short distances. However, special attention must be given to the compatibility and location of various land uses in reference to the availability of transport network.

a. *Align location of different land uses with availability of transport infrastructure[8]*

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[6] http://www.commonfloor.com/guide/guidelines-for-transfer-of-development-rights-2162.html

[7] Sustainable Urban transport in India –Principles, Standards, Implementation and Best practices, Environmental Planning Collaborative (2012)

[8] Sustainable Urban transport in India –Principles, Standards, Implementation and Best practices, Environmental Planning Collaborative (2012)

Traffic intensive land uses usually generate high levels of vehicular movement at concentrated spots. This can increase traffic congestion greatly if the location of certain spots is not aligned with the street network, intersections etc.

b.   Ensure availability of affordable housing

Cities employ and need a large section of population for delivery of urban services; household chores; construction activities and other activities. Due to inability to afford a house within the city and also unavailability of low income housing, this section generally lives on the outskirts of the cities and travel large distances for their daily needs. Consequently, a large share of their income is spent on meeting their mobility needs.

It is important to understand the inter-dependability of the various income groups in the functioning of a city and hence include them in city planning especially in close proximity to mass rapid transit nodes. If these low or middle groups are provided housing solutions at affordable prices into the city structure, a large number of unnecessary trips can be avoided. Secondly, it will help in bridging the rich-poor divide that exists in our cities and ultimately lead to creation of socially inclusive neighbourhoods.

o   ***Improve accessibility around transit stations/nodes***

Physical accessibility plays a dominant role in the overall success of the public transport systems. Well-designed public transport modes, if not accessible can lead to low ridership. Even where buses and routes are available, access to them within comfortable walking distance and by all user groups is a challenge in most cities[9]. Accessibility indicates the collective performance of land use and transportation systems and determines how well that complex system serves its residents[10]. Therefore, it is important to improve accessibility of transit stations and nodes in our cities.

a.   Ensure a complete network of streets

To ensure easy accessibility of transit stations/nodes, a continuous and complete network of streets with safe and adequate walking and cycling infrastructure is important.

C.   Use of new Information and Communications Technology (ICT) systems to reduce travel demand

Information and Communications Technology (ICT) is increasingly seen as a possible means to complement and/or improve the efficiency of physical mobility[11]. It has several direct as well as indirect impacts on transportation in a number of ways. ICT may have an impact on transport demand and mobility, by influencing their volume and distribution in time as well as space[12].

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[9] An exploration of sustainability in the provision of basic urban services in Indian cities, TERI (2009)

[10] Ahmed M. El-Geneidy, David M. Levinson (2006), Access to Destinations: Development of Accessibility Measures

[11] TERI and World Business Council for Sustainable Development, Mobility for development, Bangalore, India, 2010

[12] http://www.eurofound.europa.eu/emcc/content/source/eu04060s.htm?p1=sector&p2=Transport_and_Storage

Given the above, it is realised that ICT can play a critical role in promoting sustainable mobility. To promote use of ICT in transportation, certain areas have been identified which are discussed below:

o   ***Promote virtual mobility***

'Virtual Mobility' is defined as the process of accessing activities that traditionally require physical mobility, but which can now be undertaken without recourse to physical travel by the individual undertaking the activity[13]. ICT is changing the way a person reaches various activities in his day to day life including work, shopping, learning and other forms of social interaction. Today, undertaking these activities do not necessarily require transport or physical travel and has consequently resulted in a significant reduction in the overall number of motorised trips. It not only helps in substituting physical travel but also enables improved access to places which otherwise were considered inaccessible due to large distances or other constraints. Some examples of virtual mobility include working from locations outside office (teleworking), online shopping, online formal and informal education, conducting business online, video conferencing, and many more.

There is a growing consensus on the fact that improving physical mobility might not be sufficiently able to completely tackle mobility related problems. Any improvements in public transport or other infrastructure will take substantial time and a considerable amount of money. Virtual mobility, in this regard is gaining popularity as a possible means of travel that can promote sustainable mobility due to the large benefits associated to its use in terms of lesser need to travel, reduced travel times, lesser congestion on roads, opportunities for the physically disabled, etc.

Virtual mobility has a large potential to reduce/minimise the travel demand. To promote virtual mobility, the following instruments have been identified and can be further explored:

a.   *Promote telecommuting/e-work and e-trade*

"Tele" means distance and the term "telework", means "distant working". Also referred to as telecommuting, it is a specific mode of working whereby employees or freelancers offer their services, using telematics[14], at a site which is geographically separated from the main office. In simple words, it mainly involves working from distant locations online.

In Indian cities, especially mega cities like Bangalore, Mumbai and Delhi, a commuter spends an average of two to three hours in travel to work. Therefore, telecommuting can be a very effective tool in reducing the number of hours spent on commuting and hence improve resource efficiency by reducing congestion on roads, fuel consumption and pollution levels.

City officials must be encouraged to develop a tele/e-work culture and adopt flexible working hours for their staff members. However, certain factors need to be considered – availability of reliable technologies, certain level of trust and discipline among employees, type of work to be undertaken, basic training to employees to deal with minor errors or troubleshooting errors.

Telecommuting is an established phenomenon across the world with over 100 million telecommuters, but in India it is still in its infancy. A study of three cities – Mumbai, Bangalore and Calcutta – shows that the concept of telework is more commonly understood in the context of international outsourcing in software services or remote processing of

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[13] http://www.trg.soton.ac.uk/vm/v-m.htm

[14] "Telematics" refers to a combination of information and technologies, which connect the computers of employees or freelancers to the computers of the main employing organization.

transactions than in the context of telecommuting. Still there is a huge potential in this field and given the urban transport crisis in our cities, telecommuting can be very helpful in dealing with mobility related problems in our cities.

b. *Encourage e-governance programmes:*

E-Governance or electronic-governance is the application of Information and Communication Technology (ICT) for delivering government services, exchange of information communication transactions, integration of various stand-alone systems and services between Government-to-Citizens (G2C), Government-to-Business (G2B), Government-to-Government (G2G) as well as back office processes and interactions within the entire government framework[15].

It helps provide government services in a much simpler, faster, reliable, efficient and transparent manner to the user groups. E-governance has gained significant attention in the recent years and has brought significant transparency in the government processes and services. It has made government services available in a much simpler, faster, reliable and efficient manner. Due to significant reduction in the number of trips, e governance is being realised as an important tool to improve the traffic situation in cities. Government is making substantial investments in this field. For example, the Government of Karnataka (GoK) has used ICT to implement an e-governance project called 'BangaloreOne' or B1 Project which serves as a 'one-stop-shop' facility to the citizens.

o **Encourage use of Intelligent Transport Systems (ITS)**

Quick, reliable, efficient and safe transportation is one of the greatest needs of today given the growing problems of road congestion, high emission levels, high pollution, etc. associated to the use of current transport systems. Intelligent transport systems (ITS) have been realised as one of the possible tools to achieve sustainable mobility.

ITS encompass a broad range of wireless and wire line communications-based information, control and electronic technologies. When integrated into the transport system (infrastructure and vehicles), these technologies help monitor and manage traffic flows, reduce congestion, provide alternative routes to travellers, enhance productivity and save lives, time and money . It covers all modes of transportation – air, water, rail and road; and intersects various components of each mode – vehicles, infrastructure, communication and operational systems. In India, ITS is still in its nascent stage. Several single-city-based pilot studies and projects have been undertaken in different cities in India incorporating ITS at various fronts.

City governments or the concerned authorities require certain pre requisite tools to incorporate and operate ITS in our current transport systems. Firstly, these systems are highly expensive and complicated in terms of operations. Given the limited funds available and limited capacity of our city governments, proper measures should be adopted to build the capacity of the city officials to use these systems, or otherwise, government must collaborate with the private companies to plan and ensure efficient use of these systems wherever possible. The upper levels of government should encourage and provide financial support to the city governments in adopting and implementing ITS in their city transport systems.

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[15] Saugata,B., and Masud,R,R.(2007. Implementing E-Governance Using OECD Model(Modified) and Gartner Model (Modified) Upon Agriculture of Bangladesh. IEEE. 1-4244-1551-9/07.

II.   SHIFT/RETAIN *the more sustainable modes*

Shift/Retain, the second principle of the ASRI approach focuses towards preserving and promoting the shares of environment friendly modes like public transport (PT) and non-motorised transport (NMT). It includes measures that can help in attracting people towards these modes and bring about a modal shift from personalised vehicles to PT or NMT. In its endeavour to promote PT and NMT, it also deals with measures to discourage private vehicle use in cities.

Table 2 SHIFT/RETAIN - Strategies and measures

Strategies	*Measures*	*Type of Measure*
Plan and provide adequate PT services	Develop mobility plans	Regulatory
	Use appropriate technologies to meet travel demand	Planning
	Ensure seamless travel through multi modal integration	Planning, Regulatory, Institutional, Information
	Improve the quality of service of the existing PT systems	Planning, Regulatory
Plan and provide NMT infrastructure	Develop NMT plans as a subcomponent to CMPs	Planning
	Ensure city wide connectivity	Planning
	Plan and encourage bicycle sharing	Planning, Regulatory
Discourage Car use	Develop efficient traffic management plans at the city level (using ITS)	Planning, Regulatory

A. Plan and provide adequate PT services

A good and efficient public transport has been universally acknowledged as one of the most important pillars of any sustainable transport system as it is to a large extent, able to mitigate the social, economic and environmental negative externalities of travelling[16]. In India, PT systems have largely been unable to cope with the rapid urbanisation rates and the resulting travel demands of the population. This can be further emphasized given that formal PT services exist in less than 20 cities in India. In absence of formal PT services, several other modes like intermediate modes (like 3 wheelers, taxis etc.); and informal modes have emerged with time to meet the mobility needs. These modes are run by individuals/ private associations/unions, are largely unregulated and have several environmental implications.

Therefore, to move towards sustainable mobility, it becomes critical to plan and provide adequate PT services in our cities. To do so, the following measures have been identified:

o   ***Develop Comprehensive mobility Plans (CMP's)***

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[16] An exploration of sustainability in the provision of basic urban services in Indian cities, TERI (2009)

Currently, the city governments (with city population 1 million) are required to prepare CMP's as a mandatory requirement to avail funding under JNNURM. Till date, only 65 cities in India are covered under JNNURM and the rest of the cities, have no mobility plans and are largely undergoing haphazard development. Secondly, a study conducted by TERI in 2011 to review the CMP's of selected Indian cities brings out the CMP's fail to address and do justice to all the transport modes (especially non-motorised modes), and has several gaps in terms of lack of stakeholder engagement, lack of clear implementation strategies, etc.

To ensure planned and efficient transport system, it is important that all city governments should be encouraged to develop transport plans to meet the current as well as future travel demands. The plans should incorporate and cater to all transport modes including the informal modes that currently have extended themselves to serve as the PT system in small and medium cities.

o   *Use appropriate technologies to meet travel demand*

Each city has its own unique set of problems and would need unique solutions. There exists no single transit model that can be applicable to all cities. Rather, each city needs a PT system (or a combination of two or more systems) which is customized to meet its own needs and demands.

The choice of PT mode for any city depends on the travel demand generated in the city which is mainly a function of the city characteristics (Refer Box 1). There is a wide array of public transport technologies available ranging from the high capacity metro rail, medium capacity monorail systems, BRT, etc. to low capacity bus systems running in mixed traffic. As discussed earlier, intermediate para-transit and informal modes (like auto rickshaws, minibuses, tempos etc.) also play a key role in meeting the mobility needs in Indian cities, especially the small and medium cities. While some of these modes are most effective in transporting large masses of people in minimum space, others play an enhanced role as feeder systems providing first or last mile connectivity especially in areas where PT is unable to reach. Therefore, a good transport system should include a combination of various modes serving different requirements and needs.

Box 1 Public Transportation Technology - Selection criteria

The choice of system technology chosen for a city, should ideally depend on multiple variables including city population, income levels, activity patterns, travel demand, density, land availability, funds available etc. However, transportation projects involve high capital costs, it is suggested that the options should be properly analysed and then decided upon. The chosen technology should be helpful in meeting the travel demand as well as minimise the negative externalities resulting out of its operations and maintenance.
The various prevalent modes of PT are discussed below:

1.   Mass Rapid Transit Systems (Rail based or bus based)
Mass Rapid transit systems carry a very large number of commuters in minimum space and saves considerably on time, costs etc. in comparison to private automobiles used to transport the same no. of people. The main modes of mass transit systems includes the high capacity systems like metro rail, commuter rail etc. as well as the medium capacity systems like BRT, Monorail, etc.

Table 3 Selection criteria of Mass Rapid Transit Modes

Source: Recommendations of Working Group on Urban Transport for 12th Five Year Plan

Mode choices	PHPDT[17] in 2021	Population as per 2011 census (Million)	Average Trip length for motorized trips
Metro Rail	>=15000 for at least 5km continuous length	>=2	>7-8 km
LRT primarily at grade	=<10,000	>1	> 7-8 km
Monorail	=<10,000	>2	About 5-6 km
Bus Rapid Transit System	>=4,000 and Up to 20,000	> 1	> 5 km
Organised City Bus Service		>1 lac hilly towns (50,000)	>2 to 3 km

2. <u>Organised City Bus services</u>

In small cities (with population less than one lakh persons), the average trip length is generally short. In such a case, an organised city bus service can prove helpful to meet the travel needs. With growing needs, more buses can be added in to the system. It is when the demand exceeds the overall capacity of the bus service; other mass transit systems should be introduced based on the context and applicability of the same.

3. <u>Others</u>

Intermediate public transport systems form as essential part of passenger public transportation services in Indian cities, irrespective of the city size and structure. Apart from these, there are informal modes offering faster, flexible and affordable services to the commuters. These modes play a significant role as feeder modes and in catering to the niche demand which is not met by public transport or the personalised modes. They provide door to door services, last mile connectivity between the public transport nodes and the final destination, or complement other formal modes like BRT, Metro, etc. In absence of public transportation in most Indian cities and with deteriorating services in other cities, these modes act as a substitute for public transport, which is the current scenario in small and medium size cities. However, it is realized that the modes, if integrated with other modes has the potential in meeting the future mobility needs in a more efficient manner. It is important to assess the mode for its role in providing sustainable urban transport in cities – in avoiding unnecessary trips, planning a shift to more sustainable transport modes, improve vehicle design/technology leading to lower emissions and improved safety levels and environment.

o   *Ensure seamless travel through multi modal integration*

A good public transport system is one that is perceived by the user as a single system and allows seamless travel between one made and the other as also between systems managed by different operators.[18] For this, it is important that the systems are well integrated with the land use planning as well as amongst various modes. We have discussed transport and land use integration in detail earlier in relation to avoiding the need to travel and here we shall focus on multi modal integration only.

An integrated multi modal system can prove very helpful in efficiently moving people from one to another. The traditional approach of increasing capacity to meet the growing demand has not proved very helpful and has led to increased pressures on finances, resources etc. It is

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[17] Peak hour peak direction traffic

[18] National Urban Transport Policy (NUTP), 2006

realized that one of the key solutions to sustainable mobility lies in efficient operations of the current systems which can be achieved through integrating the various aspects of different modes including operations, institutions responsible for operating, managing and monitoring various systems, integration in fares through provision of smart cards, etc. and also information integration of different modes.

o ***Improve service quality***

In India, Public transportation is often perceived as being overcrowded, dirty, slow, uncomfortable, and unsafe. These basic issues related to uncomfortable travelling environment have a considerable effect on an individual's choice to use public transportation modes for their daily travel. As a result, the choice riders prefer to use other personalized modes of travel whereas the captive users aspire to have their own modes of transport as and when their income levels rise. Therefore, if more users especially from personalized modes are to be convinced into using PT, their needs of improved system quality have to be catered to. For an improved PT system, the following issues have to be addressed:

a. <u>Availability – routes, system</u>

Availability includes both the availability of a public transport system as well as the availability of routes on the system. A good and efficient system must ensure availability of public transportation to all traveller groups in all parts of the city. As also highlighted earlier, less than 20 cities are provided with formal PT services. Therefore, it is critical that government plans for some sort of PT in its cities. Owing to the huge capital investments involved in provision of PT services, the city governments should first provide services on the routes where there is high demand. The system can then be expanded to include low demand routes in the long run and cover the entire city.

Currently, informal modes like auto rickshaws, minivans, etc. emerge to meet the travel demand and serve as public transport modes in small and medium sized towns. In bigger cities, these informal modes arrange themselves around the PT transit stations/nodes and serve as feeder systems. It is advised that the city governments gives due recognition to these informal modes of transport as PT modes in our cities, especially where PT is not available. Government can step in to organize the sector to a certain extent.

b. <u>Accessibility issues</u>

Access to public transportation is the opportunity to use the service. This may be interpreted in terms of proximity to and the cost of using transport services[19]. Here, the focus is on physical accessibility and the cost of services is dealt separately in the pricing or affordability section. Despite the availability of public transport in Indian cities, accessibility often remains a challenge in terms of physical distances. Also, the growing popularity of gated communities in our cities further exacerbates the issue of accessibility of PT. The most affected are the poor/low income groups who cannot afford other modes and have to rely on PT for their daily travel. They generally end up walking long distances to reach the stations and then back home. Also currently, the investments in public transport sector have largely been focused on increasing the capacity of the transport systems. Physical accessibility of the transport systems still remains a neglected area or dimension in city planning projects.

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[19] Murray, A. T., R. Davis, et al. (September 1998). "Public Transportation Access" Transportation Research Part D: Transport and Environment 3(5): Pages 319-328

Studies show that physical accessibility to public transport is a key component of a successful public transport system. ***Therefore, the city officials must ensure availability as well as easy accessibility of public transport services to all traveller groups within walkable distances in all parts of the city. To do so, it is important that the feeder modes including the NMT modes and informal modes of transport are strengthened around the transit stations/nodes.*** Provision of adequate infrastructure for the feeder modes (footpaths, cycle tracks, parking spaces etc.) is the most important step to improve PT accessibility. In case of motorised feeder modes, the city officials may or may not define the routes of operation. However, it is to be ensured that all the systems (PT and the feeders) work in integration with each other.

c. *Operations and user comfort*

Even where PT is available, the service is largely looked upon as unreliable and inefficient. Breakdowns and accidents are common. Reliability and comfort of using PT services determine the ease of accessibility and eventually the number of people that will switch over from private modes[20]. It is important that efficient and frequent service is made available with the idea of reducing travel times as well as waiting time.

User comfort includes comfort and convenience levels for the users for all aspects of the entire trip. It encompasses convenience in boarding/alighting, comfort levels within the travel modes while journey and also the convenience of interchanging modes if required.

d. *Pricing*

Currently, PT users in Indian cities comprise mainly the captive riders, i.e. those who cannot afford other personalised modes of transport. And therefore, PT is largely subsidised to ensure that the services are affordable for these captive low income groups and the poorer sections of society. On the other hand, city government is largely fiscal deficit and is unable to even meet their operational costs and hence leads to poor quality of service. The city government should be encouraged to arrange for alternative funding options or cross subsidies to make up for their operational losses.

On the other hand, there is a large section of population who can afford higher fares and quality of service is the major concern for them for using PT. Therefore, the city government should aim to provide a combination of both – low cost service as well as high quality service with higher fares to meet the varying demands of different sections of society and shift people to PT.

e. *Safety*

In India, the problem of road fatalities and injuries is more acute than in most countries with an average annual increase of 8-9% in the number of road fatalities in the past 7 years. In 2012, the number of deaths due to road accidents was as high as 1.39 lakhs which is nearly 37 percent of the total deaths in India in the same year (NCRB Report)[21]. To address the issue of increasing road accidents, it is recommended that safety becomes a priority while designing our transport systems.

All vehicles operating on road should adhere to the minimum safety standards especially in context to vehicle design. Concerned authorities should ensure that only type approved vehicles are allowed to operate on road and customized vehicles (also referred to as *jugaads*)

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[20] Sustainable Urban transport in India –Principles, Standards, Implementation and Best practices, Environmental Planning Collaborative (2012)

[21] http://ncrb.nic.in/CD-ADSI-2012/accidental-deaths-11.pdf

like *chakkadas* in Gujarat and others should be banned. It is extremely important not only for the safety of these operators and their passengers but also for the safety of the other road users.

f.   Security

Growing incidents of thefts, assaults (especially women) etc. have led to the negative image of PT systems in Indian cities and is considered highly unsafe especially after the sun sets. And once again, the PT users travelling late are the 'captive' users returning home from work etc. and become victims to the rising crimes. Therefore, it is important that the city officials ensure a safe environment in our cities which allows safe and smooth travel at all hours. Ensuring a sense of security will help in promoting use of public transportation significantly.

Currently, certain measures have been adopted, for example, women's only local trains, women coaches in Delhi metro, women helpline no.'s, deploying women personnel on board, etc. But, in the long run, the government should aim to establish an environment in which all individuals irrespective of their caste, gender, age, etc. are able to travel safely at all times of the day.

B.   Plan and provide NMT infrastructure

Currently, walking and cycling accounts for at least 30-40 per cent of the total daily trips both as a major mode as well as a feeder mode irrespective of the city size and structure22. The user group comprises mainly the captive users rather than the choice mode users. These NMT users also form a significant share of the road fatalities and injuries. Despite the high captive ridership and high vulnerability of the users on road, NMT is a marginalized area in urban transportation policy making as well as city level planning. The cities lack the very basic infrastructure for the NMT users. As a result, these NMT users have to struggle for space with the other motorized and faster modes of transport leading to their high vulnerability on road.

With growing consensus towards the high benefits related to the use of NMT, it is important that adequate measures are taken to retain the current modal shares and also further promote it as a mode of choice.

o   ***Develop NMT plans as a subcomponent to CMPs***

In Indian cities, NMT infrastructure or facilities are generally an afterthought and are retrofitted from time to time as and when the need is felt. The city officials must be encouraged to develop NMT plans as a subcomponent of CMP and all investments must be done in line with the plan. The plan must incorporate hawkers and must also adhere to standards facilitating easy and comfortable mobility for the aged as well as disabled groups. The city officials must be encouraged to design adequate infrastructure to meet the current and future demand effectively. A sudden increase in infrastructure usage, should not lead to an early requirement for any increase in capacity or other retrofitting.

Currently, the transportation planning process follows an approach where space is allocated to fit the motorized modes first. Infrastructural provisions for NMT users are generally seen as unnecessary and a costly affair. NMT should be given the topmost priority in the road design hierarchy followed by public transport and then others. It is required that the space needs of the pedestrians and cyclists are first analyzed and provided for, while designing

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[22] Key mobility challenges in Indian cities, G. Tiwari (2011)

roads and planning. The current approach must shift from 'centerline outwards' to 'right-of-way inwards' so as to ensure allocation of adequate road space on our roads. This will also ensure provision of NMT infrastructure in a planned manner rather than as a consequential requirement.

o   ***Ensure availability of city- wide, quality infrastructure***

Availability of continuous footpaths, cycle tracks/lanes etc. is important to ensure usability of NMT infrastructure by the existing users and also to attract potential users. The existing infrastructure in our cities (cycle tracks, footpaths, etc.) wherever available is under planned and often illegally encroached by the poor including hawkers/vendors. Obstructions like telephone boxes, lighting poles, etc. are also very common in our cities. Also, there is no provision for maintenance leaving them unusable.

Therefore, it is important to maintain the existing infrastructure so as to allow its proper usage to the fullest potential. The footpaths and cycle tracks should be free from all obstructions and allow easy comfortable usage of the same.

o   ***Introduce and encourage cycle sharing schemes in cities***

Bicycle sharing is a service which allows shared use of bicycles by individuals on rental basis. Public bike sharing programmes helps address some of the primary disadvantages to bicycle ownership including loss from theft or vandalism, lack of parking or storage, and maintenance requirements23. The global experience clearly indicates that bicycle sharing or bicycle hire schemes have led to overall increase in levels of cycling by ensuring easy availability of bicycles along with a cycling conducive environment.

In India, the concept of bicycle sharing is still in a nascent stage. The National Urban Transport Policy (NUTP, 2006) launched by the Government of India stresses upon the need to promote non-motorized transport modes and also encourages the cities "to explore the possibility of a public bicycle program, where people can rent a bicycle for use in specially designated areas" (NUTP, 2006). Despite this, there is hardly any focus on bicycle inclusive city planning at the local levels. Several initiatives have been taken up in Delhi, Bangalore and Mumbai. However, the systems have not achieved much success and have led to closing of operations at many places.

Government should encourage and support cycle sharing schemes at city level so as to promote cycling as a travel mode especially for shorter trips. It is important to understand what led to the success of these schemes abroad and what can be done to promote them in the Indian context.

C.   Discourage use of private vehicles

The number of registered motor vehicles on road has increased at a much faster rate than the road infrastructure; as a result physical infrastructure in our cities face capacity saturation. Between 1951 and 2002 the vehicle population grew at a compound annual growth rate (CAGR) of close to 11 per cent compared to CAGR of 4.3 per cent in the total road length with National Highway segment increasing by a mere 2.1 per cent24. Given the current

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[23] Shaheen, Susan; Guzman, S., and H. Zhang. (2010). "Bikesharing in Europe, the Americas, and Asia: Past, Present, and Future". Transportation Research Record: Journal of the Transportation Research.

[24] Working Group On Road Transport For The Eleventh Five Year Plan, Planning Commission, Government of India

problems of traffic congestion, it is high time that India adopts measures to check the number of vehicles being added on to the roads per day in order to move towards sustainable transportation. Several measures have been adopted and practiced/implemented in various countries which are as discussed below:

o ***Control vehicle ownership***

One of the most common and popular strategies is to increase the cost of owning a vehicle by laying down several policies and pre requisites to be fulfilled for buying a car. This is managed either through the imposition of high upfront ownership costs/ licensing or restriction on the actual growth/registration of the car population25. Currently, buying a car is not a very difficult process in India. Infact availability of low cost, small cars like Tata Nano and increase in affordability of the population has considerably reduced the cost of car ownership over the last two decades.

Measures like high fuel prices, vehicle related taxes, vehicle quota scheme, registration tax, annual vehicle license fees and linking vehicle purchase with parking availability can help in discouraging vehicle ownership to a great extent.

o ***Control vehicle usage***

Controlling vehicle usage becomes important as vehicle ownership controls do not help once the vehicles are on road. This strategy deals with measures that control the usage of private vehicles on road by increasing the cost of usage of private modes and alter the travel behavior of motorists. Some of the measures under this approach include road pricing/ congestion pricing,

o ***Parking Management***

This approach deals with both demand side as well as supply management measures. Parking management is one of the most common strategies used in context to Travel demand management (TDM) plans and generally produces high prices for parking. Measures include priced parking linked to time, unbundled parking, limited supply of parking in commercial and institutional areas, parking taxation on buildings in commercial and institutional areas, flexitime, parking cash out, etc. Cost-based parking pricing typically reduces vehicle trips 10-30% compared with unpriced parking26. Manual pricing schemes, metered parking systems using ITS or electronic payment schemes can be adopted to implement priced parking in different areas. Also, providing limited parking in activity areas like CBD areas in a city accompanied by high pricing linked to time for which the vehicle is parked and efficient enforcement can prove to be very helpful in reducing the total traffic inflow into these areas. Another approach is to set the maximum number of parking spaces by the private developers rather than go by the minimum standards set by the government in order to promote PT and carpooling schemes.

It is high time that parking should be used as a tool to discourage car use and manage travel demand. However, the city officials must ensure availability of alternate transport modes before applying these measures. The revenue generated from parking measures can be used as investments in promoting sustainable transport modes like PT and NMT. Enforcement of parking laws or rules play a key role in the overall success of the strategies adopted and hence, proper attention should be paid to ensure efficient and strict enforcement.

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[25] Toolkit on Travel Demand Management, Ministry of urban development (2013)

[26] Toolkit on Transport Demand Management, Ministry of urban development (2013)

o   *Promote ride sharing programs*

A ridesharing program is a comprehensive package of a number of commute trip reduction strategies and thus can prove to be highly effective in reducing the number of vehicles on road. Schemes like prioritizing high occupancy vehicles on roads, promoting carpooling etc. can help in reducing social, economic and environmental implications and promote sustainable mobility in our cities.

a.   Prioritise HOV's

High occupancy vehicle (HOV) facilities are facilities/incentives that are given to vehicles/cars with high occupancy (2+, 3+ or 4+ occupants) while entering highways/expressways, to promote high occupancy of vehicles and discourage single occupancy of cars[27]. The most common measures adopted to promote HOV's include provision of dedicated or reserved lanes for HOV's (for 24 hours or during peak hours), reserved parking facilities, free parking or lower parking charges, etc.

b.   Promote car pooling

Carpooling is highly beneficial for that category of people who have to travel long distances daily for work or education. It helps in saving money by allowing sharing of travel costs including fuel costs, parking and tolls. It also helps in reducing congestion on the roads.

III.   IMPROVE the current ways of travel

As per IPCC, nearly 30 per cent of the global GHG emissions are contributed by the transport sector. The transport sector in India contributes about 10 per cent of the energy related GHG emissions in the country[28]. The growing travel demands and the increasing number of vehicles on road are further expected to exasperate the environmental conditions and public health.

Improving vehicle technologies, using cleaner fuels and improving the traffic movement pattern within our cities can significantly help in reducing the environmental impact of each kilometre travelled on road. This strategy, therefore, deals with improvements in our current ways of travel and making it more environmentally efficient. Several measures have been identified, which are as discussed below:

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[27] Toolkit on Transport Demand Management, Ministry of urban development (2013)

[28] GRIHA for Large Developments (GRIHA-LD), TERI (2013)

Table 4 IMPROVE - Strategies and measures

Strategies	Measures	Type of Measure
Improve vehicle efficiency	Set vehicle efficiency standards	Regulatory
	Encourage use of clean and efficient vehicle technologies	Planning, Regulatory
	Ensure regular maintenance	Regulatory
	Discourage older fleet	Regulatory
Improve fuel efficiency	Set and enforce stringent fuel standards	Regulatory
	Promote use of clean fuels	Planning, Regulatory
	Check fuel adulteration	Regulatory
Improve traffic movement in the cities	Develop efficient traffic management plans at the city level (using ITS)	Planning, Regulatory

A.   Improve vehicle efficiency

Leapfrogging from the current unsustainable modes of transport, significant efforts are required to develop and promote cleaner and more efficient vehicle technologies with lower levels of GHG emissions and air pollution. To do so,

o   *Set vehicle efficiency standards*

India is one of the major exporters of cars and hence it should not be difficult for Indian auto manufacturing industry to meet or adhere to more stringent standards if planned properly. ***The government should, therefore, set and enforce statutory vehicle efficiency standards to stimulate manufacturers to invest in and promote technological change and improve the fuel economy of vehicles[29].***

o   *Encourage use of clean and efficient vehicle technologies*

Government must promote the use of clean low carbon technologies to reduce the overall emissions from the transport sector. Successfully implemented clean technologies include hybrid cars, electric cars and two-wheelers, and flexi-fuel cars, cars, and three-wheelers using CNG and LPG[30]. However, it is crucial that adequate supporting infrastructure (charging infrastructure or filling stations, etc.) must be developed and continuous supply of fuels must be ensured by the government in the long run.

Successfully implemented clean technologies include hybrid cars, electric cars and two-wheelers, and flexi-fuel cars, cars, and three-wheelers using CNG and LPG. It should be possible for India to replace 50 per cent of motorized vehicles using fossil fuel by electric

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[29] Low carbon Green Growth Roadmap for Asia and the Pacific: Urban Transport

[30] Putting Urban Transport Sector on a Low Energy and Low Carbon Path - A Focus on the Passenger Transport Sector in Million-Plus Cities, Ghate and Sundar (2010)

vehicles drawing electricity from renewables by 2050.[31] Government must also promote the use of small, lightweight vehicles with ultra-low emission engines.

o   *Ensure regular maintenance*

The performance of vehicles deteriorates with increased use and age. One of the simplest measures to improve vehicle efficiency is to ensure regular service and maintenance of the vehicle. Maintenance practices that are low cost and easy to implement must be encouraged among the masses. These measures include oil and filter cleaning and replacement, spark plug replacement, spot checks for leaks in the fuel and other fluid delivery systems, and maintenance of correct tyre pressure[32]. To ensure adherence to these practices, it is important to ensure regular inspection and monitoring mechanisms in our cities.

Currently, traffic police carries out spot checks manually and punish the offenders by levying monetary fines or abducting the vehicle or license in case of repeated faults by an individual. Given the rising number of vehicles and modes in our cities, manual inspection does not serve the purpose and it is high time that India adopts/upgrades to modern technologies for inspection which also enables storing of data that can be further used in situation or policy analysis by transport planners and decision makers. The Pollution under Control (PUC) certificate systems now in place in Indian cities are woefully inadequate and serve little purpose[33].

A robust inspection and maintenance regime must be developed for vehicles which include modern and efficient technologies for Indian cities.

o   *Discourage older fleet*

Currently, India does not have a scrapping policy to remove the older fleet from the road. Several countries like Singapore, Germany, etc. have introduced scrapping schemes to ensure environmental impact reductions. It is high time that India adopts a certain cut off in terms of age of vehicle operating on road. The vehicle owners using over aged vehicles should be encouraged to exchange their vehicles for new vehicles. Fiscal incentives can help facilitate the process. There are several initiatives or efforts being taken in Indian cities to discourage old vehicles from operating on road. For example, the state of Andhra Pradesh has introduced a 'Green Tax' on an annual basis on the older fleet (transport vehicles that have completed above 7 years from the date of registration[34]) so as to discourage their further use. However, rest of the country does not have any guidelines/ rules to check older fleet on road.

A body or authority needs to be set up at the national level to set up the age limit of various transport modes and also develop a mechanism to ensure inspection and proper implementation of the rules at the city level.

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[31] Putting Urban Transport Sector on a Low Energy and Low Carbon Path - A Focus on the Passenger Transport Sector in Million-Plus Cities, Ghate and Sundar (2010)

[32] Putting Urban Transport Sector on a Low Energy and Low Carbon Path - A Focus on the Passenger Transport Sector in Million-Plus Cities, Ghate and Sundar (2010)

[33] Putting Urban Transport Sector on a Low Energy and Low Carbon Path - A Focus on the Passenger Transport Sector in Million-Plus Cities, Ghate and Sundar (2010)

[34] http://aptransport.org/html/tax_green_tax.htm#

## B.	Improve fuel efficiency

o	*Set and enforce stringent fuel standards*

India lacks any fuel economy standards unlike most large automobile producing countries. While Euro IV standards are introduced in 13 major cities (Delhi/National Capital Region (NCR), Mumbai, Kolkata, Chennai, Bangalore, Hyderabad, Ahmedabad, Pune, Surat, Kanpur, Agra, Sholapur, and Lucknow) from April 2010 and Bharat Stage III standards for the whole country are expected to be implemented by October 2010, no date has been fixed for the introduction of Euro IV norms for the rest of the country[35].

Given this, it is important that *India develops a clear and well–defined road map that facilitates smooth transition to higher technologies and higher emission norms in the long run*. It is also important to ensure availability of adequate technologies and mechanisms enabling acceptance and implementation of the norms in all cities.

o	*Promote use of clean fuels*

Use of alternative or clean fuels (like CNG, LPG, electricity, biodiesel, etc.) is gaining importance in view of the increasing concerns of rising petroleum prices, need to cut down our carbon footprints and reduce dependence on oil-abundant countries. Currently, CNG and electric vehicles are emerging as the new alternatives in India. However, there is little penetration of these modes in our cities and are still far from sharing the same popularity as compared to other traditional petroleum based vehicles especially in case of private modes.

Government must draw a road map that facilitates adoption of alternate fuels in the long run for both public as well as private modes. Here, it is important that adequate infrastructure (e.g. filling stations, adequate fuel supply, etc.) should be planned for and provided while planning for a shift to any of the clean fuels. Fiscal incentives (subsidies, tax rebates, etc.) from the upper levels of government can help in also be provided on clean modes as well as fuels.

o	*Check fuel adulteration*

Fuel adulteration is common in Indian cities especially in informal public transport modes like local customized versions of auto-rickshaws, mini vans, etc. It generally helps in reducing fuel costs but also leads to a significant increase in emissions of harmful pollutants.

It is, therefore, critical to develop a mechanism deploying modern technologies to check fuel adulteration in vehicles. Also, Traffic Police must be adequately equipped to carry out spot or random checks to inspect and monitor use of dirty fuels.

## C.	Improve traffic movement in the cities

Given the rapid increase in motor vehicles, congestion and idling is becoming a common feature in our cities which leads to increased fuel burning and high emission levels. It is realised that an efficient traffic management system, therefore, is critical to improve the overall traffic situation in our cities.

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[35] Putting Urban Transport Sector on a Low Energy and Low Carbon Path - A Focus on the Passenger Transport Sector in Million-Plus Cities, Ghate and Sundar (2010)

o   *Develop efficient traffic management plans at the city level*

To improve the current traffic situation in our cities, city officials must develop an efficient traffic management system, which ensures minimum delays, less congestion, and optimal journey speeds. The system must incorporate a wide range of advanced technologies (also referred to as intelligent transport systems (ITS)) available in the public, private and freight transport sectors to manage and monitor traffic movement in our cities. It is important to understand that lack of availability of technical expertise in this area can lead to poorly designed schemes.

4. Conclusion

The ASRI approach discussed above in this paper shall help in reducing the need to travel and as a result lead to lesser number of vehicles on road, increase in shares of PT and NMT and also improve the quality of vehicle fleet in cities.

It is important to note that not all measures will be applicable or suitable to all cities. Each city should adopt a combination of these measures based on their context, requirements and the applicability of these measures. However, to ensure success of all the above measures, it is important to support them by frequent monitoring, awareness generation and capacity building measures at city level.

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