The Energy and Resources Institute

TERI-NFA Working Paper No. (12)

Sustainable Urban Transport Indicators

Megha Kumar

March, 2014

Acknowledgements

This paper was written as part of a project **Analyzing Sustainable Urban Transport: A City Level Modeling Approach** under the Program of Activities, Framework Agreement between the Norwegian Ministry of Foreign Affairs (MFA) and The Energy and Resources Institute (TERI), briefly referred to as the Norwegian Framework Agreement (NFA). We are grateful to Mr Sri Prakash, Distinguished Fellow, CRSUD&TS, TERI, for critically reviewing the paper. We would also like thank Ms Akshima Ghate, Fellow and Area Convenor, CRSUD&TS, TERI for her constant guidance.

Corresponding Author, Ms Megha Kumar, is a Research Associate at TERI, New Delhi.

Email: megha.kumar@teri.res.in

Contacts
The Energy and Resources Institute
Darbari Seth Block
India Habitat Centre
Lodhi Road
New Delhi 110 003
Tel: + 91 - 11- 24682100 / 41504900

Abstract

The paper on sustainable urban transport (SUT) indicators attempts to present a comprehensive set of indicators in order to help cities for setting a trajectory of sustainable transportation. The transport system in an urban environment is made up of different sub-systems. Hence it is important to understand how these sub systems perform. The framework therefore discusses the SUT indicators separately for each of these sub systems. The sub-systems of urban transportation discussed in the paper are: urban transport characteristics, public transport, intermediate public transport, non-motorized transport, parking and landuse. For promoting sustainable urban transport in a holistic manner it is equally important to understand the social, economic and environmental sustainability of each of these sub-systems. The SUT framework developed in the paper, discusses indicators from these three angles for all the six sub-systems.

Table of contents

List of Tables

List of Figures

List of Boxes

1. Introduction

The current working paper recommends transport sustainability indicators for Indian cities which aim to assist planners and policy makers across the country to evaluate the performance of transport sector from the point of sustainability and thus help in formulation of socially, economically and environmentally sustainable transport policies and plans in the Indian cities.

Indicators are key measures which reveal the condition of the whole system. Therefore indicators are especially helpful to decision makers as looking at the indicators they can understand whether the system is performing well or unsatisfactorily. Since indictors are a reflection of health of the whole system, upgrading the performance of the system would imply simply working towards improving the value of each of the indicators, rather than working in the whole of a complex system.

The indicators recommended in the study aim to provide a framework to policymakers to help them evaluate the performance of the system through the value of few system parameters and assess which of the plan and policy measures are most suitable for a given city.

Before proceeding to indicators, it would be beneficial to understand the meaning and components of sustainable urban transport.

2. Understanding sustainable urban transport

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

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

- 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"1 defines sustainable 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 fulfill 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

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

- 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
  - ensuring smooth movement on roads
  - 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:
  - should not cause habitat loss (e.g. cutting of huge forest patches)
  - should not pollute local ecosystems (air and water)
  - Promotes social cohesion by conscious deigning/planning
  - Promotes community livability by appropriate neighbourhood design
  - Enhances and not alters the image of areas that have unique identity/cultural heritage

It is seen that the definitions of sustainable transport provided by different sources (refer Box 1 and discussions in section 2.1) have common elements and all the definitions lay emphasis on access to all, socio-economic and environmental sustainability. The table 1 discusses the elements of sustainable transport, as provided by various sources in the international literature.

Table 1 Elements of sustainable transport

Sources	**WBCSD (2001)**	**MOST (1999)**	**OECD (1998)**	**ECMT (2004)**	**TERI (2011)**
Elements of SUT	Sustainable mobility	Sustainable transport	Environmentally sustainable transportation	Sustainable transport system	Sustainable transport system
Accessibility to all	meets need of society to move freely, gain access,	-	meets needs for access	Basic access	access to all
Transport system	-	-	-	operates fairly and efficiently, offers a	modal choice

Sources	WBCSD (2001)	MOST (1999)	OECD (1998)	ECMT (2004)	TERI (2011)
				choice of transport modes,	
Socio-economic aspect	communicate, trade, and establish relationships	social and economic considerations are factored into decisions affecting transportation activity	-	development needs, equity within and between successive generations, affordable, supports a competitive economy	equity, reduced dependence on fossil fuel
Environment and health aspect	without sacrificing other essential human or ecological values today or in the future	environment;	health and environmental quality (should not negatively impact - air pollution, noise pollution, ecosystem integrity, global climate change and stratospeheric ozone depletion)	safety, human health, ecosystem, limits emissions and waste, judicious use of renewable and non-renewable resources	human health (diseases and accidents) and environment (air, noise, water, land pollution, waste generation, ozone depeletion, ecosystem integrity),
Other	-	-	-	promotes balanced regional development **	-

**Not relevant for sustainable urban transport

3. Approach to derive SUT indicators

To derive transport performance indicators for Indian cities first of all, indicators provided by different organizations were studies and compiled. Based on relevance of each of the indicator with respect to Indian conditions, these indicators were filtered. The new set of indicators are the ones which are well suited to Indian conditions and adequately represent the transport performance of any urban area with respect to sustainability criteria.

Step I. Compilation of sustainable transport indicators provided by different sources

Step II. Selection of recommended indicators

Selection of recommended indicators involves filtering down of indicators from the list of compiled indicators based on the following criteria:

- **Relevance of indicators to Indian conditions:** It was noticed that some of the indicators may not be significant or at times may even be misguiding due to unique traffic conditions, travel patterns and user behavior for Indian conditions.
- **Data availability:** Availability of authentic and up to date data is one of the biggest challenges in India. As far as possible, only those indicators have been shortlisted which could be assessed on the basis of data which is easily available. However, there are still certain indicators which would use data which may not be easily available. In the subsequent discussions, such indicators have been appropriately highlighted.
- **Quantifiable:** As far as possible quantitative indicators have been included in the framework but at certain points qualitative indicators had to be retained as they represented important aspect of transport performance. The qualitative indicators have also been highlighted.

The most common way to analyse the performance of transport activities is through developing a three-dimensional framework based on social, economic and environment impacts of the transport activity. The recommended indicators have also been developed in the form of a similar framework consisting of social, economic, environmental impacts. One category of transport related measures have also been added to this framework, as some of the indicators are purely transport-oriented and provide primary information about transport situation in a city.

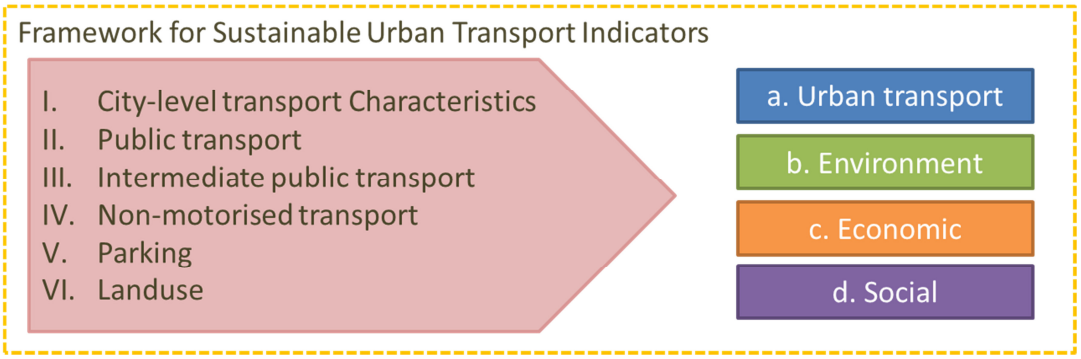

Figure 1 Framework for SUT Indicators

Further, the indicators have been discussed under six different categories, as described in figure 1. Urban transport is a result of interaction between different elements like transport systems, landuse, parking, etc. The whole picture of urban transport in a given area could be understood only when we understand the different elements which constitute it. Therefore, under each of the impact heads, the indicators have been sub-categorized.

It should be noted that the impact of some of the indicators may not be limited to one particular dimension. It is possible that certain indicators would have a more wide-spread impact and its effects may spans across sectors. For instance, fare of public transportation is not only a social indicator, as it determines whether or not the public transport system is affordable, but it also has an implication on the economic side, as it effects the amount of revenue generated by the public transport authority and hence the financial sustainability of the service providing agency. On the other hand, pricing of public transportation would also

impact the amount of usage of public transportation and therefore it will also have an implication on the environmental quality of the city. Hence, for the purpose of ease, indicators have been grouped considering their predominant impact.

Besides the public transport, intermediate public transport, non-motorised transport, parking and landuse indicators, general city level indicators are also discussed under the head - 'city-level transport characteristics'. Such indicators represent basic attributes of a city's transport system, whose impact cannot be confined under environment, economic or social impact. Such indicators have impact across all these sectors.

Step I. Compilation of SUT Indicators from various sources

To derive sustainable transport indicators for Indian cities, first of all, sustainable urban transport indicators developed by various organizations have been compiled. Seven sources have been referred to for this step. These sources are mentioned below:

i. WBCSD's Sustainable Mobility Project - Bangalore 2010
ii. UNEP (City level indicators - promoting low carbon transport in Indian cities)
iii. Service level benchmarks for urban transport, MoUD, Government of India
iv. Sustainable cities report (TERI)
v. Study on traffic and transportation policies and strategies in urban areas in India, MoUD, WSA
vi. City Mobility Plan (CMP) review study- TERI
vii. Association of State Road Transport Undertakings (ASRTU)

Step II. Selection of recommended indicators

This section discusses all the recommended indicators in detail. The focus has been laid on:

- Understanding the indicator and its relevance
- Identifying the data requirement to assess the value of indicator,
- Identifying likely data sources, and
- Indicating the desired direction in which the indicator should grow over time in order to attain higher level of sustainability.

Comprehensive list of all the recommended indicators has been provided in Annex-I.

4. Recommended Indicators

4.1 Urban transport Characteristics

The indicators grouped under urban transport characteristics are those indicators which reflect the key transport characteristics of the city, like, the per capita trip rate, average trip length, average daily travel time, etc.

Table 2 List of urban transport indicators

a. Transport related	b. Environment	c. Economic	d. Social
PCTR	Total GHG emissions (per capita)	Investment in PT and NMT infrastructure vs. investment in projects on road building and improvement, flyovers, etc.	Safety: No. of road and rail fatalities
PCTR (motorized)	SO2 levels	Green jobs created	Safety: No. of persons injured in road and rail accidents
ATL	Levels of Oxides of nitrogen		Security: % of road network having adequate street lighting
ATL (PT)	SPM levels		
Daily ATL (NMT)	RSPM levels		
Average travel time	Health hazard: % of population exposed to air pollution		
Average travel time (PT)	Health hazard:% of population exposed to noise pollution		
	Noise levels: db level		
Use of ITS	Area under circulation		
	Fuel consumption by transport sector		
	% of total vehicle fleet in the city on clean fuels		

**Note: The indicators highlighted in blue are qualitative indicators

a) Transport related indicators

This section discusses each of the transport-related indicators, along with its data requirement and data source.

1. Per Capita Trip Rate (PCTR) is a measure of mobility. It can be defined as the total number of trips undertaken by all the modes in an area divided by the total population

of the anrea/city. Higher PCTR value implies that large numbers of trips are being undertaken in an area/city, hence signifying higher levels of mobility.

To asses PCTR for a city, one would require information on total number of trips being carried out in a city and total population of the city. The information on total number trips can be obtained from the household survey.

2. PCTR (motorized) is the total number of trips undertaken in an area/city by motorized means of transport divided by the total population of the area/city. It denotes levels of mobility through motorized means of transport.
3. Average Trip Length (ATL) of a city depicts the length people have to travel on an average. It can be defined as total trip length commuted in a day divided by total number of trips carried out in the city.
4. ATL (Public transport) is the average trip length of public transport users. It is trip length commuted by public transport user in a day divided by total number of trips undertaken by public transport.

   All the indicators discussed above, can be derived from information collected through a household survey.
5. Use of Intelligent Transport System (ITS) is a qualitative indicator. ITS is the use of information and communication technology in making the transport system more efficient. Some of the ITS applications employed around the globe are intelligent traffic management system, automatic vehicle identification system, automatic vehicle classification system, intelligent fleet management system, automatic passenger information system etc. Under this head one needs to understand the extent of usage of ITS application in provision of transport services and management of urban traffic in the city.

The information on the extent of use of ITS in the functioning of city's transport system can be obtained from the Transport Department, the Traffic Police or the Urban Development Authority.

Table 3 List of Transport related Indicators (urban transport indicators)

S.no.	Transport related Indicators	Description	Data required	Source
1	PCTR	Total no of trips undertaken by all the modes/total population	Total no of trip undertaken by all the modes	HH survey
2	PCTR (motorized)	Total no of trips undertaken by motorized modes/total population	Total no of trip undertaken by motorized modes	HH survey
3	ATL	Total trip length commuted in a day in the city/No. of trips undertaken	Trip length of all the trips by all the modes	HH survey
4	ATL (PT trips)	Total trip length(Undertaken by	Trip length of all the trips by	HH survey

S.no.	Transport related Indicators	Description	Data required	Source
		PT)/No. of trips undertaken by PT	different modes (PT)	
5	Use of ITS	Is ITS being employed for various transport applications, like efficient traffic management, real time monitoring of public transport systems, parking management etc.	For which all transportation applications is ITS being used	Transport Department, Traffic Police, Urban Development Authority

**Note: The indicators highlighted in blue are qualitative indicators

b) Environment related indicators

The environmental indicators provide a list of parameters whose measure can help in determining the level of improvement in the environmental quality of the context area. These include:

- Total GHG emissions (per capita)
- SO2 levels
- Levels of Oxides of nitrogen
- SPM levels
- RSPM levels
- Noise levels: db level

The data on air quality can be obtained from the State Pollution Control Board.

- Exposure to health hazard (air pollution): % of population exposed to air pollution
- Exposure to health hazard (noise pollution):% of population exposed to noise pollution

Change in the levels of exposure to health hazard to the population is also a crucial indicator to understand the impact of environment on human health. Health hazard can be assessed as the percentage of population exposed to air and noise pollution. Understanding these indicators would require undertaking environmental quality survey.

- Area under circulation

In a city optimal area should be under transport use or circulation. Higher percentage of landuse under circulation is undesirable due to a variety reasons. For instance, large land under circulation implies higher percentage of impermeable surface in the city, higher risk of non-point pollution to water bodies etc.

The information on area under circulation can be retrieved from any of the city level planning document, like Master Plan or City Development Plan.

- Fuel consumption by transport sector

Fuel consumed by transport sector is a reflection of fuel efficiency of the transport system. The amount of fuel consumed by transport sector would have direct consequence on the amount of GHG emissions. The data related to fuel consumption can be obtained from the State Transport Authority.

- % of total vehicle fleet in the city on clean fuels

Larger the percentage of vehicle fleet running on clean fuel, lesser would be transport related emissions from public transportation. The data on vehicle fleet running on clean fuel can be collected from the State Public Transport Authority. Information about public transport fleet running on clean fuel can be obtained from City Public Transport Authority/ies.

Table 4 List of Environment indicators (urban transport indicators)

Environment indicators	**Source**
Total GHG emissions (per capita)	State Pollution Control Board
SO2 levels	State Pollution Control Board
Levels of Oxides of nitrogen	State Pollution Control Board
SPM levels	State Pollution Control Board
RSPM levels	State Pollution Control Board
Health hazard: % of population exposed to air pollution	Computed
Health hazard:% of population exposed to noise pollution	Computed
Noise levels: db level	State Pollution control board
Area under circulation	Urban Development Authority ((Master Plan/City Development Plan)
Fuel consumption by transport sector	State Transport authority
% of total vehicle fleet in the city on clean fuels	State Public Transport Authority, State Public Bus Transport Authority

**Note: The indicators highlighted in blue are qualitative indicators

a) Economic indicators

The economic policy and the way economic resources are utilized in a city can be instrumental in determining levels of sustainability in transport sector. The economic indicators are qualitative in nature.

- Investment in PT and NMT infrastructure vs. investment in projects on road building and improvement, flyovers, etc.

Higher investment in sustainable transport infrastructure like, improvement of public bus service, development of infrastructure for movement of non-motorized traffic, e.g., footpaths, dedicated cycle lanes etc, are critical to promote sustainable transportation in a city. Higher

investments into road building and widening projects indicate a supply-oriented approach of city authorities to solve the traffic and transport related issues of their city.

Information on the amount of investments on different types of transport projects can be obtained from the Department of Transport, State Urban Development Authority, State PWD, and the Municipal Corporation.

- Green jobs created

There is no well accepted definition of green job. The term "green jobs" is used to describe people engaged in green, sustainable or environmental friendly jobs. As per the ILO and UNEP (2008)2 green jobs are defined "as work in agricultural, manufacturing, research and development (R&D), administrative, and service activities that contribute substantially to preserving or restoring environmental quality. Specifically, but not exclusively, this includes jobs that help to protect ecosystems and biodiversity, reduce energy, materials, and water consumption through high efficiency strategies, de-carbonize the economy, and minimize or altogether avoid generation of all forms of waste and pollution" But according to the ILO, green jobs have to be decent jobs as well.

For transport sector green such jobs could be those employment opportunities which are generated through environmentally sustainable transportation projects such as building of public transport systems, NMT infrastructure etc. Larger proportion of green jobs in transport sector implies higher focus on sustainable transport in the city.

Data on green jobs generated in the transport sector in the city can be obtained from the Department of Transport, the State Urban Development Authority, the State PWD or the Municipal Corporation.

Table 5 List of Economic indicators (urban transport indicators)

Economic indicators	**Data required & source**
Investment in PT and NMT infrastructure vs. investment in projects on road building and improvement, flyovers, etc.	Department of Transport, State Urban Development Authority, State PWD, Municipal Corporation
Green jobs created	Department of Transport, State Urban Development Authority, State PWD, Municipal Corporation

**Note: The indicators highlighted in blue are qualitative indicators

b) Social indicators

Traffic and transportation activity has deep impact on the society. Hence it becomes important to lay down social indicators, which reflect the social impact of traffic and transportation activity.

Transport-related accidents causing injuries and fatalities to the transport users are the most crucial negative externalities of traffic and transportation activity. To assess social impact of transport activity, the below mentioned indicators have been suggested:

- Safety: Number of road and rail fatalities
- Safety: No of persons injured in road and rail accidents

[2] http://www.unep.org/PDF/UNEPGreenjobs_report08.pdf

The data on traffic and transport related accidents can be obtained from the Traffic Police.

Apart from safety, security is also of huge importance to a transport user. Levels of security in public spaces and public transportation can be a determining factor of public transport ridership and modal share in favour of non-motorized transportation. Percentage of road network with adequate street lighting has been selected as the indicator of safety.

- Security: % of road network having adequate street lighting

This data is generally available with the Municipality or else it can be obtained by conducting a road inventory survey.

Table 6 List of social indicators (urban transport indicators)

Social indicators	Source
Safety: No of road and rail fatalities	Traffic Police
Safety: No of persons injured in road and rail accidents	Traffic Police
Security: % of road network having adequate street lighting	Road inventory survey, Municipal Corporation

4.2 Public transport

The indicators grouped under public transport are those indicators which reflect the key characteristics of the city's public transport system, like, the mode share in favour of public transport, public transport fleet size, length of public transport network, etc.

Table 7 List of public transport indicators

a. Transport related	b. Environment	c.Economic	d.Social
Mode share of PT (of total daily trips)	Fuel efficiency of PT fleet	EPK/CPK	% of low-income settlements within 500 mts of any PT stop
Number of buses/1000 population	% share of PT fleet on clean fuels	Staff per bus ratio ratio	Reliability: Avg. waiting time for PT services near low income areas
BRTS network per million population	Avg. fleet age (years)	Passengers carried/km by seats/km	Affordable PT: % of HH income for low income households spent on PT
Metro rail network per million population	% of PT fleet complying with emission standards	Fleet utilization	% of PT fleet and stops with Passenger information systems
Availability of sub-urban rail services			Security: % of PT fleet with GPS installation and CCTVs
Accessibility to bus stops: % of population within 500m of bus			Per km fare

a. Transport related	b. Environment	c.Economic	d.Social
stops			
Metro network availability: % of population within 500m of metro station			Universal accessibility of PT vehicles and PT stops
BRTS availability: % of population within 500m of BRTS station			Security: Security personnel deployed in PT
Overcrowding: Avg. no. of passengers per seat in peak hours (for all PT services)			
Reliability: Avg. waiting time for PT services- in outer areas and city core			
% of bus fleet - low floor			
% of bus fleet - AC			
Quality of bus stops (seating, shade, lighting and passenger information systems): % of bus stops meeting quality criteria			
Total no. of PT related accidents/ Total effective kilometer			
No. of breakdowns of PT fleet/ Total effective kilometer			

**Note: The indicators highlighted in blue are qualitative indicators

a) Transport related indicators

This section discusses each of the transport-related indicators of (formal) public transport, along with its data requirement and data source.

1. Mode share of Public Transport (of total daily trips) is the percentage of total trips undertaken by public transportation. Higher modal share in favour private motorized modes is undesirable. Higher mode share in favour of public transportation and non-motorized transportation reflects that the city is on the path of sustainability.

The data on modal share of public transportation can be obtained by conducting a household survey.

2. Number of buses/1000 population shows the adequacy of public bus system. Higher number of buses/1000 population indicates higher public transportation supply in the city and thus higher levels of sustainability.

The information on public bus fleet can be obtained from the City Public Bus Transport Authority.

3. BRTS network (km) per million population indicates the availability of BRTS network in the city. Higher length of BRTS network reflects larger extent of high quality public transportation in the city.

The information about the length of BRTS network in city can be gathered from the City's BRTS Authority.

4. Metro rail network (km) per million population reflects the extent of availability of metro network in the city. Higher metro rail network per million in a city as it reflects higher mode share in favour of public transportation.

The information about the length of metro network in city can be obtained from the City's Metro Rail Authority.

5. Availability of sub-urban rail services

Information about sub-urban rail network serving the city can be obtained from the Indian Railways.

Accessibility to bus stops: % of population within 500m of bus stops: percentage of population residing within 500m i.e. the catchment zone of public transport system can be a key determinant of number of people using the bus system in a city. It will show the levels of accessibility of public transport system in the city.

6. Information on bus network in the city can be collected from the City Public Bus Transport Authority.
7. Metro network availability: % of population within 500m of metro station: similar is the case with metro network. The information on metro network can be obtained from the city's Metro Rail Corporation.
8. BRTS availability: % of population within 500m of BRTS station: This indicator would show the levels of accessibility of the population to a high quality bus system in the city. Information about BRTS network can be obtained from the city's BRTS Authority.
9. Overcrowding: Avg. no. of passengers per seat in peak hours (for all PT services): This indicator would reveal the quality of public transportation in the city.

The information on the levels of overcrowding can be calculated as average number of passenger/seat during the peak hours can be collected from the transport agencies or by conducting an on-board passenger survey in the public transport modes.

10. Reliability: Avg. waiting time for PT services- in outer areas and city core: Reliability of public transport system can be assessed by finding out average waiting of passengers for public transport system. High waiting time is undesirable for public transportation and can affect the levels of ridership of the public transportation.

Average waiting time of passengers can be obtained by conducting a transport user survey at transit stations (bus stops/stops of other public transport modes, like BRTS, metro, etc).

11. % of bus fleet - low floor: low floor of buses make public transportation easily accessible to larger section of society, especially the elderly, children and physically

challenged people. A larger low floor bus fleet suggests higher levels of accessibility to public transportation. Data on low floor fleet can be collected from the city's Public Bus Transport Authority.

12. % of bus fleet – AC: Comfort in the public bus transportation can be assessed by measuring the % of AC bus fleet present in the city. Information about % AC fleet of public buses can be obtained from the city's public Bus Transport Authority.
13. Quality of bus stops (seating, shade, lighting and passenger information systems): % of bus stops meeting the set quality criteria.

This information will have to be collected through conducting observation based surveys of the bus stops.

14. Total no. of PT related accidents/ Total effective kilometer: Large number of accidents involving public transport shows issues of lack of enforcement and lack of driver training.

This information can be gathered from the Traffic Police.

15. No. of breakdowns of PT fleet/ Total effective kilometer: Higher number of breakdown incidences of public fleet show poor performance of public transport system. This information can be gathered from the City's Public Bus Transport Authority or by conducting operator's/driver's survey.

Table 8 List of Transport related indicators (public transport indicators)

Transport related	Description	Data required	Source
Mode share of PT (of total daily trips)	Percentage of trips undertaken by PT	Total number of trips, Total number of trips undertaken by PT	HH survey
Number of buses/1000 population		Total bus fleet (no of buses), Total population of the city	City Public Bus transport Authority; Total population of the city - Census of India 2011
BRTS network per million population	Length of BRTS network (km)/ Population of the city (in millions)	Length of BRTS network (km), Total population of the city (in million)	BRTS Authority
Metro rail network per million population	Length of metro rail network (km)/ Population of the city (in millions)	Length of metro rail network (km), Total population of the city (in million)	City Metro Rail Authority
Availability of sub-urban rail services	Length of Sub-urban rail network (km)/ Population of the city (in millions)	Length of Sub-urban rail network (km), Total population of the city (in million)	Indian Railways
Accessibility to bus	Estimate of	Location of bus	City Public Bus

Transport related	Description	Data required	Source
stops: % of population within 500m of bus stops	population residing within 500m of a bus stop	stops in the city, population density map of city	transport Authority (Map with location of bus stops), Urban Development Authority (Master Plan of city - density map)
Metro network availability: % of population within 500m of metro station	Estimate of population residing within 500m of a bus stop	Location of bus stops in the city, population density map of city	Metro Rail Authority (Map with location of metro stops), Urban Development Authority (Master Plan of city - density map)
BRTS availability: % of population within 500m of BRTS station	Estimate of population residing within 500m of a BRTS stop	Location of BRTS stops in the city, population density map of city	BRTS Authority (Map with location of BRTS stops), Urban Development Authority (Master Plan of city - density map)
Overcrowding: Avg. no. of passengers per seat in peak hours (for all PT services)		No. of PT services (with their respective capacities) plying during peak hour, Peak hour ridership	On-board Survey on Bus/City Public Bus transport Authority
Reliability: Avg. waiting time for PT services- in outer areas and city core		Waiting time of passengers in city center and city peripheries	On-board Survey on Bus/City Public Bus transport Authority
% of bus fleet - low floor		Number of low floor buses, Total fleet of buses	City Public Bus transport Authority
% of bus fleet - AC		Number of AC floor buses, Total fleet of buses	City Public Bus transport Authority
Quality of bus stops (seating, shade, lighting and passenger information systems): % of bus stops meeting quality criteria			On-board Survey on Bus
No. of PT related accidents			Traffic Police
No. of breakdowns of			Bus Driver survey/City Public Bus transport

Transport related	Description	Data required	Source
PT fleet			Authority

**Note: The indicators highlighted in blue are qualitative indicators

b) Environment related indicators

An efficient public transport system is beneficial in more than one way. A fuel efficient fleet will directly reduce emissions from the tail pipe; a good quality, reliable and safe public transport service would attract more riders and thus reduce dependency on private motorized vehicles, thereby reducing air pollution; hence, contributing towards better environment quality.

1. Fuel efficiency of PT fleet: Fuel efficiency of public transport fleet can be defined as distance the vehicle travels per unit volume of fuel consumed. It is generally expressed in km/l. higher fuel efficiency is a desirable characteristic of public transport fleet.
2. % share of PT fleet on clean fuels: Public transportation with zero tail-pipe emissions can significantly reduce the levels of local pollution in a city. Public Bus Transport Authority.
3. Avg. fleet age (years): Over the years, the efficiency of vehicles reduces. Thus older fleet generally implies lower efficiency, especially considering the typical Indian practices and conditions, like inconsistent maintenance of public transport fleet and poor road conditions.
4. % of PT fleet complying with emission standards: Emission standards are formulated by the government in order to regulate the amount of pollutants emitted from the tailpipe of the vehicles.

Most of the above discussed information on public transport fleet can be either obtained from the city's Public Bus Transport Authority or by conducting operator/driver's survey of public transport provider.

Table 9 List of Environment related indicators (public transport indicators)

Environment related	Description	Data required
Fuel efficiency of PT fleet	Distance the vehicle travels per unit volume of fuel consumed	City's Public Bus Transport Authority
% share of PT fleet on clean fuels	(No. of public transport vehicles emitting zero tail pipe emissions/total number of public transport vehicles)*100	City's Public Bus Transport Authority
Avg. fleet age (years)		City's Public Bus Transport Authority
% of PT fleet complying with emission standards		City's Public Bus Transport Authority

**Note: The indicators highlighted in blue are qualitative indicators

c) Economic indicators

Economic indicators discussed under this section showcase the economic performance of the city's public transportation.

1. EPK/CPK: The ratio of earning per km/ cost per km depicts whether or not the public transport is in operating profitably. When the ratio is more than one it suggests that the public transport operations are running in profits, whereas, EPK/CPK ratio less than one shows loss in the operations of public transportation.
2. Staff per bus ratio: it is the ratio of number of people employed (for operation of public transport fleet, like the operating crew, the mechanical staff and the administrative staff) to the total number of scheduled bus fleet operated. Lower staff per bus ratio is desirable, as it represents higher productivity of the staff employed.
3. Passengers carried/km by seats/km: This ratio is also called the load factor. When estimated for the peak hours, it is referred to as Crush Load. If the value of the ratio is more than one it depicts higher demand (than supply) for public transportation. If the value is lower than one, it shows that the available public transportation is underutilized.
4. Fleet utilization: it can be defined as the percentage of vehicles on road to total fleet of public transportation. It is one of key indicators reflecting efficiency of public transport fleet. A low fleet utilization indicated that a large number of public transport vehicles are not operating, suggesting poor quality of fleet, and issues related to maintenance and upkeep of fleet, old age of the fleet, etc. A high fleet utilization is desirable.

Information on the performance of public transportation can be obtained from the city's Public Bus Transport Authority.

d) Social indicators

Social indicators help in measuring the social impact of public transportation. The social indicators focus on affordability of public transport services, availability in terms of network availability and quality of service, in terms of average waiting time for commuters, near low income settlements (within 550m from low income settlements), issues of security, and universal accessibility etc.

1. % of low-income settlements within 500 m of any public transport stop: This indicator would help in assessing the levels of accessibility of public transportation to low income settlements by examining the location of public transport stops in the city.

The location of public transport stops can be obtained from the city's Public Transportation Authority, and location of low income settlements can be gathered from the Municipality.

2. Reliability: Avg. waiting time for PT services near low income areas: high waiting time reflect poor quality of public transport service. Hence, average waiting time for public transport in low income area would reveal the quality of public transport service in such areas.

Information on waiting times in public transport stops can be collected by conducting passenger survey on the bus stops near the low income settlements.

3. Affordable PT: % of Household income for low income households spent on PT: This indicator would show what percentage of total household income is spent on public transportation. This would indicate the level of affordability of public transportation for the low income households.

Expenditure on public transportation by low income households can be obtained through passenger survey on the bus stops, near the low income settlements.

4. % of PT fleet and stops with Passenger information systems (PIS): PIS is an electronic information system which provides real-time passenger information to the users. An effective PIS can help the users to take informed decisions about the trips he/she is going to carry out and thus enhance the attractiveness of public transport system. Higher % of fleet with PIS is desirable.

This information can be obtained from the public transport fleet operators of the city.

5. Security: % of PT fleet with GPS installation and CCTVs: A secure public transportation can lead to higher ridership. Installation of CCTVs and GPS on the public transport fleet and also in public transport stops can be effective in enhancing security in public transportation system. Higher percentage of fleet with GPS and CCTVs is desirable.

Information on % of fleet with GPS and CCTV installation can be gathered from public transport fleet operators of the city.

6. Per km fare: An affordable fare is critical to ridership levels in public transportation. Affordable fares are desirable from user point of view but from financial sustainability angle of the public transport operator, it is important that the fares reflect the operating cost of public transportation (to the operator).

Per km fare of public transportation can be obtained from the public transport fleet operators of the city.

7. Universal accessibility of public transport vehicles and public transport stops: For an equitable society, it is important that all the sections of the society have access to public transportation. Thus universal accessibility of public transport vehicles and public transport stops is an important criterion.

Information on whether or not the public transport fleet and public transport infrastructure is universally accessible and to what extent, can be determined either by carrying on-board survey on public transport modes and on the public transport stops or collecting information from the public transport fleet operators of the city.

8. Security: Security personnel deployed in public transport vehicles: levels of security can affect level of ridership on public transportation.

This information can be either obtained by carrying on-board survey on public transport modes or by collecting this information from the public transport fleet operators of the city.

Table 10 List of social related indicators (public transport indicators)

Social	**Data required**	**Source**
% of low-income settlements within 500 mts of any PT stop	Location of bus stops in the city, location of low income settlements	City Public Bus transport Authority (Map with loaction of bus stops), Urban Development Authority (Master Plan of city - low-income)
Reliability: Avg. waiting time for PT services near low income areas	Waiting time of passengers in bust stops near low income area	On-board Survey on Bus/City Public Bus transport Authority

Social	Data required	Source
Affordable PT: % of household income for low income households spent on PT		HH Survey
% of PT fleet and stops with Passenger information systems		State Public Bus Transport Authority
Security: % of PT fleet with GPS installation and CCTVs		City's Public Bus Transport Authority
Per km fare		City's Public Bus Transport Authority
Universal accessibility of PT vehicles and PT stops		On-board Survey on Bus/City Public Bus transport Authority
Security: Security personnels deployed in PT		City's Public Bus Transport Authority

**Note: The indicators highlighted in blue are qualitative indicators

4.3 Intermediate public transport

In most of the Indian cities intermediate public transportation plays an important in meeting the urban travel demand. In large cities intermediate public transport is crucial for last mile connectivity. In case of small and medium size cities, intermediate public transport modes many a times, assumes an even important role. Intermediate public transport in such cities, serve as a main mode of travel, as they typically lack any kind of formal public transport system.

The indicators grouped under intermediate public transport are those indicators which reflect the key characteristics of the city's intermediate public transport system, like, the mode share in favour of intermediate public transport, intermediate public transport fleet, etc.

It should be noted that all the indicators should take into account the formal as well as the informal supply of IPT in the city. There is no universally accepted definition of formal and informal transport systems. For the purpose of this paper, the formal supply of IPT is being considered to be the one which would comprise of those modes which are provided and regulated by the government. On the other hand, informal supply would consist of IPT systems which are run by private operators and they work and operate outside the government regulations.

Table 11 List of IPT indicators

a. Transport related	b. Environment	c. Economic	d. Social
No of IPT mode/1000 population	Fuel efficiency of IPT fleet	Employment generation	Security: % of IPT fleet with GPS installation
IPT mode share	Avg. fleet age (years)		Availability of IPT modes near low

a. Transport related	b. Environment	c. Economic	d. Social
			income settlements
No. of IPT related accidents	% share of IPT fleet on clean fuels		Per km fare
Quality: Overcrowding, passenger comfort	% of IPT fleet complying with emission standards		
Quality: compliance of vehicle design with safety standards			

**Note: The indicators highlighted in blue are qualitative indicators

a) Transport related indicators

Transport related indicators measure important transport characteristics of the intermediate public transportation (IPT).

1. Number of IPT modes/1000 population: This indicator would reflect the availability of IPT modes in the city.

The information on number of IPT modes plying in a city can be obtained by interviewing IPT operators.

2. IPT mode share: IPT mode share can be defined as the percentage of total trips undertaken by IPT modes in a city. Higher mode share in favour of intermediate public transport reflects the higher dependence of people on these modes to fulfill their travel demand.

The data on modal share of intermediate public transportation can be obtained by conducting a household survey.

3. Number of IPT related accidents: Accident rate of IPT modes would show how safe the IPT transport is. Higher accident rate is a highly undesirable attribute.

This information can be gathered from the Traffic Police.

4. Overcrowding: it is a qualitative indicator. It will reflects the level of passenger comfort in IPT mode.

To assess the levels of overcrowding one would need to conduct an on-board survey on the IPT modes.

5. % of IPT fleet compliant with safety standards: It has been observed that at times the vehicle design of IPT transport modes do not comply with safety standards. This makes the IPT modes highly unsafe. Higher % of IPT fleet complaint with the safety standards is desirable.

This information can be obtained by interviewing the operators of IPT services.

Table 12 List of transport related (IPT indicators)

Transport related	Description	Data required	Source
No of IPT modes/1000 population		No. of IPT modes, Total population of the city	IPT operators (To assess total number of IPT modes in the city), Total population of the city - Census of India 2011
IPT mode share	Percentage of trips undertaken by IPT	Total number of trips, Total number of trips undertaken by IPT	HH survey
No. of IPT related accidents			Traffic Police
Overcrowding (qualitative indicator)	On board IPT survey	Overcrowding (qualitative indicator)	On board IPT survey
Compliance of vehicle design with safety standards	Operator's Survey	Compliance of vehicle design with safety standards	Operator's Survey

**Note: The indicators highlighted in blue are qualitative indicators

b) Environment related indicators

Environment related indicators would reflect the impact of IPT on environment. The environment related indicators analyze a variety of factors like, fuel efficiency of IPT modes, use of clean fuels by IPT, compliance to emission standards by IPT modes etc.

1. Fuel efficiency of IPT fleet: Fuel efficiency of IPT modes can be defined as distance the vehicle travels per unit volume of fuel consumed. It is generally expressed in km/l. Higher fuel efficiency is a desirable characteristic of IPT modes.
2. Avg. fleet age (years): With the aging of vehicles, its efficiency reduces. Thus older fleet generally implies lower efficiency.
3. % share of IPT fleet on clean fuels: Use of clean fuel implies that operations of IPT are emission free. Thus higher percentage share of IPT fleet running on clean fuels is desirable.
4. % of IPT fleet complying with emission standards: Higher percentage of IPT fleet complying with emission standards is desirable for a city.

All the above discussed indicators can be derived through conducting IPT driver/IPT operator survey.

Table 13 List of environment related (IPT indicators)

Environment	Data required & source
Fuel efficiency of IPT fleet	Driver/Operator's survey
Avg. fleet age (years)	Driver/Operator's survey
% share of IPT fleet on clean fuels	Driver/Operator's survey
% of IPT fleet complying with emission standards	Driver/Operator's survey

c) Economic indicators

Transport activity has significant economic impact on the society, employment generation being one of the significant impacts.

This information can be obtained by conducting IPT operator's survey.

Table 14 List of economic related (IPT indicators)

Economic	Source
Employment generation	Operator's survey

**Note: The indicators highlighted in blue are qualitative indicators

d) Social indicators

1. Security of IPT is a social indicator. It can be measured in terms of percentage of IPT fleet with GPS installed. Higher percentage of IPT fleet with GPS installed shows higher levels of security of IPT fleet.
2. Availability of IPT modes near low income settlements: Availability of IPT modes near low income settlements can be measured by analyzing the availability of IPT routes and frequency of such services near the low income settlements.
3. Per km fare: per km fare of IPT would reflect the level of affordability of such transport services.

Information about per km fare of IPT services can be obtained by conducting operator's or driver's survey.

Table 15 List of social related (IPT indicators)

Social	Source
Security: % of IPT fleet with GPS installation	On-board Survey on Bus/City Public Bus transport Authority
Availability of IPT modes near low income settlements	Availability of routes, frequency of IPT modes near low income settlements
Per km fare	Operator's/Driver's survey

**Note: The indicators highlighted in blue are qualitative indicators

4.4 Non-motorized transport

(Comprising walking, cycling and cycle rickshaws)

Non-motorized transport (NMT) modes like walking and cycling are environmentally friendly and a cheap mode of transportation. They most suited to carry out short trips and as access and dispersal trips in case of longer line haul trips. Due to poor pedestrian and cycling infrastructure in Indian cities, non-motorized transportation has become a mode for captive riders only.

Table 16 List of NMT indicators

a. **Transport related**	b. **Environment**	c. **Economic**	d. **Social**
% of roads having footpaths	-	Employment generation - CR sector	% share of NMT users in road injuries
% of main roads (arterials to collectors) having cycle tracks	-	-	% share of NMT users in road fatalities
NMT (walking, cycling and CRs) mode share in total daily trips	-	-	Per km fare of cycle rickshaws
Encroachment of NMT lanes by Vehicle parking (%)	-	-	
Quality of footpath and cycle tracks paving	-	-	-
Footpaths - universal accessibility	-	-	-
Cycle tracks - continuity of tracks	-	-	-
Treatment at interface with motorized traffic - Separate signal phase for pedestrians and cyclists? Pedestrian crossings, etc.?	-	-	-
Qualitative: Bicycle and Cycle rickshaw (CR) parking facilities at interchanges/PT stops	-	-	-
No. of pedestrian zone sin the city	-	-	-
Qualitative: Supporting facilities and infrastructure for cyclists/pedestrians	-	-	-

**Note: The indicators highlighted in blue are qualitative indicators

a) Transport related indicators

Some of the key characteristics which determine the quality of infrastructure of non-motorized transport have been grouped under this section.

1. % of roads having footpaths: Ideally, all the roads should have footpaths. Higher percentage of roads with footpath is desirable.
2. % of main roads (arterials to collectors) having cycle tracks: the road space should be equally shared by the motorized transport users and NMT users. Higher percentage of main roads with cycle tracks is desirable.
3. NMT (walking, cycling and cycle rickshaws) mode share in total daily trips: it can be defined as the percentage of total trips undertaken by NMT modes. Higher mode share in favour of NMT is highly desirable.
4. Encroachment of NMT lanes (%): Encroachment of NMT lanes will affect the effective width of the NMT lane. Higher percentage of encroached NMT lanes reflects poor condition of NMT infrastructure in the city and is highly undesirable.
5. Quality of footpath and cycle tracks paving: % length of footpath and cycle tracks meeting the set quality criteria for quality of paving.
6. % of footpath length universally accessible: The walking infrastructure should be accessible by all the segments of society. Hence, the footpaths should be universally accessible.
7. Cycle tracks - % length of cycle tracks with continuous cycle tracks i.e. % length of cycle tracks without missing portions and major disruptions like broken paving, obstruction due to street infrastructure, etc.
8. Treatment at interface with motorized traffic - Treatment at interface with motorized traffic, in the form of separate signal phase for pedestrians and cyclists, grade separated intersection crossing facilities, etc. can considerably improve the safety of pedestrians and cyclists.
9. Qualitative: Bicycle and Cycle rickshaw (CR) parking facilities at interchanges/PT stops: Facility of parking for non-motorized transport mode would help in ensuring equity in the use of road space for different categories of road users.
10. Number of pedestrian zones in the city: Pedestrian zones are areas where there is restriction on movement of motorized transport. Large number of pedestrian zones in a city is desirable.
11. Qualitative: Supporting facilities and infrastructure for cyclists/pedestrians: Supporting facilities for

Information on above discussed indicators can be obtained by conducting road inventory survey.

Table 17 List of transport related (NMT indicators)

Transport related	Description	Data required	Source
% of roads having footpaths		Total length of road network, Length of road network with footpaths	Road inventory survey
% of main roads (arterials to		Total length of main roads, Total	Road inventory

collectors) having cycle tracks		length of main roads with cycle tracks	survey
NMT (walking, cycling and CRs) mode share in total daily trips	Percentage of trips undertaken by NMT	Total number of trips, Total number of trips undertaken by NMT	Road inventory survey
Encroachment of NMT lanes by Vehicle parking (%)			Road inventory survey
Quality of footpath and cycle tracks paving			Road inventory survey
% of footpath length universally accessible			Road inventory survey
Cycle tracks - continuity of tracks			Road inventory survey
Treatment at interface with motorized traffic - Separate signal phase for pedestrians and cyclists, pedestrian crossings, etc			Road inventory survey
Bicycle and Cycle rickshaw (CR) parking facilities at interchanges/PT stops			Road inventory survey
No. of pedestrian zones in the city			Urban Development Authority, Road inventory survey
Supporting facilities and infrastructure for cyclists/pedestrians			Road inventory survey

**Note: The indicators highlighted in blue are qualitative indicators

b) Environment indicators

NMT has least negative impact on environment and therefore there are no environmental indicators for NMT modes.

c) Economic indicators

Cycle Rickshaw sector provides employment opportunities to a large number of people. This information can be obtained by conducting survey of cycle rickshaw transport operator.

Table 18 List of economic indicators (NMT indicators)

Economic	Source
Employment generation	Cycle rickshaw operator's survey

**Note: The indicators highlighted in blue are qualitative indicators

d) Social indicators

Vulnerability of NMT users is an important social indicator which gives insight on the quality of NMT infrastructure present in a city.

1. % share of NMT users in road injuries: this indicator would reflect the vulnerability of NMT users. Higher % share of NMT users in road injuries shows higher vulnerability of this segment of road users; and is highly undesirable.
2. % share of NMT users in road fatalities: Higher % share of NMT users in road fatalities is a highly undesirable trait for a city.

Information on injuries and fatalities in accidents involving NMT road user can be obtained from the traffic Police.

3. Per km fare of cycle rickshaws: Per km fare of cycle rickshaws would reflect the level of affordability of this mode.

Information about per km fare of cycle rickshaw services can be obtained by conducting cycle rickshaw operator's/driver's survey

Table 19 List of social indicators (NMT indicators)

Social	**Source**
% share of NMT users in road injuries	Traffic Police
% share of NMT users in road fatalities	Traffic Police
Per km fare of cycle rickshaws	Operator's/Driver's survey

4.5 Parking

Managing parking has become a key to sustainable transportation. Parking supply and parking pricing have become important tools in the hands of urban manager to limit the use of private motorized vehicles.

Table 20 List of parking indicators

e. **Transport related**	f. **Environment**	g. **Economic**	h. **Social**
% of main roads having on-street parking	-	Revenue generation from parking fees and its utilization	-
Parking availability at metro stations, interchanges			
Park and ride services around business districts			
Special parking provisions for vehicles using clean fuels			
Pricing mechanism for parking - does it disincentivize use of personal modes?			

**Note: The indicators highlighted in blue are qualitative indicators

a) Transport related indicators

1. % of main roads having on-street parking: on-street parking can reduce the effective width of the carriageway and become a hindrance in the free-flow of traffic. On the other hand on-street parking is also said to have traffic calming effect on the traffic and hence enhancing the level s of safety.

This information can be obtained by conducting road inventory survey.

2. Parking availability at metro stations, interchanges: parking availability at metro stations increases the influence zone of metro riders and also encourages people to use metro.

This information can be obtained from the city's Metro Rail Authority.

3. Park and ride services around business districts/ or P&R services in the city or number of commercial centers in the city with P&R services available: Such services encourage people to use public transportation and reduce dependence on personal motorized transport modes.

This information can be gathered from the Urban Development Authority, the Municipal Corporation, or the Parking survey.

4. Special parking provisions for vehicles using clean fuels: Such incentives can encourage people to use vehicles which run on clean fuel.
5. Pricing mechanism for parking – parking pricing can be one of the most effective means to discourage the use of personal motorize modes. Higher parking charges can discourage users from using their cars/two-wheelers frequently. Hence it is important that the parking prices should be reflective of the existing land prices and should disincentivize the use of personal transport modes.

Information on pricing mechanism of parking can be obtained either from the Urban Development Authority, Municipal Corporation or by conducting a parking survey.

Table 21 List of transport related indicators (parking indicators)

Transport related	Source
% of main roads having on-street parking	Road inventory survey
Parking availability at metro stations, interchanges	Metro Rail Authority
Park and ride services around business districts	Urban Development Authority, Municipal Corporation, Parking survey
Special parking provisions for vehicles using clean fuels	Urban Development Authority, Municipal Corporation, Parking survey
Pricing mechanism for parking - does it disincentivize use of personal modes?	Urban Development Authority, Municipal Corporation, Parking survey

**Note: The indicators highlighted in blue are qualitative indicators

b) Environment related indicators

Not applicable

c) Economic indicators

Parking is one of the important sources of revenue for the urban local bodies. It is important that the revenue generated from parking is utilized in funding sustainable transport projects in the city.

The information on how the revenue generated from parking is utilized, can be acquired from the Urban Development Authority or the Municipal Corporation

Table 22 List of Economic indicators (parking indicators)

Economic	Source
Revenue generation from parking fees and its utilization	Urban Development Authority, Municipal Corporation

d) Social indicators

Not applicable

4.6 Landuse

The pattern of landuse development in a city can have a significant impact on the way people travel. A dense and compact city with mixed landuse would usually have shorter trip lengths than a low density city.

Table 23 List of landuse indicators

i. Transport related	j. Environment	k. Economic	l. Social
Population density -gross (persons/developed area)	-	Land monetization to meet the costs for investments in sustainable transport	-
% of Mixed landuse	-		-
Mixed landuse, densities and FAR on major transit corridors/near transit stations	-		-

**Note: The indicators highlighted in blue are qualitative indicators

a) Transport related indicators

1. Population density -gross (persons/developed area): Population density can be calculated as number of people persons living per unit developed area in a city.
2. % of Mixed landuse: higher percentage of mixed landuse in a city reduces need for people to travel longer distances to fulfill their daily needs like education, shopping, etc. higher percentage of mixed landuse in a city is highly desirable.

3. Mixed landuse, densities and FAR on major transit corridors/near transit stations: This information would help in assessing the levels of development along the transit corridors. Higher density along transit corridors is desirable as it promotes the use of public transportation in the city.

Information on above discussed indicators can be obtained from the Urban Development Authority of the city.

Table 24: List of Transport related indicators (landuse indicators)

Transport related	**Source**
Population density -gross (persons/developed area)	Urban Development Authority (Master Plan)
% of Mixed landuse	Urban Development Authority (Master Plan)
Mixed landuse, densities and FAR on major transit corridors/near transit stations	Land use survey, Urban Development Authority (Master Plan)

**Note: The indicators highlighted in blue are qualitative indicators

b) Environment related indicators

Not applicable

c) Economic indicators

Land monetization is the process of capturing the land value. Generally, investments in new transport system catalyze development in the surrounding areas and lead to escalation in land prices. Capturing increase in land value acts as one of the important revenue streams for newly developed transport infrastructure. Higher contribution of land monetization towards recovery of transport infrastructure investments is desirable.

This information can be obtained from the State Urban development Authority or from the State Public Transport Authority.

Table 25: List of economic indicators (landuse indicators)

Economic	**Source**
Land monetization to meet the costs for investments in sustainable transport	State Urban development Authority, State Public Transport Authority

**Note: The indicators highlighted in blue are qualitative indicators

d) Social indicators

Not applicable

5. Conclusion

While studying the levels of sustainability of transport system of a city, it is important to look at sustainability from all the three angles – social, economic and environment. A sustainable transport system would cater to the mobility needs of all the section of the societies. It will

provide modal choices which would suit the needs of different types of users. It would be economically sustainable not just in terms of affordability for the user but also financially viable for the transport provider. Also, such a system would have least impact on the environment. While looking at the transport system of the city all the different elements of transport system should be taken into consideration, whether it is the public transportation, IPT, NMT, personal transport or landuse or parking.

The list of indicators discussed in the paper attempts to address the transport system in a comprehensive manner, focussing specifically on different elements of transport system. Mostly the indicators discussed are quantitative in nature. However the paper also includes some qualitative indicators, which are difficult to measure, as they reflected important aspect of the sustainability of the transport system. The desirable direction of how these indicators should grow in future has also been indicated, intending to aid cities in setting a path of sustainable mobility for themselves.

Annex-I: List of recommended indicators

Table 26 All indicators related to Urban transport

Transport related	Environment	Economic	Social
Daily PCTR (Motorized)	Total GHG emissions (per capita)	Investment in sustainable transport infrastructure vs. investment in projects focusing on roads, flyovers, etc.	Safety: No of road and rail fatalities
Daily PCTR (Non-motorized)	SO2 levels	Green jobs created	Safety: No of persons injured in road and rail accidents
Daily ATL (PT/IPT trips)	Levels of Oxides of nitrogen		Security: % of road network having adequate street lighting
Daily ATL (trips using personal motorized modes)	SPM levels		
Daily ATL (NMT)	RSPM levels		
Avg, daily travel time (public transport/IPT trips)	Health hazard: % of population exposed to air pollution		
Avg, daily travel time (trips using personal motorized modes)	Health hazard:% of population exposed to noise pollution		
Avg, daily travel time (NMT trips)	Noise levels: db level		
Use of ITS	Area under circulation		
	Fuel consumption by transport sector		
	% of total vehicle fleet in the city on clean fuels		

**Note: The indicators highlighted in blue are qualitative indicators

Table 27 All indicators related to Public transport

Transport related	Environment	Economic	Social
Mode share of PT (of total daily trips)	Fuel efficiency of PT fleet	EPK/CPK	% of low-income settlements within 500 mts of any PT stop
Number of buses/1000 population	% share of PT fleet on clean fuels	Staff per bus ratio	Reliability: Avg. waiting time for PT services near low income areas
BRTS network per million population	Avg. fleet age (years)	Passengers carried/km by seats/km	Affordable PT: % of hh income for low income households spent on PT
Metro rail network per million population	% of PT fleet complying with emission standards	Fleet utilization	% of PT fleet and stops with Passenger information systems
Availability of sub-urban rail services			Security: % of PT fleet with GPS installation and CCTVs
Accessibility to bus stops: % of population within 500m of bus stops			Per km fare
Metro network availability: % of population within 500m of metro station			Universal accessibility of PT vehicles and PT stops
BRTS availability: % of population within 500m of BRTS station			Security: Security personnel deployed in PT
Overcrowding: Avg. no. of passengers per seat in peak hours (for all PT services)			
Reliability: Avg. waiting time for PT services- in outer areas and city core			
% of bus fleet - low floor			
% of bus fleet - AC			
Quality of bus stops			

Transport related	Environment	Economic	Social
(seating, shade, lighting and passenger information systems): % of bus stops meeting quality criteria			
No. of PT related accidents			
No. of breakdowns of PT fleet			

**Note: The indicators highlighted in blue are qualitative indicators

Table 28 All indicators related to Intermediate public transport

Transport related	Environment	Economic	Social
No of IPT mode/1000 population	Fuel efficiency of IPT fleet	Employment generation	Security: % of IPT fleet with GPS installation
IPT mode share	Avg. fleet age (years)		Availability of IPT modes near low income settlements
No. of IPT related accidents	% share of IPT fleet on clean fuels		Per km fare
Quality: Overcrowding, passenger comfort	% of IPT fleet complying with emission standards		
Quality: compliance of vehicle design with safety standards			

**Note: The indicators highlighted in blue are qualitative indicators

Table 29 All indicators related to Non-motorized transport

Transport related	Environment	Economic	Social
% of roads having footpaths	-	Employment generation - CR sector	% share of NMT users in road injuries
% of main roads (arterials to collectors) having cycle tracks	-	-	% share of NMT users in road fatalities

Transport related	Environment	Economic	Social
NMT (walking, cycling and CRs) mode share in total daily trips	-	-	Per km fare of cycle rickshaws
Encroachment of NMT lanes by Vehicle parking (%)	-	-	
Quality of footpath and cycle tracks paving	-	-	-
Footpaths - universal accessibility	-	-	-
Cycle tracks - continuity of tracks	-	-	-
Treatment at interface with motorized traffic - Separate signal phase for pedestrians and cyclists, pedestrian crossings, etc.	-	-	-
Bicycle and cycle rickshaw (CR) parking facilities at interchanges/PT stops	-	-	-
No. of pedestrian zone sin the city	-	-	-
Supporting facilities and infrastructure for cyclists/pedestrians	-	-	-

**Note: The indicators highlighted in blue are qualitative indicators

Table 30 All indicators related to Parking

Transport related	Environment	Economic	Social
% of main roads having on-street parking		Revenue generation from parking fees and its utilization	
Parking availability at metro stations, interchanges			
Park and ride services around business districts			
Special parking provisions for vehicles using clean fuels			
Pricing mechanism for parking - does it disincentivise use of personal modes?			

**Note: The indicators highlighted in blue are qualitative indicators

Table 31 All indicators related to Landuse

Transport related	Environment	Economic	Social
Population density -gross (persons/developed area)		Land monetization to meet the costs for investments in sustainable transport	
% of Mixed landuse			
Mixed landuse, densities and FAR on major transit corridors/near transit stations			

**Note: The indicators highlighted in blue are qualitative indicators

Bibliography

1. GIZ, *Measuring public transport performance – lessons from developing cities*, 2011
2. International Energy Agency, *A Tale of renewed cities - A policy guide on how to transform cities by improving energy efficiency in urban transport systems*, 2013
3. Ministry of Urban Development, Government of India, "*Study on traffic and transportation policies and strategies in urban areas in India*", 2008
4. Ministry of Urban Development (2006), Government of India, National Urban Transport Policy (NUTP)
5. Ministry of Urban Development, Government of India, Asian Development Bank, *Comprehensive Mobility Plans (CMPs): Preparation Toolkit,* 2008
6. Ministry of Urban Development, Government of India, *Service Level Benchmarks for Urban Transport at a Glance*", available at http://urbanindia.nic.in/programme/ut/Service_level.pdf
7. TERI and World Business Council for Sustainable Development, *Mobility for development, Bangalore, India*, 2010
8. TERI, Arghyam, Sustainable Urbanism International, *An exploration of sustainability in the provision of basic urban services in Indian cities*, 2009
9. TERI, *Review of Comprehensive Mobility Plans,* 2011
10. UNEP*, Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World"* Available at http://www.unep.org/PDF/UNEPGreenjobs_report08.pdf
11. UNEP, *Promoting low carbon transport in Indian cities*, available at http://www.unep.org/transport/lowcarbon/
12. Working Group on Road Transport for the Eleventh Five Year Plan, Planning Commission, Government of India
13. TransAfrica, *Report on statistical indicators of public transport performance in Africa*, 2010
14. UNEP*, Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World"* Available at http://www.unep.org/PDF/UNEPGreenjobs_report08.pdf
15. UNEP, *Promoting low carbon transport in Indian cities*, available at http://www.unep.org/transport/lowcarbon/
16. UNEP, *Share the road: Investment in walking and cycling road infrastructure, 2010*
17. United Nations Environment Programme, 2011 *Green economy - Transport investing in resource and energy efficiency*