




SERVICE LEVEL BENCHMARK IN URBAN TRANSPORT FOR INDIAN CITIES

VOLUME- I – BENCHMARKING MANUAL

1. Introduction to Benchmarking
2. Development of Key Performance Indicators
3. Approach, Methodology and Data Establishment

Project Cities : Ahmedabad , Surat, Hubli-Dharwad, Mysore . Bhubeswar, kohima

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Foreword

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List of Abbreviations

MoUD	Ministry of Urban Development
IPT	Intermediate Public Transport
CBD	Central Business District
CDP	City Development Plan
CEPT	Center for Environmental Planning and Technology
FSI	Floor Space Index
GIS	Geographic information system
GPS	Global positioning System
ITMS	Information Technology Management System
ITS	Intelligent Transportation System
PIS	Passenger information system
SPV	Special Purpose Vehicle
STU	State Transport Undertaking
SPM	Suspended Particulate Matter
RSPM	Respirable Suspended Particulate Matter
SOX	Sulphur Oxides

NOX	Nitrogen Oxide
UBS	Urban Bus Specification
CNG	Compressed Natural Gas
UBS	Urban Bus Specification
IUT	Institute of Urban Transport
SLB	Service Level Benchmarking
LOS	Level Of Service
NO2	Nitrogen Dioxide
SO2	Sulfur Dioxide
VOC	Volatile Organic Compound
NMT	Non-Motorized Transport
PT	Public Transport
LED	Light Emitting Diode
JnNURM	Jawaharlal Nehru National Urban Renewal Mission
ECS	Equivalent Car Space
CPCB	Central Pollution Control Board
RTO	Regional Transport Office

CCTV	Closed Circuit Television
SMC	Surat Municipal Corporation
SUDA	Surat Urban Development Authority
DCR	Development Control Regulation
BRTS	Bus Rapid Transport System
IRC	Indian Roads Congress
DP	Development Plan

1 Introduction

Measuring performance of different transport facilities is necessary to identify gaps and problems in service levels. Performance levels can be evaluated using various indicators that can help in establishing baselines, identifying trends, predicting problems, assessing options and setting performance targets. Benchmarking - comparing performance levels against set targets or best practice cases - has now been recognized as integral to ensuring accountability in service delivery with the Ministry of Urban Development (MoUD), Government of India announcing "Service Level Benchmarking" for Urban Transport.

The service level benchmarks essentially focus on performance (as outlined in the Service level benchmarks developed by MoUD) and these can be augmented by considering aspects as outlined primarily by National Mission for Sustainable Habitat (Urban planning and Transportation) and proposals 12th Five year plan.

Benchmarks could also be in relation to national/international best practices, but as outlined above, the tools and processes vary with country/ cities and one of the outcomes of this exercise would be to set national benchmarks linked to appropriate standards. In case of Urban Transport Benchmarking, the target group involves a wide range of organizations such as the municipalities, regional authorities, public transport operators, and other urban transport stakeholders.

The objective of this research is to develop operational guidelines for undertaking benchmarking using MoUD's Service Level Benchmarks. This study is conducted to help in standardization of procedures for benchmarking to arrive at performance level indicators including methodology of delineating urban area as well as outlining methodology for data collection, storage, and analysis to enable continuous updating.

The outcome of the study will be helpful in developing a toolkit standard procedures/ processes for carrying out benchmarking for transport in urban areas which cities would then be able to replicate the process of implementing the SLB. The benchmarks and indicators will also be validated through actual data collection and research on ground. This is to establish weightage, significance, ease and consistency of measurability of each indicator. MoUD has appointed IUT and CEPT University to undertake this research in twelve cities in India. Of these Delhi, Vijaywada, Nanded, Patna, Jaipur and Jammu which will be taken up by IUT and CEPT University will be undertaking the study for Ahmedabad, Surat, Hubli-Dharwad, Mysore, Bhubaneswar and Kohima.

1.1 Objectives

The objectives of this research are to:

- To develop operational guidelines for undertaking benchmarking using the MoUD's SLBs,
- To outline a systematic approach for data collection, analysis and storage for regular data update of the data collected
- Suggest additional measures that can be adopted in line with National Mission for Sustainable Habitat (Transportation and Urban Planning) and 12thFive year plan

1.2 Study Approach

The research will follow a four step approach as detailed below:

1. Delineation of the study area

   - The study area would not just be limited to the municipal boundary but be defined such that it includes the urban agglomeration area. It would include the urban area along with contiguous growth/sprawl area outside the municipal limits.

2. Development of baseline study for performance monitoring of urban transport indicators with respect to developed SLB standards.

   - Review MOUD service level benchmarks and indicators
   - Identify data requirements and sources for data collection (primary and secondary)
   - Develop an understanding of the existing transportation system for each case study city from secondary data sources – network, traffic volume, etc.
   - Data collection

   Primary Survey

   - Identify survey locations, sampling, data collection methods

   Secondary data

   - Data analysis, interpretation, aggregation at city level for ascertaining
   - the LOS for the benchmarks

3. Preparation of a toolkit of standard procedures/processes for carrying out Benchmarking of transport in urban areas. On the basis of benchmarking undertaken for the case study cities, a standardized set of operational guidelines would be developed which can be used for undertaking benchmarking in other cities.

4. Establishment of a routine monitoring plan for SLBs

1.3 Study Output

One of the main outputs of the study is to standardize the procedure of benchmarking the urban transport facilities in Indian Cities. For this, it includes defining the methodology for data collection and data analysis. In addition to the given Indicators, more Indicators are added and proposed for the study.

1.4 Benefits of Benchmarking

The benefits of benchmarking can be perceived in two folds;

1. Direct Benefits of the study are-

    - It will provide a platform to discuss and debate transport issues at local level
    - It will lead to creation for city level database on transport which will help set targets for plan formulation

2. Indirect Benefits perceived form these studies are-

    - Help in promoting National Urban Transport Policy
    - It will also help in creating a competitive environment within and between cities.

2 Literature Review

This chapter deals with literature review and understanding the importance of benchmarking for cities

2.1 Why cities must do benchmarking?

Benchmarking is the process of measuring the performances of various elements of urban transport against a set standard or target. It provides policymakers with tools to continuously seek enhanced performance for their urban transport (Henning, et al., 2011).It is also an intrinsic part of the transport policy process (Bärlund, 2000). "In a nutshell, benchmarking is a multi-layer strategy to achieve greater effectiveness and higher quality services and encourage change" (Wobbe, 2000). Others define it as a tool to provide important reference for decision makers, planners and operators to monitor and evaluate the sustainability of urban transport at local, regional and national levels (Hongyang, Yulin, Hu, & Suoxiang).

2.2 How and what to benchmark?

The process of benchmarking has been conceived and carried out differently by various cities, authorities and agencies. Nevertheless each had their own issues and problems during the process which one also needs to understand such as to be able to overcome the common issues that is to come during the study. Benchmarking is no straight method where one is expected to gather data, analyze, rank and produce some quantitative results. Therefore it is important to understand the learning from various resources before carrying out the study for Indian cities.

The pilot study conducted by The World Bank proposes a framework for urban transport focusing on the performance of public transport in five categories—uptake of public transport, travel efficiency, accessibility, affordability, and quality of travel experience (Henning, et al., 2011). One of the important points emphasized in the study is that despite the performance measures indication for a city, one has to contextualize because each city would differ in its socio-economic, demography and physical aspects. With this, contextual indicators have also been included in the study such as area, population, income level, public transport length etc. The study also recommends 5-stage process for benchmarking i.e. initiating, planning, information gathering, analysis, and implementation for impact.

A research paper for benchmarking in China proposes 10 benchmarks that focus around economy, urbanization, motorization, public transport, rail transit, modal split, travel behavior, affordability, energy consumption, and traffic safety. However in this study the benchmarks for China have been compared to other international cities.

In a paper for Thessaloniki, the process of benchmarking is categorized into four stages - self-analysis, partnering, learning and implementation. Self-analysis deals with the performance measures and selection of the performance topics. Partnering is to find similar agencies to compare with. Learning Stages include the best practices and comparative analysis. And the last stage of the process is the action plans to fill in the performance gaps. Some of the performance indicators proposed are focus around the areas of spatial availability, temporal availability, capacity, reliability, Availability, fare structure and policy, travel time and

Customer satisfaction. However when partnering, i.e. Thessaloniki being compared to European cities due to lack of database, only population, population density and GDP per inhabitant were comparable.

2.3 Performance Indicators used for benchmarking

From all the literature gathered and studied, the list of performance indicators used is not the same. Comparatively the service level benchmarking in urban transport for Indian Cities encompasses a lot more aspect of urban transport i.e. including land use integration measures. The table below provides a summary of all the indicators from the literature review.

Sr.no	Benchmark	The World Bank	China Urban Sustainable Transport Research Centre	European Commission Directorate General For Energy & Transport	The role of benchmarking in public transport Case of Thessaloniki, Greece
1	Service Coverage	Modal share (percentage of trips made by private cars, public transport, bike, and walking)	-	Length of segregated, dedicated cycle paths in the administrative area	Percentage of households within walking distance of bus stops
2		Annual public transport passenger-kilometer travelled	-	Length of network by mode (bus/train/metro/tram)	Passengers per hour
3		Annual public transport patronage (number of passengers)	-	Length of road network	On-time departures / arrivals
4			-	Length of bus lanes and segregated right of way for trams	Percentage of trips not served
5	Efficiency	Average and variance of public transport speed of home-based work trips	-	Average speed of cars/motorcycles in peak hour	
6		Average and variance of public transport travel time of home-based work trips	-	Average speed of buses/trains/metro vehicles/trams in peak hour	Average speed of vehicles on bus lanes

Sr.no	Benchmark	The World Bank	China Urban Sustainable Transport Research Centre	European Commission Directorate General For Energy & Transport	The role of benchmarking in public transport Case of Thessaloniki, Greece
7		Public transport departure and arrival time reliability, and vehicle fuel consumption.	-	Typical service intervals of buses/trains/metro vehicles/trams in peak hour	
8		-	-	Total number of daily one-way journeys by mode in the administrative area	
9		-	-	Average vehicle occupancy by mode (car/bus/train/metro/tram) in peak hour	
10	Accessibility	Distance and/or walking time from public transport stops to outer rim of patron dwellings (i.e., catchment areas).	-	Number of cars registered in the administrative area	PT vehicles per hour
		-	-	Number of vehicles (by mode) operating in the administrative area	-
		-	-	% of public transport vehicles with low floors, by mode	-
11	Affordability	Average cost of home-based work trips.	Monthly expenditures on travel for both urban and rural areas	Average cost to user of car use	Price structure
12		-	-	Average cost to user of public transport by mode	-

Sr.no	Benchmark	The World Bank	China Urban Sustainable Transport Research Centre	European Commission Directorate General For Energy & Transport	The role of benchmarking in public transport Case of Thessaloniki, Greece
13		-	-	Capital expenditure on public transport, by mode, averaged over the last 5 years	-
16	Financial sustainability	-	-	Capital expenditure on roads, averaged over the last 5 years	-
17		-	-	GDP per head of population	-
18		-	-	% of resident population currently employed	-
19	Safety	Annual road accident fatalities	-	Number of injuries and deaths on the road network, per annum	Passengers ratings of quality attributes
20		Annual number of crimes occurred on public transport vehicles and at stations	-		-
21		Percentage of people feeling safe when using public transport	-		-
22	Environment		Gasoline consumption per capita	Cleanliness of vehicles in the fleet How many vehicles in your city's bus fleet can be described as: • Euro 0 rating – Pre 1993 • Euro 1 rating – 1993-95 • Euro 2 rating – 1996-99 • Euro 3 rating – 2000-2004 • Euro 4 rating – 2005 onwards • Vehicles from before EU	-

Sr.no	Benchmark	The World Bank	China Urban Sustainable Transport Research Centre	European Commission Directorate General For Energy & Transport	The role of benchmarking in public transport Case of Thessaloniki, Greece
				membership	
23		-	-	Sustainable fuel technologies for vehicles in the fleet How many vehicles in your city's bus fleet can be described as; · Powered with liquid petroleum gas (LPG) · Powered with compressed natural gas (CNG) · Powered with Bio fuel · Powered with ethanol · Powered with electric · Powered with another sustainable fuel	-
24		-	-	Additional pollution reduction technologies for vehicles in the fleet How many vehicles in your city's bus fleet have; · Particulate traps · Oxidization catalysts · Pollution reduction technology	-
25		-	-	Average fuel consumption of vehicles in the fleet	-

Sr.no	Benchmark	The World Bank	China Urban Sustainable Transport Research Centre	European Commission Directorate General For Energy & Transport	The role of benchmarking in public transport Case of Thessaloniki, Greece
26		-	-	Age of the vehicles in the fleet	-
27		-	-	Air quality by pollutant (NO2, SO2, NOx, VOC, particulates) per annum	-

2.4 Lessons from literature

It is evident from the literature study that there were issues during the process of benchmarking which needs to be highlighted. Following are some of the issues defined in several of the studies:-

1. Definition problem: defining the boundary for carrying out the study. When more than one jurisdiction is included in the study, data collection becomes more difficult.
2. Data unavailability
3. Benchmarking urban transport initiatives may also face lack of support, lack of capacity etc.

Apart from the issues, there are also few important points that can be noted from the literature:-

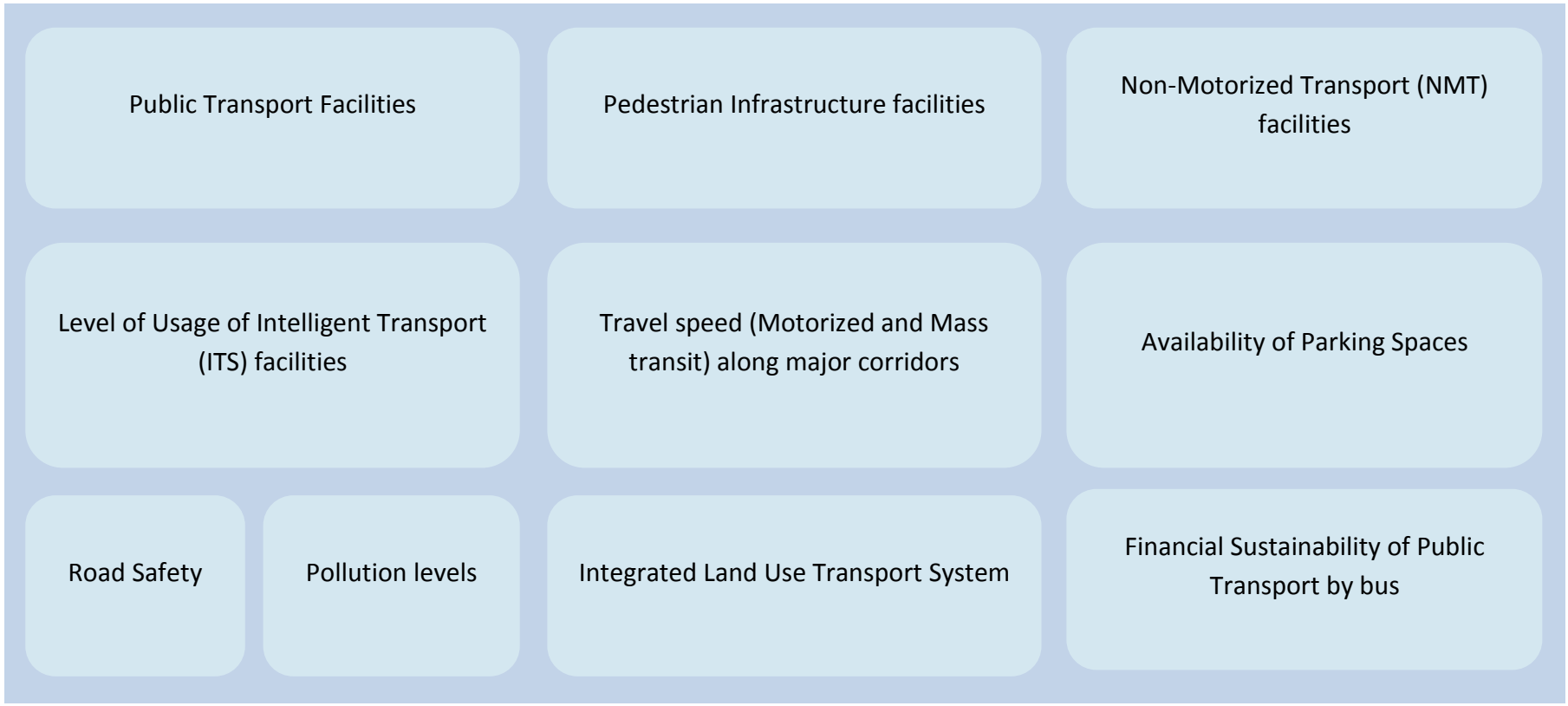
While it would not be correct to determine one's position from the results of the benchmarks with peer group cities. However it is considered that one of the success factors is to cooperate with the peer groups who have already exercised this process. This would help especially the newcomers.

One thing that still remains unclear is the methodology adopted for most of the indicators in these literatures. There is also no clarity regarding setting of targets for each of these performance indicators. In other words, there are no 'levels' defined instead cities are ranked against each other thereby lacking a clarity over if one city is performing good compared to the rest then what should be the target for the other cities. For example: what percentage of service coverage area would one say is good enough for a city? if a city has a 20% of coverage area then is it supposed to be good or how far it is from achieving 100%? Nevertheless there are many factors that determine the network coverage however keeping all of these factors it is more easily read and comprehendible when a city is tagged a 'level' for its performance in a focus area. With this also, it becomes easier to set measureable targets.

The benchmarking process as we look at various documents and literature have been exercised differently even as we compare it with the service level benchmarking in urban transport developed for Indian Cities. It is difficult to judge upon which the right method of doing it or even which indicator is more appropriate. But what one needs to understand is to select and develop those performance indicators that fit the context of Indian cities. As such indicators and benchmark focus areas should be one that is comprehensive, comparable, and easy to understand and those for which one can establish achievable targets. Citing all of these in the following chapters the benchmarks have been discussed with definitions for all the indicators and terms. It also discusses the additional indicators, modification in the methodology of indicators and suggested change in the level of service.

3 Developing Key Performance Measures

This chapter discusses the benchmarks and indicators outlined and defined by MoUD's Service level Benchmarking document. Service level performance benchmarks have been identified for the following areas:



3.1 Public Transport (PT) Facilities

This Indicator measures the overall performance of public transport in the city. Key performance Indicators are mainly in the form of operational performances of the service providers.

It is important to understand the meaning of the following terms:

Headway
Time interval between vehicles moving in the same direction on a particular route.
Service Coverage Area
The ratio between PT network length (PT having headways less than 60 minutes) to the study area.
Transit Accessible Area
The area covered within 500metre buffer of the PT routes having headways less than or equal to 60 minutes.
Average waiting time
It is the average time that passengers have to wait for a bus at a bus stop.
High frequency accessible area
The area covered within 500 metre buffer of stops/Terminals having headways less than or equal to 10 minutes. This area particularly refers to developed area within 500 meter buffer of stops/Terminals.
Boarding
The number of Passengers entering the Public Transport Vehicle.
% Transit Ridership
The percentage of population in an urban area using or dependent on public transport as mode of travel.
Organized PT
It indicates the city-wide level of services provided by PT systems during peak hours. PT systems includes rail or organized bus based systems. Organized PT systems are characterized by - Fixed origins and destinations; Fixed routes and schedules; Fixed stoppage points; and Fixed fares.
Peak hours
The time of the day with highest ridership. The hours during morning and evening times of a day with highest number of commuters on road or in transit.
Availability of PT
Availability of PT refers to route possibilities, timings and frequency of organized PT services. It refers to bus stops having reasonable distance of approximately 500metres.

This measure focuses on frequency of the buses, total number of buses available to the population, % of road network length with PT plying with respect to the total study area. It also include another important indicator of service quality i.e. passengers per seated capacity. In most cities, public transport carries a proportion of standing passengers and although this makes efficient use of the vehicles, the passengers are at discomfort therefore it becomes important not to allow crowding in public transport. The indicators included in this benchmark are as follows:

1. Presence of Organized Public Transport System in Urban Area (%)
2. Extent of Supply - Availability of Public Transport
3. Service Coverage of Public Transport in the city
4. Average waiting time for Public Transport users (min)
5. Level of Comfort in Public Transport (Crowding)
6. % fleet size as per urban bus specification

3.2 Pedestrian Infrastructure Facilities

It indicates the percentage of road length along the arterial and major road network or Public Transport corridors and at intersection that has adequate barrier free pedestrian facilities

The terms to understand in the context of pedestrian infrastructure facilities are as follows:

Footpath
Dedicated walkway reserved or build for free movements of pedestrians is referred as footpath, the minimum width of footpath should be 1.2 meters.
Encroachment
The space reserved for road, footpath and cycle tracks occupied by other activities like shops, hawkers, parking etc. In other words illegal occupied public space

NUTP encourages the allocation of '*road space on more equitable basis with people as its focus'*. Therefore this Indicator defines the presence of pedestrian facilities in the city. The provision of footpath segregated from the mixed traffic and adequate lighting arrangement along the footpath is essential not only for the safety of pedestrian but also as a means of improving access to major public transport stations.

It is a trend in India, that people cross the road anytime and anywhere on the road. For the concerns such as safety and smooth travel of people, it is necessary to have separate signal phasing for the people to cross the roads with ease and safely. Therefore, a city with priority signal for pedestrian is important to highlight and showcase a good example. With this, the availability of pedestrian phasing has been included as an important indicator for our study. The indicators included in this benchmark are as follows:

1. Signalized intersection delay
2. Street lighting (Lux)
3. % City covered

3.3 Non-Motorized Transport (NMT) Facilities

- Indicates the percentage of dedicated cycle track / lane along the arterial & sub arterial road network or public transport corridors with a minimum of 2.5 m width.
- It is characterized by continuous length, encroachment on NMT lanes, and parking facilities
- All JnNURM cities to have NMT tracks on all major roads within a year

Travel diary of a person constitutes of trip chain and origin and destination using different modes. Access and egress modes are important in a trip chain. These points of interchanges between different modes are important to assess and study. While the first mile and last mile connectivity is often the non-motorized modes (Cycle and Pedestrian), therefore providing proper segregated cycle lanes coupled with safe bicycle parking places is not only important for the safety of cyclist but also contribute towards increasing use of public transport. Encroachment on bicycle lanes too affects the safety and optimum use by the cyclist therefore strict enforcements needs to be addressed in the city. The indicators included in this benchmark are as follows:

1. % of network covered
2. Encroachment on Cycle roads by vehicles parking (%)
3. NMT Parking facilities at Interchanges (%)

3.4 Level of usage of Intelligent Transport System (ITS) facilities

- ITS refers to efforts to add information and communications technology to transport, infrastructure and vehicles in an effort to manage factors that typically are at odds with each other, such as vehicles, loads, and routes to improve safety and reduce vehicle wear, transportation times and fuel consumption.

Passenger Information System

Passenger information systems are the key communication link between transportation operators and the Traveling passengers. It provides accurate, current information on arrival and departure times and gates. Information the traveler needs to keep moving efficiently. The information is provided in the form of digital displays as well as through loud speakers installed at appropriate locations.

Global Positioning System (GPS)

The Global Positioning System (GPS) is a satellite-based navigation system that determines the user's position and displays it on the unit's electronic map. With the GPS installed in the vehicles, the

operators can regulate bus movements, ensuring smoother running of services. In addition, information about when the bus will arrive is sent to some bus stops to alert passengers.

Integrated Ticketing System

Integrated ticketing may be understood as a single common ticket which can be used across all modes of public transport for a single trip. It helps in providing seamless interchange across the Public transport modes and also reduces the overall travel time as the users do not have to stand in queues each time they interchange to purchase the tickets. Aim is to have complete integration across all operators of same modes and across all modes and operators.

Signalized Intersection

To improve the traffic flow along the road networks, the signals along the corridor are inter-connected. The phasing of the signal at any specific intersection is in tune with the phasing of the intersection before and after it to provide a continuous green phase for the traffic stream. It helps in reducing congestion and stopping time at each intersection.

Traffic Surveillance System

Detection of movement of persons or vehicles for the purpose of security, incidence management and also to get real time information regarding pedestrian or vehicle flow.

Source: Service level benchmark in Urban Transport

The provision of road and other physical infrastructure is not the only solution for a good transportation system but it is also essential to work around the implementation of technology, specifically a network of sensors and communication devices that collects and distributes the information about smooth functioning of the transportation system.

Much of a good transportation system is about networks and these networks are more about the information contained in it. For example; whether a vehicle is drifting out of its lane, whether a roadway is congested with traffic therefore whether it's about choosing a different route or mode shift, how to optimize traffic signals to avoid congestion or vehicle collision or even how to hold the public transport providers accountable for better services etc. All of these help to more effectively manage the daily transportation challenges. The indicators included in this benchmark are as follows:

1. Availability of traffic surveillance system
2. Passenger information system (LED displays and screens inside stations or speakers)
3. Global Positioning system
4. Signal Synchronization
5. Integrated ticketing system
6. Signalised intersection *

** This indicator is included in the list of indicators for the benchmark "Level of usage of Intelligent Transport System (ITS) facilities", to derive the level of service for signalised intersections, the ranges are not been given in the document. It has not been included in the overall calculation of level of service of the benchmark.*

3.5 Travel speed (Motorized and Mass transit) along major corridors

- Provides an indication of effective travel time or speed of public and private vehicles, therefore accounts indications of congestion or traffic density.

Spot speed
speed of vehicles measured at a particular point along the road
Average travel speed
Speed including all delays and travel time.

The relationship between vehicle speed and accidents are well established. In addition to safety, there are also other benefits from travel speed such as an increase in traffic flow and thereby a reduction in congestion and delays which further implicates reduction in vehicle operating cost, less travel time and even reduced levels of pollution and noise. Therefore it becomes important to measure the travel speeds in the city as it defines the performances of existing transportation system (private vehicle and public transport). Measuring this would eventually help the city indirectly in the fulfillment of both long term goals and short term targets for a sustainable and safe transportation system**.** The indicators included in this benchmark are as follows:

1. Average Travel speed of personal vehicles (KMPH)
2. Average Travel speed of public transport (KMPH)

3.6 Availability of Parking Spaces

- It indicates the restriction on free parking spaces for all vehicles in a city
- To cover at least 50% of on street public parking spaces under "paid parking"
- To keep maximum and minimum parking fee difference to at least 2:1 (Parking rate to be computed two hourly).

One of the most pressuring challenges that local government (municipalities) encounter today is 'how to balance the supply and demand of parking spaces' under its limit. Parking is a necessary element of a city as it also influences a lot of many other factors such as mode choice, travel speed etc. With the help of MoUD benchmark of converting 50% of the on street parking into 'paid parking', municipalities can have a better parking management plan. It may even help to incentivize alternative modes of transport. To keep the maximum and minimum parking fee at 2:1 ratio is also important for avoiding congestion in the city core area where road right of way is smaller than the newer roads in the city. The indicators included in this benchmark are as follows:

1. Availability of paid parking spaces (%)
2. Ratio of maximum and minimum parking fee in the city

3.7 Road Safety

- Fatality rate per lakh population: To bring down fatality rates to 2 persons per lakh or below in all million plus cities within two years.
- Fatality rate for pedestrian and NMT (%): To bring down fatality rates for pedestrian and NMT such that the share comes down to less than 40% within two years.

Causality
A person killed or injured in an accident. Casualties are sub-divided in to killed, seriously injured and slightly injured.
Fatal accidents
An accident in which at least one person is killed; other causalities (if any) may have serious or slightly injuries.
Serious Accidents
One in which at least one person is seriously injured but no person (other than a confirmed suicide) is killed.
Serious injury
An injury for which a person is detained in hospital as an "in-patient", or any of the following injuries whether or not they are detained in hospital: fractures, concussion, internal injuries, crushing's, burns (excluding friction burns), severe cuts, severe general shock requiring medical treatment and injuries causing death 30 or more days after the accident. An injured casualty is recorded as seriously or slightly injured by the police on the basis of information available within a short time of the accident. This generally will not reflect the results of a medical examination, but may be influenced according to whether the casualty is hospitalized or not.
Killed
Human casualties who sustained injuries which caused death less than 90 days after the accident. Confirmed suicides are excluded.
Slight accident
One in which at least one person is slightly injured but no person is killed or seriously injured.
Slight Injury
An injury of a minor character such as a sprain (including neck whiplash injury), bruise or cut which are not judged to be severe, or slight shock requiring roadside attention. This definition includes injuries not requiring medical treatment.

Source: Reported Road Casualties in Great Britain: 2010 Annual Report, Department for Transport, 2010

In order to measure road safety in the city different kinds of statistical data has to be collected and studied. In case of this study, records of the fatal and serious accidents have been collected. However it is also important to first understand road safety problems in the city. In many cases road quality, vehicle density, driving behaviour in the city is the cause for road problems.

1. Fatality rate per lakh population
2. Fatality rate for pedestrian and NMT (%)

3.8 Pollution levels

National Ambient Air Quality Standards

Allowable concentrations of air pollutants in the ambient air specified by the Central pollution control board.

Particulate Matter

"Particulate matter (PM)," also known as particle pollution, is a complex mixture of extremely small dust and soot particles. Particle pollution is divided into two categories, "PM10" and "PM2.5." PM10 is matter less than 10 micrometers in diameter. PM2.5 is even smaller - measuring 2.5 micrometers or less.

Nitrogen Oxides (NOx)

Chemicals formed in high-temperature combustion processes. The substance is toxic and can react to form ozone or PM10 in the form of nitrates. Nitrogen dioxide (NO2) is brownish red gas with a biting odor. It is highly irritating in high concentrations. Nitrogen dioxide is always accompanied by nitric oxide (NO).

Sulfur Oxides (SO2)

An invisible gas with a pungent odor. At low concentrations, this gas can often be tasted before smelled. The major source of sulfur oxides is the combustion of sulfur-containing fuels, primarily coal and fuel oil. Sulfur dioxide is a toxic substance that can impair breathing.

The environment of a city is a critical determinant of the health of its inhabitants and consequently, urban productivity. Here the annual pollutants (SO2, NOx, SPM, RSPM) have been taken to express the pollution levels in the city.

1. Annual Mean Concentration Range (µg/m3) of SO2
2. Annual Mean Concentration Range (µg/m3) of NOx
3. Annual Mean Concentration Range (µg/m3) of SPM
4. Annual Mean Concentration Range (µg/m3) of RSPM

3.9 Integrated land use transport system

Effectiveness of land use-transport Integration

Floor space Index (FSI)

Floor space Index is the gross floor area of a building to the plot area.

Mixed land use

An appropriate combination of multiple uses (residential, commercial, cultural, institutional, or industrial uses) inside a single structure or place within a neighborhood (Alpert, 2010)

The Integration of land use and transport system in a city has become one of the key elements for a city's sustainable development. There are substantial advantages and opportunities in integrating the two. Aligning land use and transport infrastructure could support (i) reduce private vehicle kilometers travelled/auto- dependency (shorter trip lengths), (ii) increases mass transit usage and also mix-use modes of transport (bicycle, walk, public transport) (iii) a good mix of job-housing density.

1. Population Density (Gross persons /Developed area in hectare)
2. Mixed land use on major transit corridors /Network (% area under non-residential use)
3. Intensity of development -Citywide (FSI)
4. Intensity of Development along Transit Corridors
5. (FSI transit corridor / FSI)
6. Clear pattern and completeness of network

3.10 Financial Sustainability of Public Transport

- It indicates the financial sustainability of public transport by Bus. This indicator focuses on operating ratio, non-fare revenues and staff per bus ratio.

The focus of this indicator is on how financially sustainable are the public transport operators because it is important that public transport services is financially sustainable to provide good public transport to the city. Ratio of fare revenue to total operating cost is a key indicator of financial performance.

The staff-per-vehicle ratio is a useful measure of the effective use of staff. Fare revenue is another important indicator that helps operators to cross subsidized operating cost of the public transport. Non-fare revenue comprises revenue from advertising on buses / coaches, at bus stations and other spaces, rental spaces at terminals, etc.

1. Extent of Non-fare revenue (%)
2. Staff/bus ratio
3. Operating Ratio

3.11 Additional / modified / "Revised SLB" focus areas

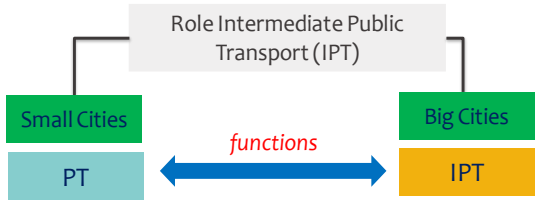
Additional indicators are indicators which are included through review of different international documents and benchmarking studies carried out in different parts of the world. Modified indicators are indicators which have been modified in terms of level of service ranges or shuffled from one benchmark to other benchmark.

3.11.1 Addition of Focus Area - Intermediate Public transport

Auto rickshaw
Auto rickshaw is a three-wheeled cabin cycle for private use and as a vehicle for hire. It is a motorized version of the traditional pulled rickshaw or cycle rickshaw.
Taxi
A taxi or a cab is a vehicle hired with a driver. It can either be hired by one single passenger or can be shared by a small group of people (shared taxi).

Intermediate public transport (IPT) refers to modes that fill the gap between private transport and formal public transport modes in cities, depending on a city's size and transport characteristics.

In Indian cities, IPT is widely referred as "Auto rickshaws", "taxi" and "Cycle rickshaws". It can be identified by a pre-defined, continuous, point to point service with intermediate stops for boarding and alighting of passengers, or taxi like services which can be identified by the intermittent nature of the service and complete flexibility in destination which is determined by the passenger.



Varies for large and smaller cities
i) Large cities : 6-8 % share
ii) Small cities : 20-25% share

Desirable level for IPT???
More is not good, less is not good

What should be the measures?
1. Availability
2. Efficiency
3. Safety & Security

How to measure?
1. Mode share
2. Speed and ITS facility

*Suggested Indicators
1. Presence of IPT per 1000 population
2. Average travel speed of IPT
3. IPT vehicles with ITS facilities / GPS

3.11.2 Modification to focus area name- Travel speed (motorized and mass transit) along major corridors" to "Street infrastructure"

Travel speed alone cannot measure the performance of the road. New Indicators needs to be added to measure the performance of road as there are many other factors that contribute to road performance.

What should be the measures ?
1. Efficiency
2. Accessibility
3. Availability
4. Safety

How are we measuring?
1. Average travel speed
2. % of Higher order roads
3. Road Density
4. Percentage of area under roads
5. Street lighting (LUX levels) on roads

As given in the service level benchmarks for urban transport basically the performance of road is defined by the speeds of private vehicles and public transport. This measurement of road performance by speed alone cannot determine how good the city is performing for a city need not necessarily need high speeds for example hill cities. Many a times, the performance is affected by the network size, distribution of network, demand etc. The performance of road should be viewed in different perspectives such as service quality, infrastructure provisions, efficiency and accessibility. Therefore it becomes necessary to include more indicators to this focus area and also the name to be changed to 'street infrastructure'. The indicators added to this focus area are mostly focused on network size (% of area under roads), efficiency (travel speed), availability/ accessibility (road density, percentage of higher order roads) and safety (street lighting).

3.12 REVISED SLB FOCUS AREA

3.12.1 Public Transport (PT) Facilities

Indicators	Additional / modified suggested indicators
1. Presence of Organized Public Transport System in Urban Area (%) 2. Extent of Supply - Availability of Public Transport 3. Service Coverage of Public Transport in the city 4. Average waiting time for Public Transport users (min) 5. Level of Comfort in Public Transport (Crowding) 6. % fleet size as per urban bus specification	• Existing Indicators 1. Transit Access Area- (% built-up area within 500m of PT plying) * 2. High frequency transit accessible area (% area with transit access 10min or less headway) * 3. Total boarding/ population* 4. Breakdown of Public Transport vehicles (on-board reliability of buses)* 5. Vehicle (bus) Utilization* 6. Interchanges having Multi-modal Facilities* 1. Average Travel speed of public transport **

*Additional indicators to be included in the benchmark
**This indicator is part of the benchmark # 5, "Average travel speed on major corridors" as per SLB document, which has shifted under Benchmark # 1 "Public transport facilities".

[1]***Mega Cities (4 Million+ People), Metro cities (1-4 Million), Other cities I(<1 - 0.2 Million population) and Other cities II (<0.2 Million population)there should be variation with the ranges to compute level of services. SLB ranges are taken as it is for Mega cities but for other size of the cities, there is proposed modification as per our study***

Sometimes the municipal limit is too large but the extent of development is not as large therefore the measurement of service coverage with respect to the built-up area along with municipal limit will be realistic. Therefore it becomes important to analyze the city in terms of the amount of built up being served with adequate frequency (i.e. less than 60minutes headway routes).

- High frequency transit accessible area is referred to the total area within 500m buffer of the bus stops in relation to the built-up area of the city as this is the area generally accessed by the residents.
- This benchmark assesses city's public transport from a user's perspective, hence it is important to assess average speeds of public transport vehicles on major corridors' of the city as a part of this benchmark.
- This benchmark focuses on public transport facilities in the city, so it is important to include Boarding/Population. Percentage Transit Ridership (Total trips on public transit / total motorized trips) could also be included, but it is difficult to measure as it requires a details household survey and hence may not be feasible to use.
- Transit ridership has not been covered in any other indicator, the easiest way to measure transit ridership is through boarding. Boarding can be computed through both primary and secondary sources; however we have considered boarding data through secondary sources. Primary data collection methods for capturing ridership are extensive efforts demanding. On the other hand, secondary sources will also be 90-95% reliable. Thus, this indicator is depending on secondary data collection

3.12.1.1 Additional suggested/modified indicators

MODIFIED INDICATORS

1. Extent of supply / Availability of Public Transport

Bus requirement is directly related to trip length and city size. Large size cities have large trip lengths; hence the need of bus fleet is higher to serve the same number of passengers in comparison with smaller cities. City classification is adopted from JnNURM city classification.

Table 3.12-1: Population density as per categories of cities

Mega Cities (4 Million+ Population)		**Metro Cities (1-4 Million population)**		**Other cities I (<1- 0.2 million population) Other cities II (<0.2 Million population)**	
Buses/1000 population	LoS	Buses/1000 population	LoS	Buses/1000 population	**LoS**
>0.6	1	>0.4	1	>0.3	**1**
0.4 – 0.6	2	0.25 – 0.4	2	0.2-0.3	**2**
0.2 – 0.4	3	0.1 – 0.25	3	0.1-0.2	**3**
<0.2	4	<0.1	4	<0.1	**4**

Public transport facilities: Metro cities (1-4 Million)			
Extent of supply / Availability of Public Transport	Range	Suggested range	LoS
	> = 0.6	>0.4	1
	0.4 – 0.6	0.25 – 0.4	2
	0.2 –0.4	0.1 – 0.25	3
	< 0.2	<0.1	4

Public transport facilities: Other cities i (1-0.2 Million) ii (<0.2 Million)				
Extent of supply / Availability of Public Transport	Range	Suggested range	LoS	Suggested target for other cities is LoS 3
	> = 0.6	>0.3	1	
	0.4 – 0.6	0.3 – 0.2	2	
	0.2 –0.4	0.1 – 0.2	3	
	< 0.2	<0.1	4	

2. Average waiting time for Public Transport Users

As per the method given in SLB, average waiting time should be computed from desktop analysis. In order to further understand this, a reconnaissance survey was conducted in Ahmedabad. It was observed that waiting time is not always half of headway. It varies according to the frequency of services. Therefore to establish this relation between waiting time and headways, a survey was conducted for;

- <10 minutes headway
- 10-20 minutes headway
- 20-60 minutes headway

The bus stop to conduct the survey was selected after studying the public transport routes. The selected stops were (i) University bus stop (ii) Navrangpura bus stop in Ahmedabad where maximum number of the routes with the categorized headways as mentioned above was catered. A sample of 30 was collected for each route during the peak hours. Finally the relation has been established through regression analysis as given below;

Table 3.12-2: Constant for bus Headways

Headways (minutes)	Constant
<10	0.40
10-20	0.40
>20 - 60	0.29

Public transport facilities				
Indicator	Range	Suggested range	LoS	Suggested target for other cities is LoS 3 i.e. less than 12 minutes
Average waiting time for public transport users	<=4	<=4	1	
	4-6	4-8	2	
	6-10	8-12	3	
	>10	>12	4	

ADDITIONAL INDICATORS

Public transport facilities				
Indicators	computation	Range	LoS	Suggested target for all categories of cities is LoS 2
Transit Access Area- (% built-up area within 500m of PT plying)	PT corridor length with effective headways <1hr *1 km catchment of built-up area (500m buffer on either side)= (a) Total developed area = (b) (a/b)*100	<=4	1	
		4-8	2	
		8-12	3	
		>12	4	
High frequency transit accessible area (% area with transit access 10min or less headway	Developed Area=(b) Developed area under 500m buffer of bus stops having effective headway less than 10mins effective headway= (c) (c/b)*100	<=4	1	
		4-8	2	
		8-12	3	
		>12	4	

Another indicator could be related to boarding's note that one needs to include all the boarding's including information from pass holders.

Public transport facilities				
Indicators	computation	Range	LoS	Suggested target for all categories of cities is LoS 2
Total boarding/ population	Total boarding's (boarding on all PT) d Total population within study area = e Boarding's per population= (d*1000)/ e	<=4	1	
		4-8	2	
		8-12	3	
		>12	4	

3. Affordability of public transport

This benchmark aims to calculate financial sustainability of public transport by bus. Moreover, it is good to assess the affordability of residents in place of usage of the bus based public transport system. Assessing the performance of public transport from user perspective alone is not enough, if affordability is not computed alongside. Hence, affordability is included as part of this benchmark.

Affordability

Affordability can be considered as the ability to make necessary journeys (to work, school, health and other social services, and make visits to other family members or urgent other journeys) without having to curtail other essential activities. (Carruthers R. et al, 2005).

Affordability index is expressed as

*Affordability index = (Number of trips * avg. cost per trip) / Per capita income"*

Public transport facilities				
Indicator	computation	Range	LoS	Suggested target for all categories of cities is LoS 2
Affordability of public transport **(% expenditure per month on transportation)**	Average trip length in the city (Secondary sources)- L Fare chart for the city(SPV, transport authority) -M Minimum wage in the country(labour Ministry) Rs115 Assumption that 2 trips made per person per day and 26 working days (Total 52 trips/month) Total expenditure on transportation= ((fare /km)* Average trip length))*52 Total expenditure on transportation/total Monthly income (as per minimum wages)	<=4	1	
		4-8	2	
		8-12	3	
		>12	4	

SUGGESTED TARGET

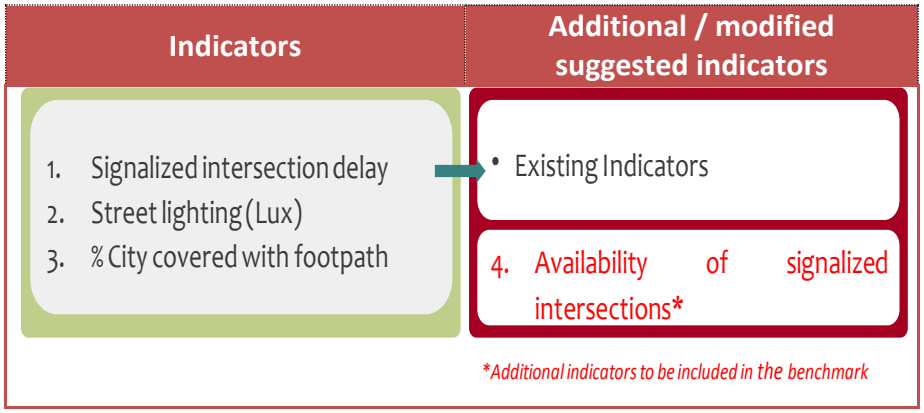
4. Service coverage area of public transport

Public transport facilities				
Indicator	Computation	Range	LoS	Suggested target for other cities is LoS 1
Service Coverage of Public Transport in the study area	Total length in road km of the corridors on which public transport systems ply in the city = (a) (Corridors along which the service frequency is one hour or less are only considered to compute the length). Total Study area= (b) Service coverage = (a/b)	>=1	1	
		0.7-1	2	
		0.3-0.7	3	
		<0.3	4	

5. Percentage of fleet size as per urban bus specifications

Public transport facilities				
Indicator	Computation	Range	LoS	Suggested target for other cities is LoS 3
Percentage fleet size as per urban bus specification (UBS)	Total number of buses in the city = (a) Number of buses as per urban bus specification = (b) % of Fleet as per Urban Bus Specifications = (b/a)*100	75-100%	1	
		50-75%	2	
		25-50%	3	
		<=25%	4	

3.12.2 Pedestrian Infrastructure Facilities



This benchmark assess the present pedestrian infrastructure facilities in the city, it is very essential to assess the major junctions are equipped with signalized intersections. Major junctions refer to the junctions serving level 1 (arterial) and level 2 (sub arterial) roads of the city. A signalized intersection is one where the junction is alternatively used by a fixed number of approaches for predefined time interval. Further, it also brings safety aspect for the pedestrian to cross junction.

While computing signalized intersection delays, the first need of the city is to install signals at all major junctions for the safety of pedestrians. Few cities do not have adequate number of signals installed at major junctions, yet they score high while computing signalized intersection delay for a pedestrian. The methodology to compute signalized intersection delays is restricted to existing number of signalized intersections. This does not represent correct picture of the city's situation. Hence, we have suggested that it should score Level of Service 4 if the city does not have adequate number of signals installed in comparison with major junctions as defined in a table below.

3.12.2.1 Additional suggested/modified indicators

ADDITIONAL INDICATORS

1. Availability of signalized intersections

Pedestrian infrastructure				
Indicator	Computation	Range	LoS	Suggested target for all category of
Availability of signalized	Major junctions* in the city = (a)	75-100%	1	

intersections	Signalized intersections = (b) Availability of signalized intersection = (b/a)*100 * Major junctions refer to junctions serving level 1 and level 2 roads of the city.	50-75%	2	cities is LoS 2
		25-50%	3	
		<=25%	4	

SUGGESTED TARGET

For this benchmark, the targets given are only for million plus cities and the targets for other cities have not been specified. However the same has also been adopted as targets for other cities [(i) 1-0.2 million population (ii) <0.2 million population] for all the indicator is LoS 2.

3.12.3 Non-Motorized Transport (NMT) Facilities

Indicators	Additional / modified suggested indicators
1. % of network covered * 2. Encroachment on Cycle roads by vehicles parking (%) 3. NMT Parking facilities at Interchanges (%)	Existing Indicators

*Width of cycle track is taken 2metre

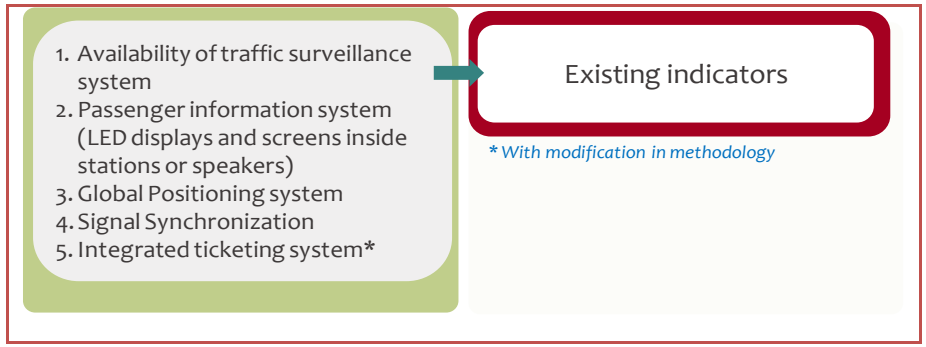
It indicates the percentage of dedicated cycle track / lane along the arterial & sub arterial road network or public transport corridors with a minimum of 2 m width. It is characterized by continuous length, encroachment on NMT lanes, and parking facilities.

Most cities are lacking in dedicated cycle network, hence computing encroachment through vehicle parking is not appropriate. Most cities score high as they don't have encroachment on cycle tracks, but those cities do not have cycle track in even 10% of the total road network. Thus, cities where cycle track is insufficient, level of service for encroachment computation should be taken as 4.

3.12.4 Level of usage of Intelligent Transport System (ITS) facilities

Integrated ticketing may be understood as a single common ticket which can be used across all modes of public transport for a single trip. It helps in providing seamless interchange across the Public transport modes and also reduces the overall travel time as the users do not have to stand in queues each time they interchange to purchase the tickets. Aim is to have complete integration across all operators of same modes and across all modes and operators. With the ranges given in SLB, it is hard to understand if a single system has provision of seamless travel such as "one system and one ticket". Incorporating concepts such as smart card and "one system one ticket" also helps in reducing the time spent in queue for the tickets. It is very important to assess it, hence, there is modification in the range is suggested.

Indicators	Additional / modified suggested indicators



3.12.4.1 Additional suggested/modified indicators

MODIFIED INDICATORS

Level of usage of intelligent system (ITS) facilities				
Indicator	Computation	Range	LoS	Suggested target for other cities is LoS 3
Integrated ticketing system	Total number of buses in the city = (a) Number of buses as per urban bus specification = (b) % of Fleet as per Urban Bus Specifications = (b/a)*100	>=75	1	
		50-75	2	
		25-50	3	
		<25	4	

SUGGESTED TARGET

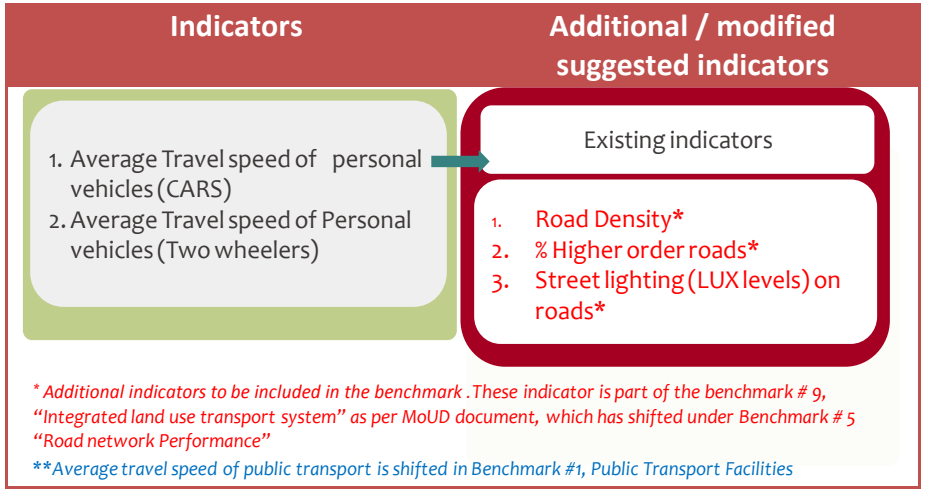
Signal Synchronization: Target for metro cities is LoS 2 and for other cities is LoS 3.

Integrated Ticketing System: Target for other cities is LoS 1

3.12.5 Street Infrastructure

Road network forms an important part of the urban fabric of the city. It also indirectly depicts growth of a city i.e. as road extends city expands to more opportunity space. Therefore it is important to measure the performance of the current road network in the city which could be by assessing road density, % of higher order roads in comparison with total road network.

This indicator aims to assess the road network performance i.e. average speeds of private vehicles hence it could be renamed as "Road network Performance". Moreover, additional indicators to be included as part of benchmark assessment are, Road density, % higher order roads, street lighting (LUX) on roads; these indicators further emphasizes on assessment of road network of the city. Hence, it is suggested that the benchmark could be renamed as "Road network Performance".



- This indicator aims to assess the road network performance, it is important to include % area under roads as part of this benchmark, hence it has moved from benchmark #9"Integrated land use and transport system".
- Average Travel Speed of Personal vehicles (KMPH) are further split in two indicators, i.e. Average Travel Speed of Cars (KMPH) and Average Travel Speed of Two wheelers (KMPH). Some cities have significant difference in travel speed of two wheelers and cars, hence splitting in two, will give precision in assessment of average travel speed. To compute the level of service, the ranges have been kept same as "SLB" document.
- As per the "SLB" document, methodology of computation of average travel speed, there is difference in measurement of LoS (Level of Service). Considering urban scenario and today's demand, the PT travel speed should be similar to private vehicles. Hence we have suggested modification for the measurement of LoS to keep all the modes on same platform for better comparison and to promote equality.

3.12.5.1 Additional suggested/modified indicators

MODIFIED INDICATORS

1. Travel speed

Street Infrastructure			
Indicator	Range	Suggested Range	LoS
Average travel speed of personal vehicles (Kmph)	25-30	18-20	2
City wide level of service of motorized vehicles (Private) Car 2 wheeler	15-25	16-18	3
	<=15	<=16	4

2. Street lighting (Lux level on road)

Street lighting in India is governed by the Indian Standards - IS 1944 (Parts I and II), 1970 as given in the table below. These standards provide the guidance to public lighting authorities who are concerned with the preparation of public lighting schemes, their installation and maintenance.

Lighting Criteria
Uniformity of the Lighting   ***Over all Uniformity (U0) :***   *Overall uniformity is the ratio of the minimum to the average road illuminance*   *A good overall uniformity ensures that all spots on the road are sufficiently visible*   ***Longitudinal Uniformity (UL) :***   *# Longitudinal uniformity - ratio of the minimum to the maximum in the middle of each lane*   *#A good longitudinal uniformity ensures comfortable driving conditions without the so-called 'Zebra' effect*

Table 3.12-3: Classification of street lighting

Classification of Lighting Installation	Type of Road	Average Luminance on Road	Ratio of Min/Avg. Illumination
Group A1	Important Traffic routes carrying fast traffic.	30	*0.4*
Group A2	Other Main Roads carrying mixed Traffic like main city streets, arterial roads, throughways etc…	15	0.4
Group B1	Secondary roads with considerable traffic like principal local traffic routes, shopping	8	0.3
Group B2	Secondary roads with light traffic	4	0.3

Table 3.12-4: Lighting standards as per codes

As per BS 5489-1 & BS EN-13201-2:2003												
Level of roads	Level 1			Level 2			Level 3			Level 4		
Lux Standard	Lux level	Uniformity		Lux level	Uniformity		Lux level	Uniformity		Lux level	Uniformity	
		U_0	U_L		U_0	U_L		U_0	U_L		U_0	U_L
Road	25-30	0.4	0.7	25-30	0.4	0.7	18-22	0.4	0.7	17-20	0.4	0.5
Footpath (Complexity low)	15-17	0.4		15-17	0.4		12-15	0.4		10-12	0.4	
Footpath (Complexity high)	17-20	0.4		17-20	0.4		15-17	0.4		12-15	0.4	
As per IS 1944-1970												
Road	30	0.4	-	30	0.4	-	15	0.4	-	15	0.4	-
Footpath	Not specified			Not specified			Not specified			Not specified		

Considering this, the British standards (BS 5489-1 & BS EN-13201-2:2003) have been studied in comparison to the Indian Standards (IS 1944 (Parts I and II), 1970) and ranges of lux standards have been proposed as given in table below.

ADDITIONAL INDICATORS

Street Infrastructure				
Indicator	computation	Range	LoS	-
Road Density	Built up area – h Total Road length – i Road density – i/h	>12	1	Suggested target for all these categories of cities is LoS 2
		10-12	2	
		8-10	3	
		6-8	4	
Percentage of higher order roads	Total length of road network =i Length of level 1 + level 2 roads= j % Higher order roads =j/i*100	>35	1	
		25-35	2	
		15-25	3	
		<15	4	
Street lighting (LUX levels) on roads	LUX reading consists of 12 point readings Average LUX levels on each of the selected links= (Q1+Q2+Q3+Q4+Q5+Q6)/6 Level of service on which cumulative frequency crosses 50% mark	>=30	1	
		>25-30	2	
		>20-25	3	
		<20	4	

3.12.6 Availability of Parking Spaces

Indicators	Additional / modified suggested indicators
1. Availability of paid parking spaces (%) 2. Ratio of maximum and minimum parking fee in the city	▪ Existing indicators

- Data collection is a major problem both in terms of secondary and primary sources.
- Secondary source: the authorities do not maintain data in terms of ECS unit. Primary source: difficult to capture the actual capacity in the pay parking area as it depends on the time of the survey.

3.12.7 Road Safety

Indicators	Additional / modified suggested indicators
1. Fatality rate per lakh population 2. Fatality rate for pedestrian & NMT (%)	▪ Existing Indicators 3. Serious injuries per lakh population*

**Additional indicators to be included in the benchmark*

With increasing road traffic, many cities are witnessing increase in accidents, leading to rise in injuries and fatalities. Level of fatality is an indication of road safety. Road design and available road infrastructure,

traffic management and other such reasons significantly contribute to road safety hence it is important to monitor fatality rate. The ideal benchmark for the same is zero, as ideally fatalities and injuries out of accidents should be brought down to nil. Additionally, serious accidents should also be considered for assessment of road safety. Hence, additional indicator "Fatal and serious accidents per lakh population" is suggested to compute level of service for this benchmark.

ADDITIONAL INDICATORS

Road Safety			
Indicator	computation	Range	LoS
Serious injuries per lakh population	Serious injuries recorded in road accidents= (k) *(Traffic police, 2011)* Population of study area =e *(Provisional population, Census, 2011)* (k*100000)/e	>2 persons	1
		2-4 persons	2
		4-6 persons	3
		>6 persons	4

3.12.8 Pollution levels

Indicators	Additional / modified suggested indicators
1. Reading of So2 2. Reading of Nox 3. Reading of SPM (PM 10)* 4. Reading of RSPM (PM2.5)	▪ Existing indicators

** With modification as per revised CPCB guidelines , 2009*

The minimum standard given in SLB for SPM is very high than the recent standards given by Central Pollution Control Board (CPCB) as shown in table. Considering this, level of service needs to be redefined considering minimum standard for SPM.

Table 3.12-5: Pollution levels

Parameters	Central Pollution Control Board (CPCB)		SLB
	Standard for Residential & Industrial Area (CPCB)	Standard for Sensitive Area (CPCB)	Minimum Standard
SO_2			
Annual	50	20	40
24 HRS.	80	80	
NO			
Annual	40	30	40
24 HRS.	80	80	
SPM / (PM10)			
Annual	60	60	180
24 HRS.	100	100	
RSPM / (PM2.5)			
Annual	40	40	40
24 HRS.	60	60	15

MODIFIED INDICATORS

Pollution levels			
Indicator	Range	Suggested range	LoS
Reading of SPM (PM 10)	0-180 (Low)	0-60	1
	180-350 (Moderate)	60-120	2
	360-540 (High)	120-180	3
	>540 (Critical)	>180	4

SUGGESTED TARGET

Target set for all the category of cities is LoS 1

3.12.9 Integrated land use transport system

Indicators	Additional / modified suggested indicators
1. Population Density (Gross persons /Developed area in hectare) 2. Mixed landuse on major transit corridors /Network 3. Intensity of development -Citywide (FSI) 4. Intensity of Development along Transit Corridors 5. Clear pattern and completeness of network 6. %age network having exclusive ROW for Transit network 7. % area under roads[1]	▪ Existing indicators

[1]This indicator is part of the benchmark # 9, "Integrated land use transport system" as per SLB document, which has shifted under Benchmark # 5 "Road network Performance"

3.12.9.1 Additional suggested/modified indicators

MODIFIED INDICATORS

1. Population Density

Table 3.12-6: Population density as per categories of cities

Mega Cities (4 Million+ Population)		Metro Cities (1-4 Million population)		Other cities I (<1- 0.2 million population) Other cities II (<0.2 Million population)	
Density	LoS	Density	LoS	Density	LoS
>150	1	>125	1	>100	1
125-150	2	100-125	2	75-100	2
100-125	3	75-100	3	50-75	3
< 100	4	<75	4	<50	4

Integrated land use transport system : Metro cities (1-4 Million)			
Indicator	Range	Suggested range	LoS
Population density	>150	>125	1
	125-150	100-125	2
	100-125	75-100	3
	< 100	<75	4

Integrated land use transport system : Other cities i (1-0.2 Million) ii (<0.2 Million)			
Indicator	Range	Suggested range	LoS
Population density	>150	>100	1
	125-150	75-100	2
	100-125	50-75	3
	< 100	<50	4

2. Intensity of Development along Transit Corridors

Integrated land use transport system : Other cities i (1-0.2 Million) ii (<0.2 Million)			
Indicator	Computation	Range	LoS
Intensity of Development along Transit Corridors	Actual FIS along transit Corridors	>=4	1
		3-4	2
		2-3	3
		<2	4

3.12.10 Financial Sustainability of Public Transport

Indicators	Additional / modified suggested indicators
1. Extent of Non-fare revenue (%)* 2. Staff/bus ratio 3. Operating Ratio	Existing indicators

* With modification in the ranges and methodology

Non-fare revenue
Non-fare revenue comprises revenue from advertising on buses / coaches, at bus stations and other spaces, rental spaces at terminals.

MODIFIED INDICATOR

1. Operating ratio

Financial sustainability of Public Transport			
Indicator	Suggested computation	Range	LoS
Operating ratio	Cost / km (a) Earning / km (b) Operating ratio = (a/b)	<0.7	1
		0.7 – 1.0	2
		1.0 – 1.5	3
		>=1.5	4

3.12.11 Intermediate Public Transport (IPT)

"Intermediate public transport (IPT) refers to modes that fill the gap between private transport and formal public transport modes in cities. Depending on a city's size and transport characteristics, IPT modes may fall under two broad categories: (1) contract carriage services, which are flexible demand-based services where the passenger determines the destination, and (2) informal public transport (bus like) services, characterized by shared fixed-route services with intermediate stops for boarding and alighting. While contract carriage services are ubiquitous in cities, informal public transport services are typically seen in small and medium-sized cities, which may not have any or adequate formal public transport services. Such services are called informal because of their ownership structure (individual owners) and lack of (or poor) regulation and enforcement, Mani A. Et al., Sustainable Urban Transport in India- Role of the Auto-rickshaw Sector, World resources Institute and Embarq).

Indicators	Additional / modified suggested indicators
	1. Presence of IPT vehicles / 1000 population 2. Average travel speed of IPT* 3. IPT vehicles with ITS facilities / GPS*

**Additional indicators to be included in the benchmark*

Considering the fact that in many of the Indian cities auto rickshaws are important modes of transport either because the city does not have a proper public transport system or sometimes IPTS like taxis have a major role to play especially in terrain constraint cities particularly in the case of hill cities. Therefore it becomes important to consider these modes of transport as it is an important element of the city's urban transport facility. Keeping this in mind a new benchmark has been suggested on IPTS.

IPT			
Indicator	computation	Range	LoS
Average travel speed of IPT	Average speed along the corridors =length /journey time (hour) LoS is calculated for each corridor as Los1 for Corridor 1, LoS2 for corriodor2, LoSn for corridor n Weightage of each corridor= W1 for C1, W2 for C2…Wn for Cn	>=30	1
		25-30	2
		15-25	3
		<15	4
ITS with GPS facility	Total number of IPT (RTO) = (a) Total number of IPT with GPS = (b) =(a) / (b)	>=75	1
		50-75	2
		25-50	3
		<25	4
Presence of IPT vehicles / 1000 population	Registered IPT vehicles (auto rickshaws and taxis) = a Population of delineated area = b Presence of IPT vehicles / 1000 population = (a/(b/1000))	3.5-4.5	1
		2.5-3.5 and 4.5-5.5	2
		1-2.5 and 5.5-6.5	3
		<1 and >6.5	4

4 Approach Data Collection and Methodology

4.1 Study Approach

The study for benchmarking performances in urban transport of various cities has been approached in the following way (as shown in the chart below):

The analytical frame consists of

1. Service level benchmark indicators suggested by MoUD and additional benchmarking indicators have also been identified through literature research.
1. Alternative methodology have also been applied and proposed (as discussed later in the chapter)
2. For carrying out the calculation of indicators data collection both in terms of primary and secondary data are collected and analyzed. Secondary data was acquired mostly from published reports and from the concerned agency/ authorities.
3. The level of service is then calculated as per the given formulas.
4. Validate results for appropriateness and representativeness.
5. If issues identified then revisit the indicators and measurement process and modify
6. If results satisfactory adopt the existing service level and the target service level for each indicator
7. Derive the overall service level for the city by using composite index method

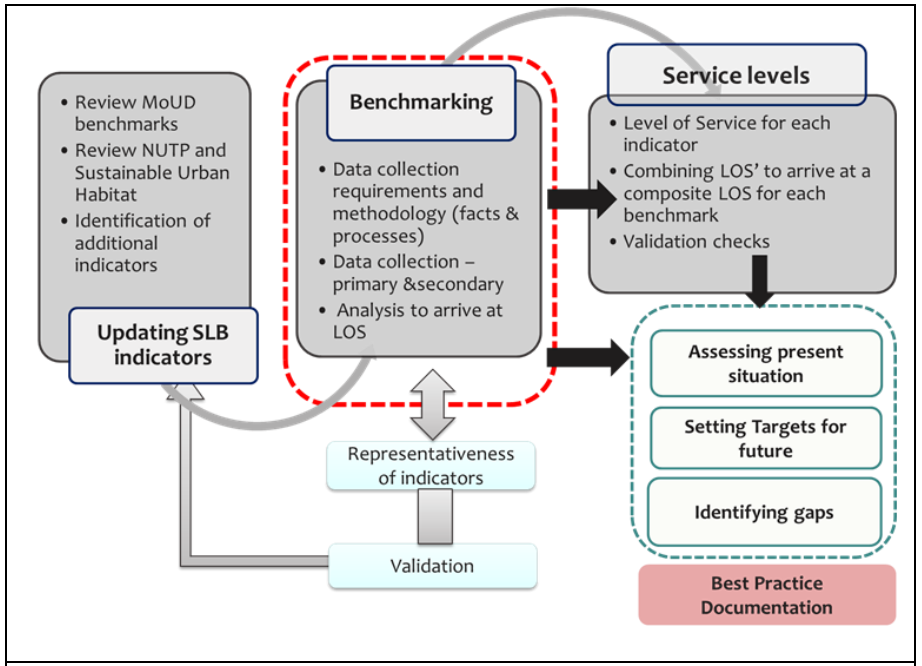


Figure 4.1-1: Study approach methodology

4.2 Study Area Delineation

The SLB suggests that the study area will be confined to the Local Planning Area given the fact that land-use decisions are for a notified area inclusive of the primary urban centre and its influence zone.

This area in some cases may be too big to consider for measurement purposes e.g. in case of Ahmedabad, the Local Planning Area is about

1866 sq km and contains 11 urban areas (Ahmedabad, Ahmedabad Cantonment, Bareja, Bopal, Singarva, Nandej, Sanand, Kalol, Chiloda, Dehgam and Mehmadabad), out growths (Ghuma, Kathva, Saij) and 163 villages, hence considering this as the study area would not be feasible.

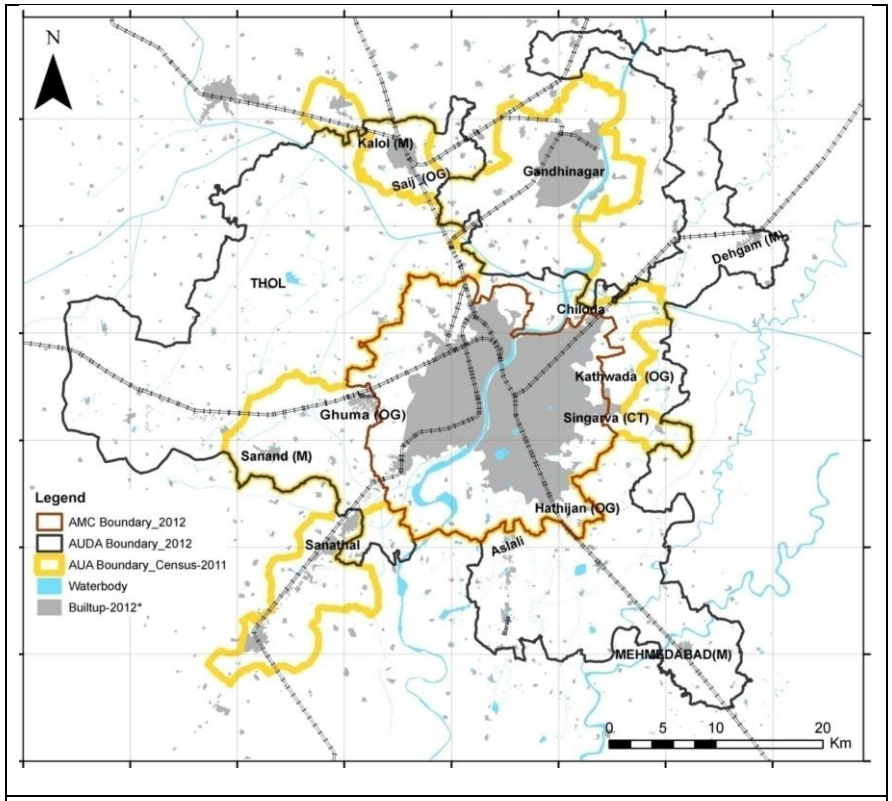
The census also defines the urban agglomeration area for the city, however in case of Ahmedabad it is observed that this area is very large and also includes the cities of Gandhinagar and Kadi and hence this too is not practical to be considered for benchmarking exercise.

Since service level benchmarks measure performance of urban area of the city the need to delineate this area becomes imperative. This urban area can be delineated by considering the municipal area limits of the city plus the city sprawl (contiguous built-up adjoining the municipal limits).

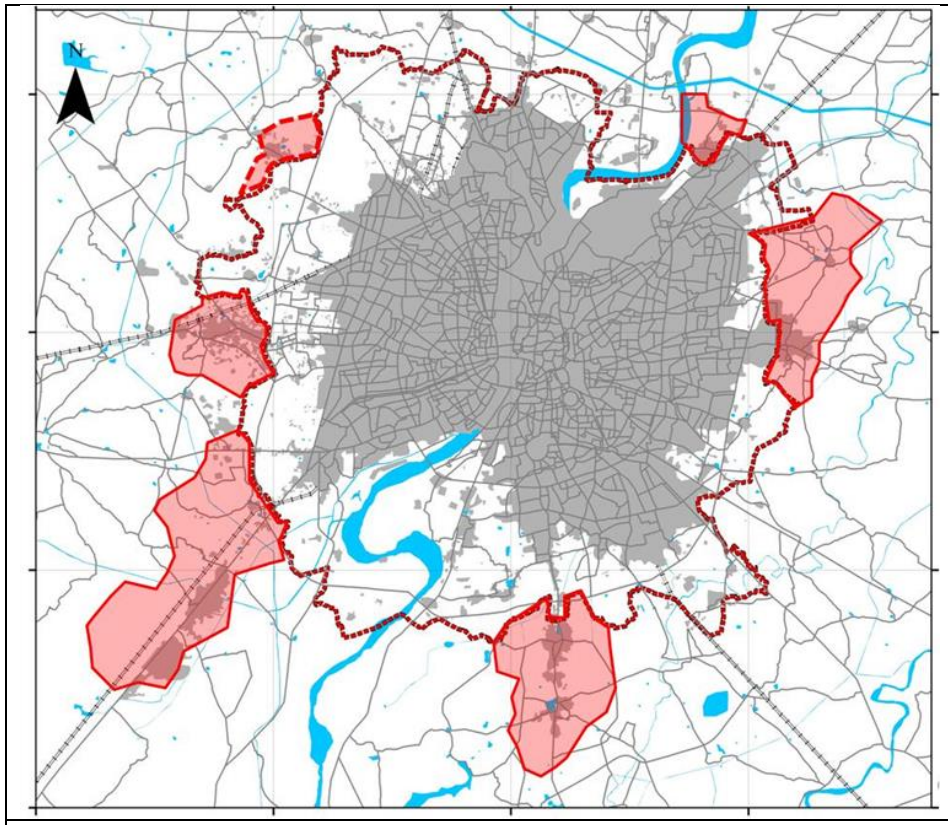
To undertake this delineation process built up area of the city along with its sprawl need to be identified using the latest satellite imagery. The following steps will be followed to delineate the study area-

- Step 1-mark the Municipal limits of the city- (a)
- Step 2- mark the village / town boundaries in Urban Development Authority area (b)
- Step 3- Digitize the contiguous built-up area adjoining the municipal limits (c)
- Step 4- Select the villages/ towns that correspond to step one. (b intersection c= d)
- Step 5- Define the Study area i.e. Municipal area + Area selected in step 4 (a + d)

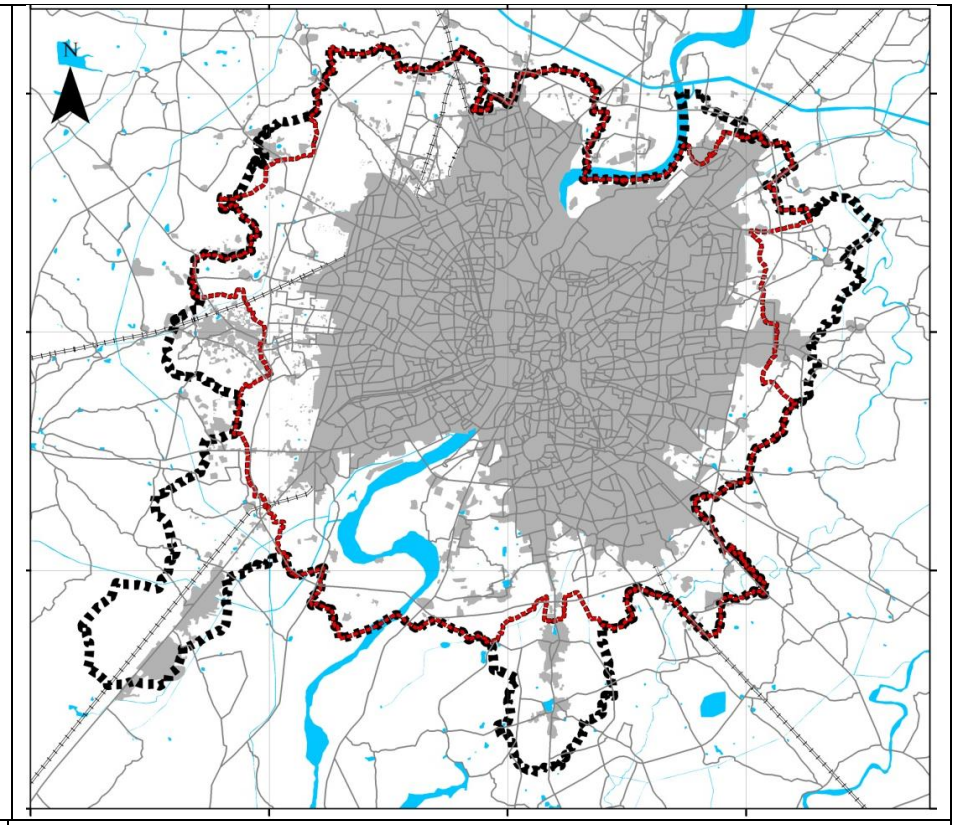
This study area will be considered while measuring indicator.



Overview of the city's authority boundary



Contiguous Developed Area



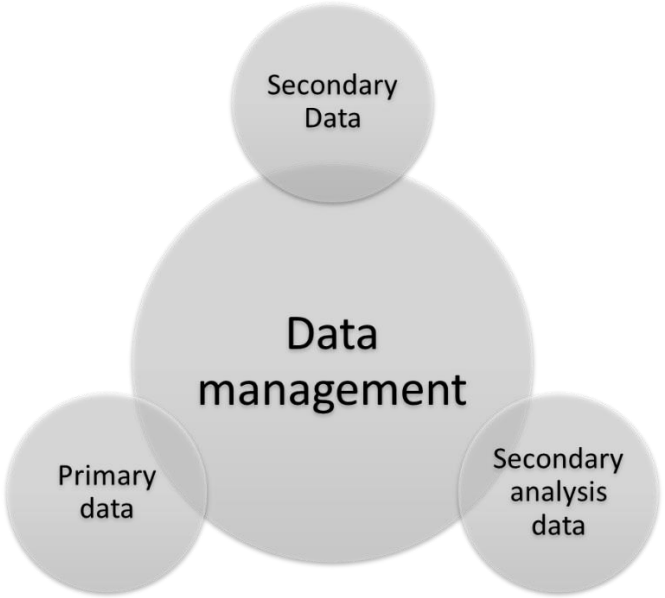
Map 4.2-1: Study area delineation

4.3 Data Establishment

Data needs to be collected and transferred spatially on maps using GIS and a data collection system put in place. It is important to understand the outputs that are desired before we start collecting information. Data collection should focus on data that will be used to measure indicators. Depending on the indicator measured the data collected needs to be representative both spatially and temporally.

Before starting the study it is also important to have some base information in hand which will be useful in primary survey sampling process. This base information is listed below-

1. Base map containing administrative boundaries, Municipal and Urban authorities (includes zones, wards, urban areas, villages)
2. Demographic – population of 2011 (In case the new census figures are not available collect information on the last three to four decades and estimate the base year population. It is also important to take into consideration the area changes that have taken place which has an implication of the growth rates used for base year estimation.
3. Built up area (digitized from Google imagery)
4. Road network
5. Location of signalized intersections, road under bridges, road over bridges and river bridges.
6. Public transport network including location of stops.
7. Rapid transit network including transit stations.
8. Land use map existing and proposed for urban development area.
9. Elevation and Slope maps for hill cities.



4.3.1 Secondary Data

The secondary data collection is data directly collected from the various authorities to compute the indicators. Indicator computation and deriving Level of service mainly rely on the data collected through various agencies.

The secondary data sources have been recorded in the following manner:

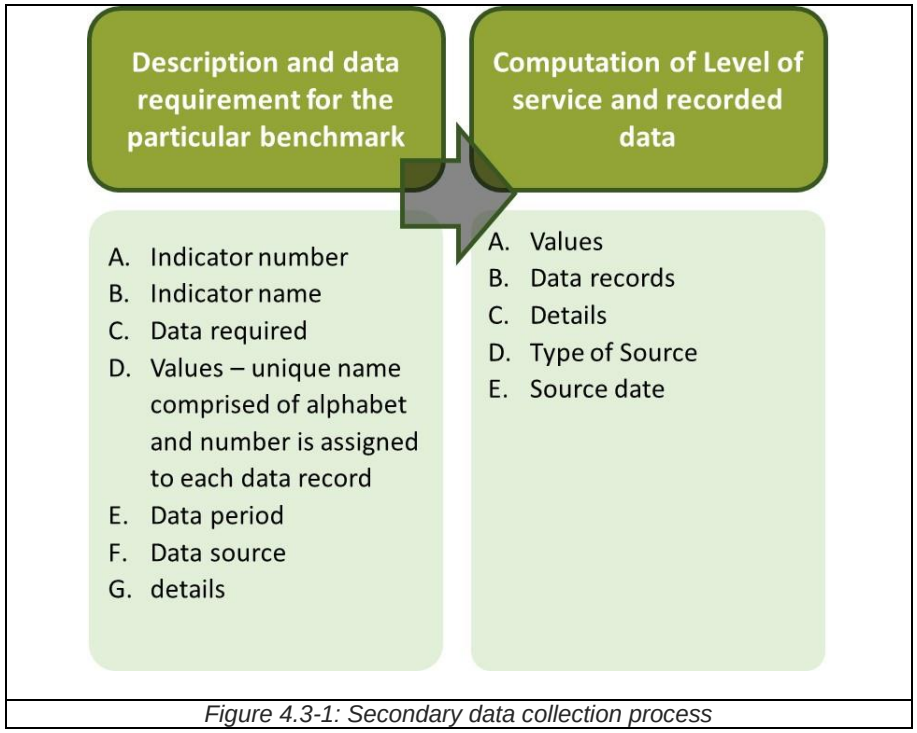


Figure 4.3-1: Secondary data collection process

Secondary analysis: is the data which will be collected from concerned authorities and then further analyzed to achieve the result. For example, for indicator signalized intersection delay: all the signal phasing plans have been collected from traffic police. After that the data is further recorded in secondary sheet, then to compute waiting times for pedestrian to cross the road will require further analysis of the signal phasing time.

The formats prepared to store the secondary/secondary analysis data is given in the annexure.

The list of secondary data that is required to be collected from various agencies and authorities for each Indicator are listed below:

Table 4.3-1: List of Secondary data to be collected

Indicator no	Activity	Data Source
1	Public transport facilities	
I	Total number of buses Fleet on road	Bus operators (STU/SPV/Municipal/Pvt)
2	Number of Buses as per Urban Bus specification	Bus operators (STU/SPV/Municipal/Pvt)
3	Total number of Bus stops	Bus operators (STU/SPV/Municipal/Pvt)
4	No of terminals / interchanges	Bus operators (STU/SPV/Municipal/Pvt)
5	Total Number of routes	Bus operators (STU/SPV/Municipal/Pvt)
6	Bus Routes (frequency & headways)	Bus operators (STU/SPV/Municipal/Pvt)
2	Pedestrian	
1	Total number of signalized intersection	Traffic Police
2	Phasing plan of a signalized intersections in the city	Traffic Police
3	Total number of junctions which are synchronized	Traffic Police
4	Total number of signalized	Traffic Police

Indicator		Activity	Data Source
		junctions with pedestrian phasing	
3		Non-Motorized Vehicle	
	1	Total number of interchanges having NMT (bicycle) parking	Municipality / Traffic police
4		ITS	
	1	No of bus stations / terminals having CCTVs	Bus operators (STU/SPV/Municipal/Pvt)
	2	Total no. of bus stops / terminals having PIS	Bus operators (STU/SPV/Municipal/Pvt)
	3	No. of buses onboard functional GPS / GPRS and connected to common control centre	Bus operators (STU/SPV/Municipal/Pvt)
	4	Total number of modes which have integrated ticketing systems	Bus operators (STU/SPV/Municipal/Pvt)
	5	Total number of signalized intersections having CCTVs	Traffic Police
6		Parking	
	1	List of designated parking areas in the city	Municipality / Traffic police
	2	Total available on street paid parking in ECS (designated by SMC/SUDA)	Municipality / Traffic police
	3	Parking fee minimum and maximum	Municipality / Traffic police
		i) In CBD	
		ii) Whole city	
7		Road safety	
	1	Total number of fatalities in road accidents	Traffic Police
	2	Total number of Pedestrian fatalities in road accidents	Traffic Police
	3	Total number of serious accidents in road accidents	Traffic Police
8		Pollution data	Pollution Control Board
	1	Annual Mean Concentration Range (µg/m3) $S0_2$	Pollution Control Board
	2	Annual Mean Concentration Range (µg/m3) NO	Pollution Control Board
	3	Annual Mean Concentration Range (µg/m3) SPM / (PM10)	Pollution Control Board
	4	Annual Mean Concentration Range (µg/m3) RSPM / (PM2.5)	Pollution Control Board
9		Integrated Land use Transport system	
	1	FSI	MC DCR
	2	FSI along transit corridors	MC DCR
	3	Total length of road network as per development plan	Development Authority/ MC
10		Financial Sustainability	
	1	Revenue collections per annum from non-fare related sources	Bus operators (STU/SPV/Municipal/Pvt)
	2	Non-fare revenue from Advertisement on buses	Bus operators (STU/SPV/Municipal/Pvt)

Indicator	Activity	Data Source
3	Non-fare revenue from Advertisement on bus stations	Bus operators (STU/SPV/Municipal/Pvt)
4	Total revenue per annum from all sources	Bus operators (STU/SPV/Municipal/Pvt)
5	Total Staff (drivers, conductors and supporting staff / officials for operations and maintenance	Bus operators (STU/SPV/Municipal/Pvt)
6	Costs (inc Depreciation , Operation & maintenance, manpower etc)	Bus operators (STU/SPV/Municipal/Pvt)
7	Bus Fare (Distance in Km)	Bus operators (STU/SPV/Municipal/Pvt)
11	IPT	
1	Total number of rickshaws	RTO
2	Total number of auto rickshaws with GPS device	Private / RTO
12	Additional information	
1	Total length of road network as per development plan	Municipal / Development authorities

Apart from the secondary data that have been collected, average waiting time has also been computed from desktop analysis as per SLB's method. In order to further understand this, a reconnaissance survey was conducted in Ahmedabad. It was observed that waiting time is not always half of headway. It varies according to the frequency of services. Therefore to establish this relation between waiting time and headways, a survey was conducted for;

1. <10 minutes
2. 10-20 minutes
3. 20-60 minutes

The bus stop to conduct the survey was selected after studying the public transport routes. The selected stops were:

1. University bus stop
2. Navrangpura bus stop in Ahmedabad where maximum number of the routes with the categorized headways as mentioned above was catered. A sample of 30 was collected for each route during the peak hours (please refer annexure). Finally the relation has been established through regression analysis as given below;

Table 4.3-2: Constant for headways

Headways (minutes)	Constant
<10	0.40
10-20	0.40
>20 - 60	0.29

4.3.2 Primary Data

The collection of primary data has been mainly through various surveys conducted to arrive at the value for calculating the level of service. The list of primary survey that was conducted in each of the 6 cities is as given in the table below:

Sr. no	Service Level Benchmarks	Primary surveys
1	Public Transport facilities	Boarding Alighting Survey

Sr. no	Service Level Benchmarks	Primary surveys
		Level of Comfort in Public Transport (Annexure 6.1.1)
2	Pedestrian Infrastructure facilities	Road inventory survey *(Annexure 6.1.2)*
		-Availability of footpaths
		-Encroachment on foot paths
		- Lux Survey
3	Non-Motorized Transport facilities	Bicycle parking survey at Interchanges *Refer figure 4.2.3*
		-Availability of cycle parking facility within 250m radius of at major bus stops/ Terminals
4	Usage of Integrated Transport System (ITS) facilities	*Not required*
5	Travel speed along major corridors (Motorized & Public Transport)	Speed and Delay survey along major arterials
		-Travel speed of personal vehicles and public transport along Arterial roads (Annexure 6.1.3) (Annexure 6.1.4)
6	Road Safety	Not required
7	Availability of Parking facilities	Road inventory Survey
		-Parking provision in the city (Annexure 6.1.2)
8	Pollution levels	Not required
9	Land Use Transport Integration	Land use and Intensity of development survey along Proposed BRTS corridor *(Annexure 6.1.5)*
		-Mixed land use zoning (% area under nonresidential use)
10	Financial Sustainability of Public Transport	Not required

4.3.3 Corridor selection for Road Network Inventory

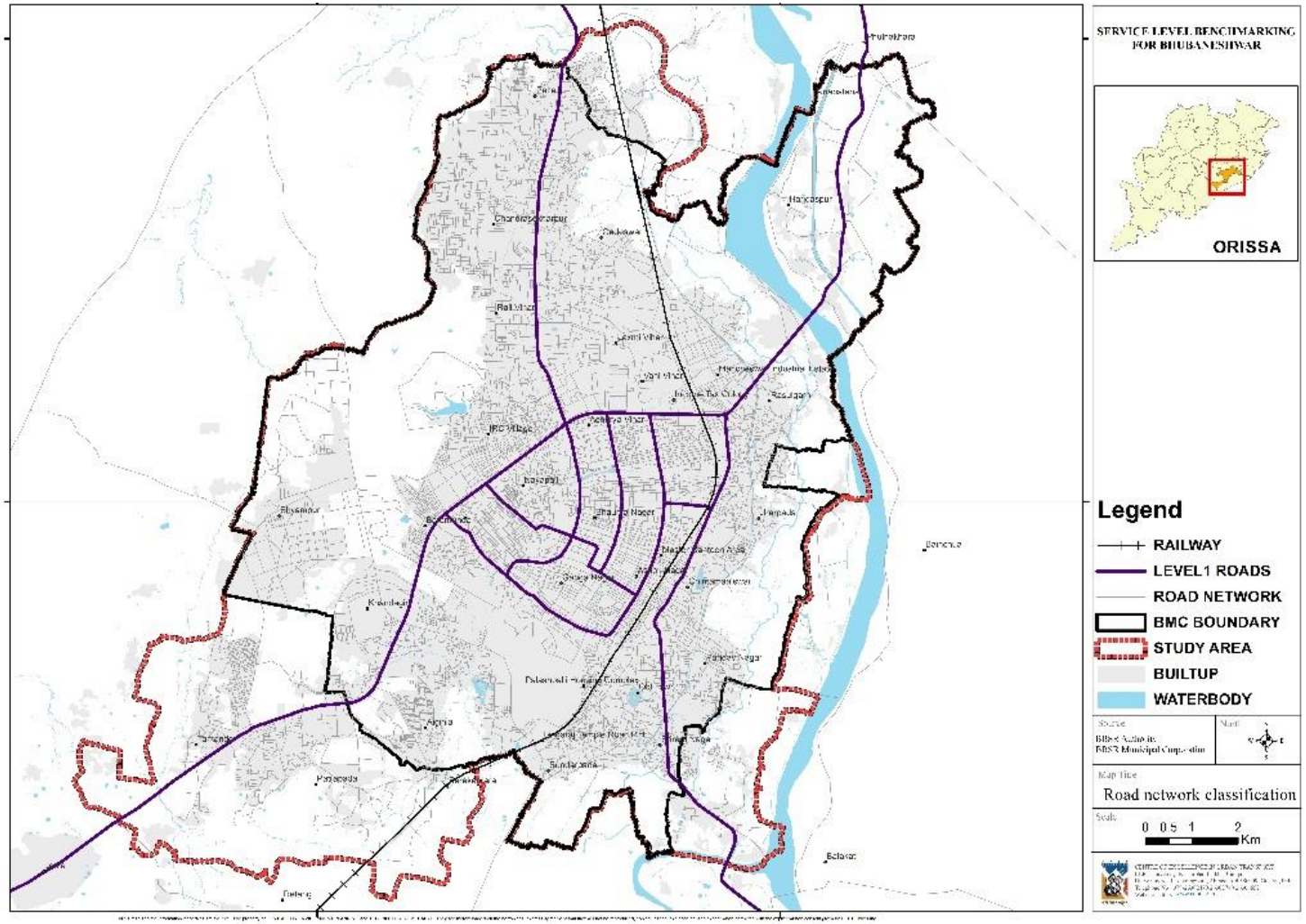
One of the foremost and the most important step in conducting primary surveys is the selection of roads that is needed to be studied and surveyed. Based on this many of the service level benchmarks are to be calculated. Therefore to arrive at the road network selection for survey it was important to develop a common basis for defining the category of roads. Based on this road network for inventory was selected. This definition for cities will vary based on their scale and size.

The cities are divided into four categories-

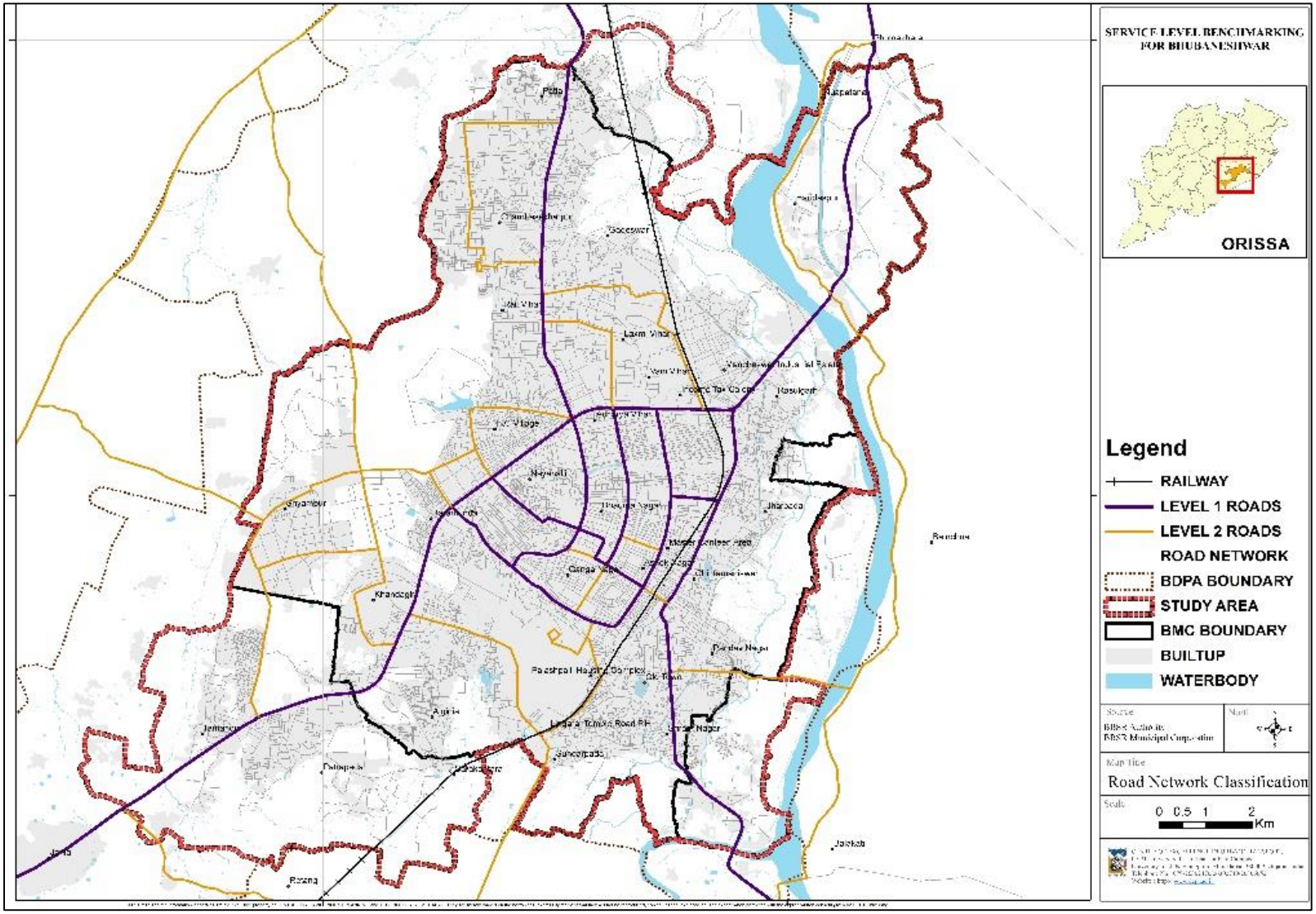
Table 4.3-3: Classification of cities as per population

Category I Cities	**Mega cities**	**>4 million population cities**
Category II Cities	Metro cities	1-4 million population cities
Category III Cities	Other cities I	<1 – 0.2 million population cities
Category IV Cities	Other cities II	< 0.2 million population cities
The above city classification is referenced from JnNURM city classification		

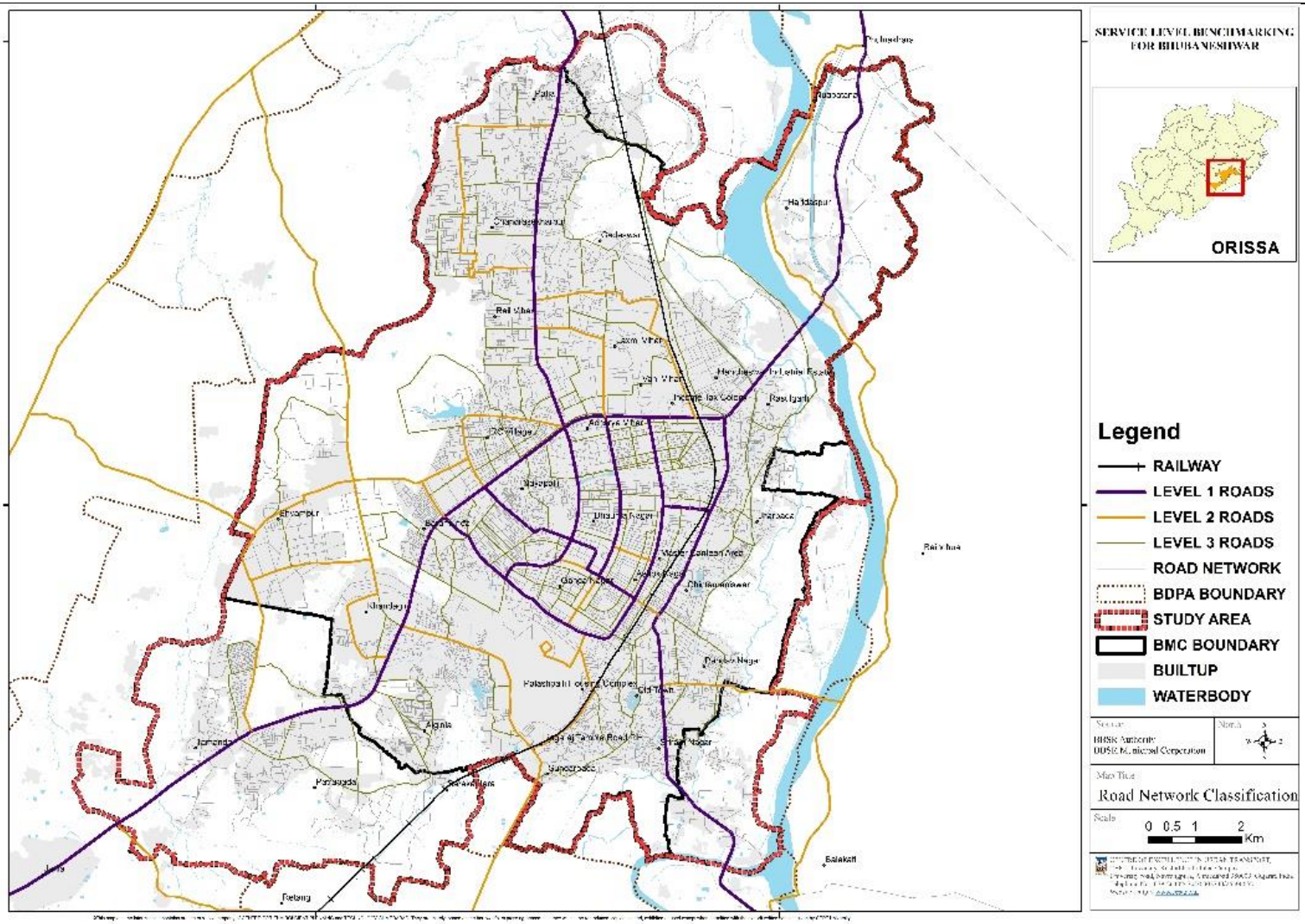
Road Classification	Definition
Level 1 **"ARTERIAL" –** Formulates the pattern or form of the city"	All radials and rings that are 80% completeness National Highway and State Highway Orbital roads that are long and that cut across the city. Roads, which are helping in forming the shape of the city i.e. ring / radials / Grid form OR Roads that have right of way Category I cities: >36m – 60m Category II cities: >24m - 60m Category III cities >9m
Level 2 **"SUBARTERIAL"** -Formulates patterns by further dissecting level 1 roads / Forms grids - patterns	All radials and rings that are 50% complete Radials which are having length less than half of the city (in case of Ahmedabad, radials not originating from walled city connecting straight to SP ring road Long roads (roads having lengths of approximately half or three quarter length to the city size) Major district roads & Other district roads Roads, which are further dissecting level 1 roads and form grids or pattern OR Roads that have right of way Category I cities: >24m - 36m Category II cities: >15m-18m Category III cities >5.5m
Level 3 "**Collector"** – creates blocks	Roads that connect level 1 and level 2 roads Roads, that further create smaller grids OR Roads that have right of way Category I & II cities: > 9m Category III cities <5.5
Level 4 **"Local roads"** – Access to the residents	Roads that connects to residential units. Roads that have right of way < 9m In case of hill cities, footsteps that connect to another level of road are taken as level 4 roads.



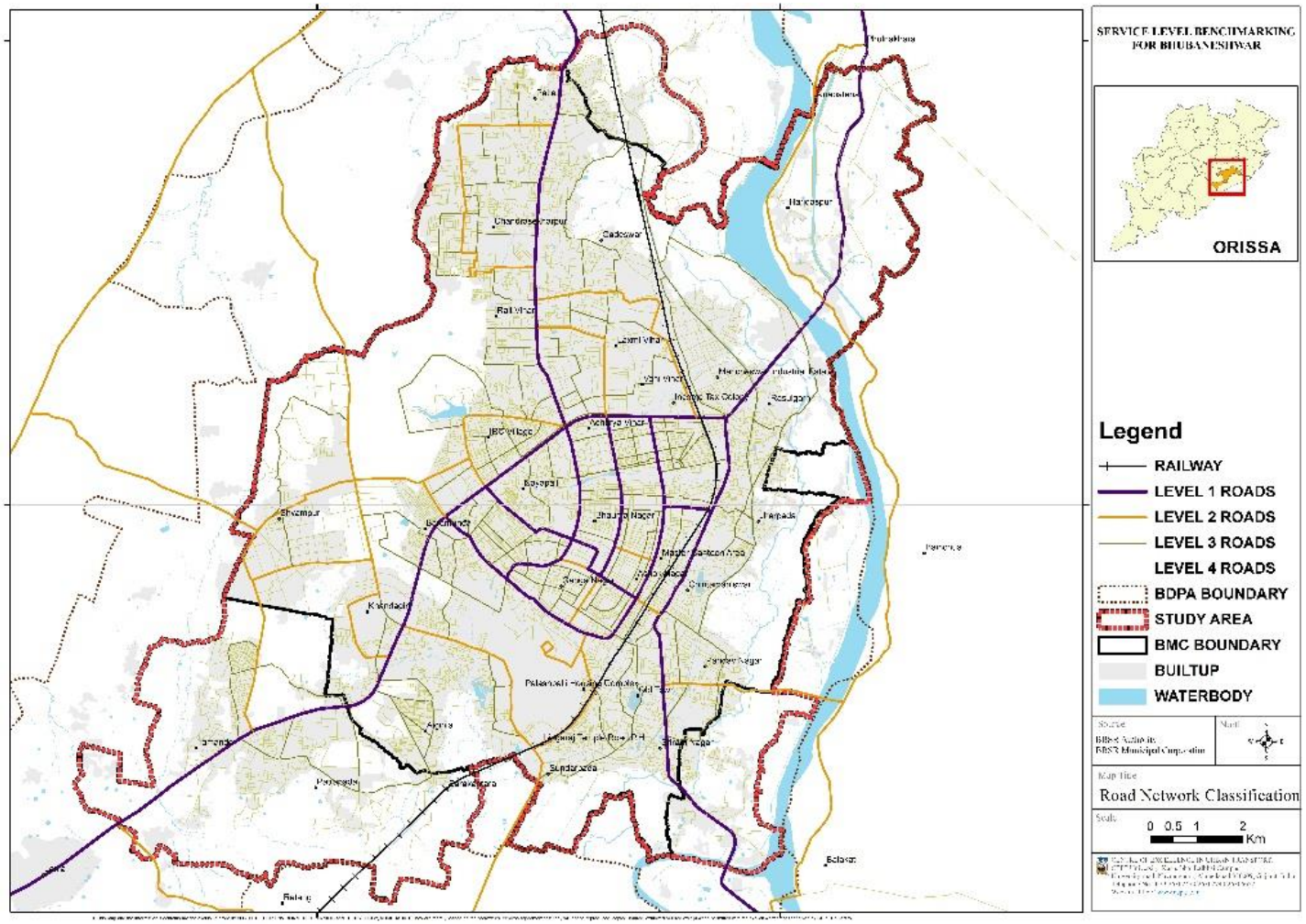
Map 4.3-1: Level 1 roads (Bhubaneswar)



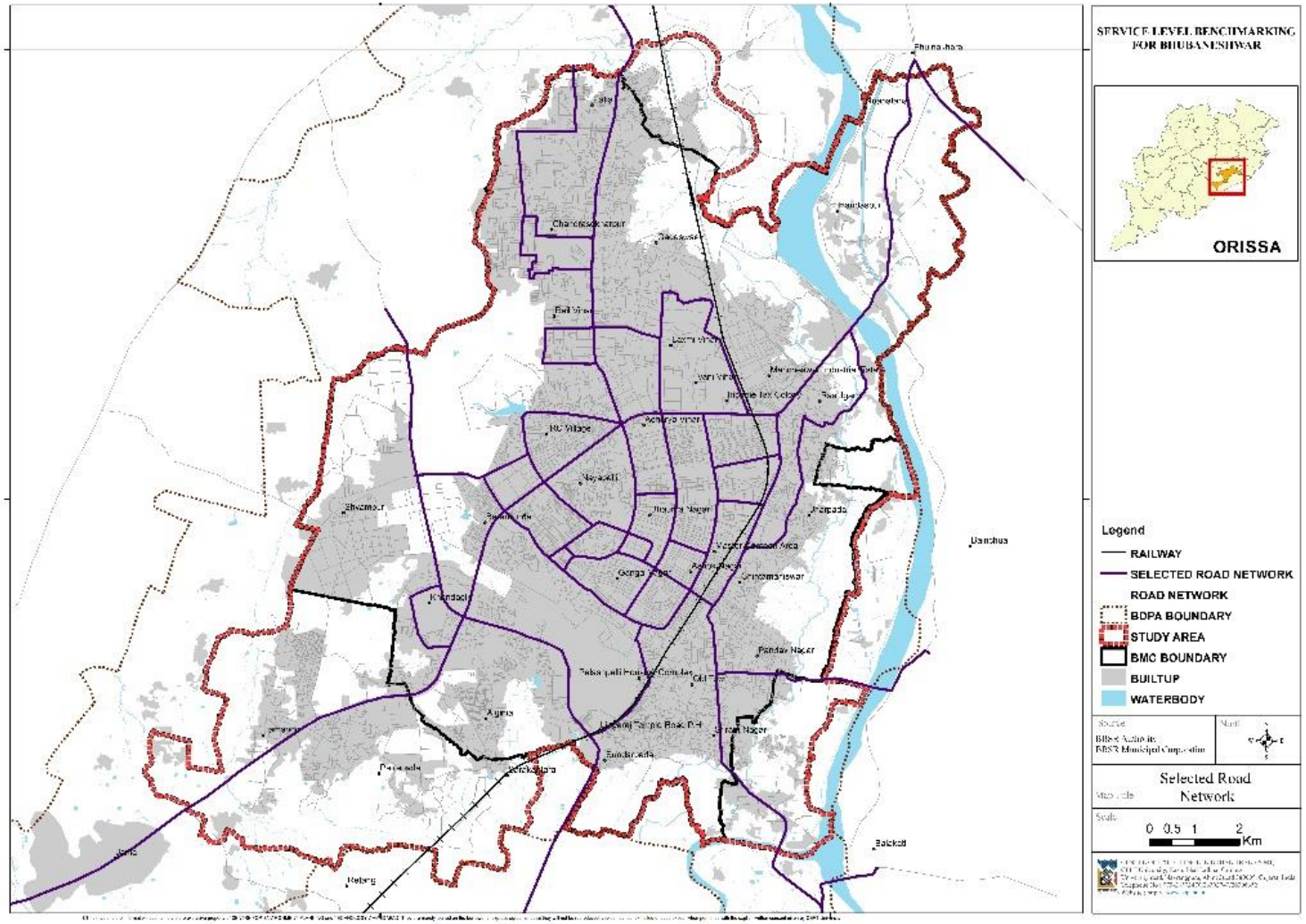
Map 4.3-2: Road network classification - level 2 roads



Map 4.3-3: Level 1,2,3 roads (Bhubaneswar)



Map 4.3-4: Level 1,2,3 & 4 roads (Bhubaneswar)



Map 4.3-5: Selected road network for inventory survey

NOTE: key points that can also be looked into while selecting the road network for road Inventory.

1. IRC road standard is generally used to define network in master plans/DP hence it can be referred for further classifying and justifying the selection.

Rings and radials along with roads having public transport make up the major network in the city.

2. Functional classification of the road.

ROAD INVENTORY

Road inventory survey is conducted on all Level 1 road and also Level 2, Level 3 roads where public transport is plying.

To carry out the survey, ARCGIS is used to create a network of road in links and nodes. Whole city was divided in to grids with a purpose of creating ease for the surveyor while carrying out surveys.

Road network inventory studies are useful in capturing actual road conditions, road designs, and horizontal alignments. In our studies, cycle network length, length of footpaths, road network with high encroachment levels, types of encroachment on major roads, on-street parking provisions are required to compute various indicators.

Field workers complete inventory sheets (primary survey data format provided in the annexure). The data captured on site is then is attached to the GIS files to generate spatial distribution of the existing infrastructure.

The data collected through road network inventory survey:

- Carriageway details on both the sides of the roads
- Shoulder details
- Service road
- Encroachments (type, length, width and nos.)
- Footpath details (Width, Length And Encroachment on Footpath)
- Cycle track details (Width, Length And Encroachment on Footpath)
- On-street parking provision (Type, Width, Length and Nos)
- Street lights

4.3.4 Methodology for primary survey

4.3.4.1 Public Transport facilities

BOARDING ALIGHTING SURVEY (LEVEL OF COMFORT IN PUBLIC TRANSPORT)

The survey was conducted on key public transport corridors in the city. The key public transport corridors were identified based on headways. Headways were categorized into 3 categories to represent an equal sample of all categories of headways that were less than 60 minutes such as;

1. Less than 10 min- Survey all the routes that has less than 10minutes headways
2. 10-20 minutes- only 25% of the routes are selected through random selection
3. 20-60 min- only 25% of the routes are selected through random selection

The survey was conducted in morning and evening peak hours. The number of runs was based on the headway of the route. The maximum value for that particular route was taken as the load in that route.

NOTE: Key public transport corridors are defined as those corridors with service frequency less than 60 minutes as there is higher demand of public transport along these corridors.

4.3.4.2 Pedestrian Infrastructure facilities

LUX SURVEY

The LUX survey was conducted taking 12 point method field measurements as shown in the figure below:

In Typical road section with centre pole and two lamps on each side of the road, 12 readings have been taken,

- 3 on the edge of median,
- 3 in the mid carriageway and
- 3 on the edge of carriageway (or footpath if any).
- 3 more will be on shoulder or footpath whichever is present.

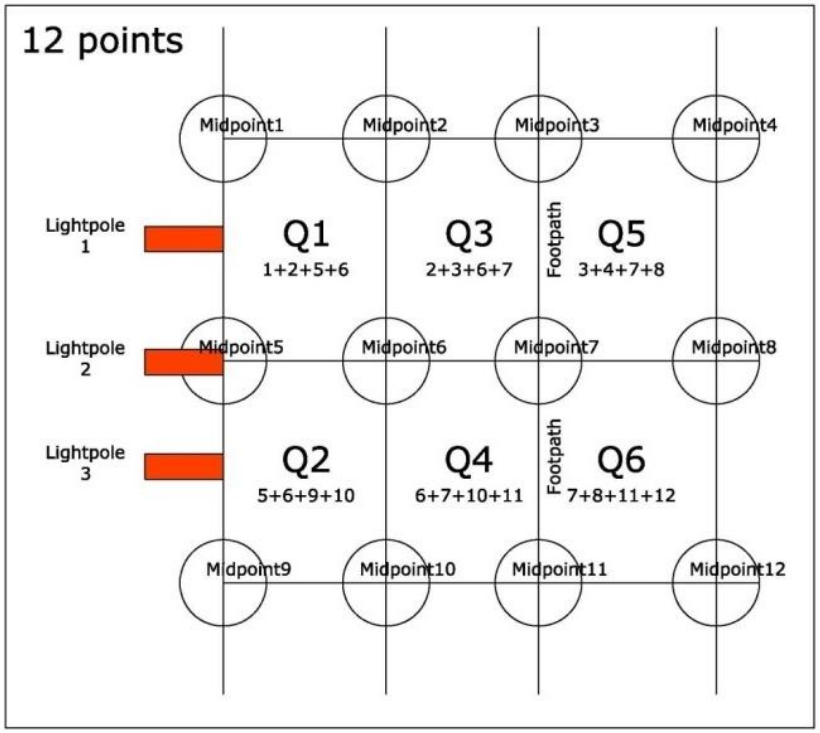
This 12 reading method of measurement will change with the change in the arrangement of the lighting. The different type of lighting arrangements that a city can have are (as shown in figure below):-

- LUX reading locations at junctions
- LUX reading locations on road section having service road / footpath / shoulder.
- Divided road where light poles are present only on one side of road

After measuring all the readings at the points shown above, the average of each of the quadrant is taken. Typically, the reading of lux is given by the average

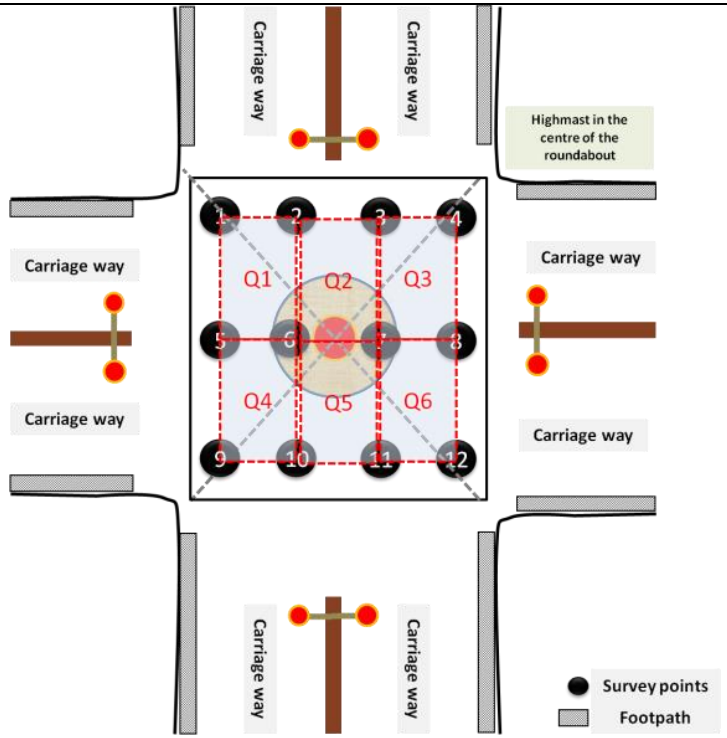
- of all six quadrants for roads
- of two quadrants for footpath

Lighting arrangement	Pole 1	Mid-Point	Pole 2
Edge of the road near light	P1	P2	P3
Mid road	P6	P5	P6
opposite edge of the road	P7	P8	P9
Edge of footpath/ shoulder	P12	P11	P10
Edge of footpath/ shoulder	P12	P11	P10



(i) LUX (road)= Q1+Q2+Q3+Q4+ Q5 + Q6 /6
(ii)Lux (footpath) = (Q5+Q6)/ 2

LUX reading locations (typical road sections)



(I)Lux (road) = (Q1+Q2+Q3+Q4+Q5+Q6)/6
(ii) lux (footpath) = (Q1+Q3+Q4+Q6)/ 4

LUX reading locations at junctions

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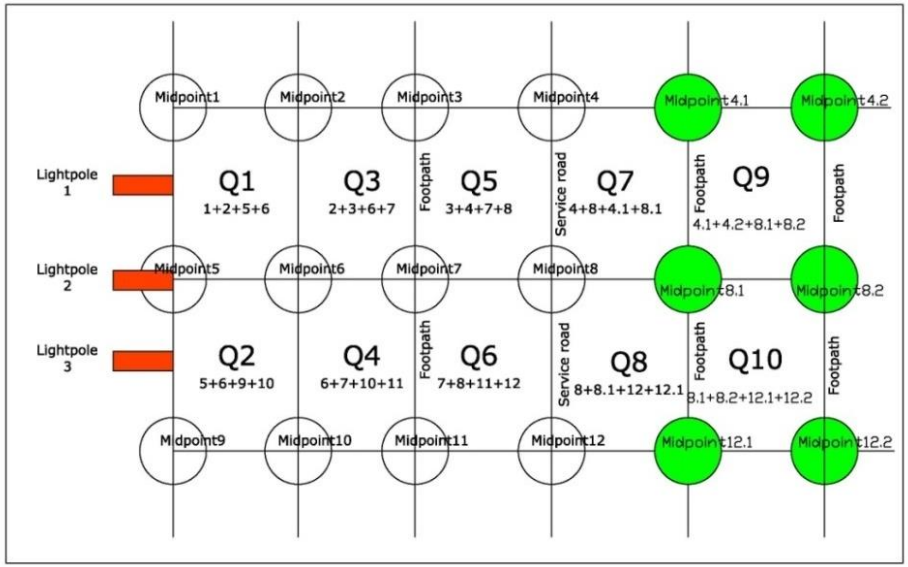
<tr>
<td> 
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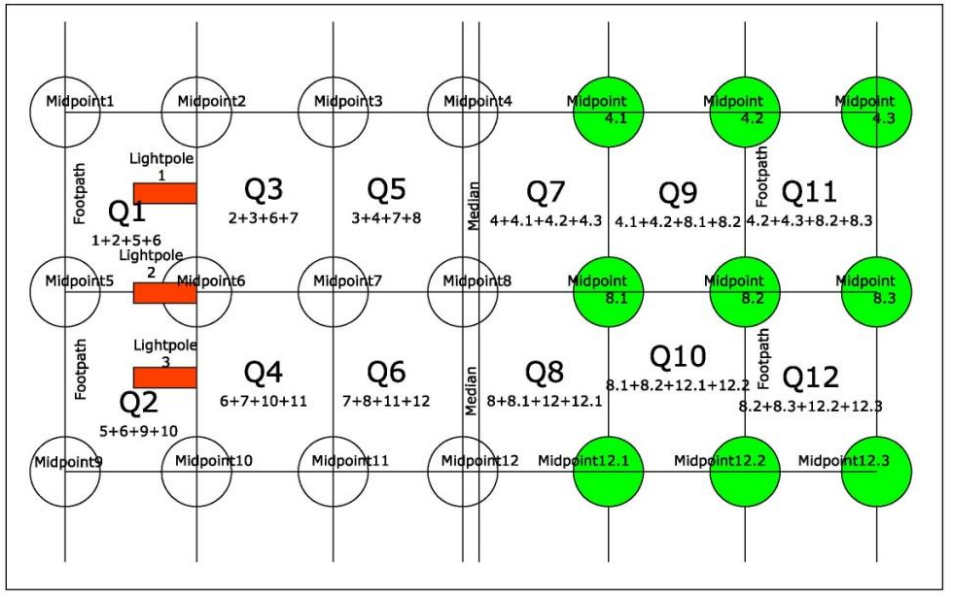
<td> 
</td>
</tr>
<tr>
<td>(I)LUX(road) = (Q1+Q2+Q3+Q4+Q5+Q6+Q7+Q8)/8
(II)Lux (footpath) = (Q7+Q9+Q8+Q10)/ 4</td>
<td>(I) LUX road = (Q3+Q4+Q5+Q6+Q7+Q8+Q9+Q10)/8
(II) Lux (footpath) = (Q9+Q10+Q11+Q12)/ 4</td>
</tr>
<tr>
<td>LUX reading locations on road section having service road</td>
<td>Divided road where light poles are present only on one side of road</td>
</tr>
<tr>
<td>LUX reading locations on road section having service road</td>
<td>Divided road where light poles are present only on one side of road</td>
</tr>
</table>

4.3.4.3 Non-Motorized Transport facilities

BICYCLE PARKING SURVEY AT INTERCHANGES

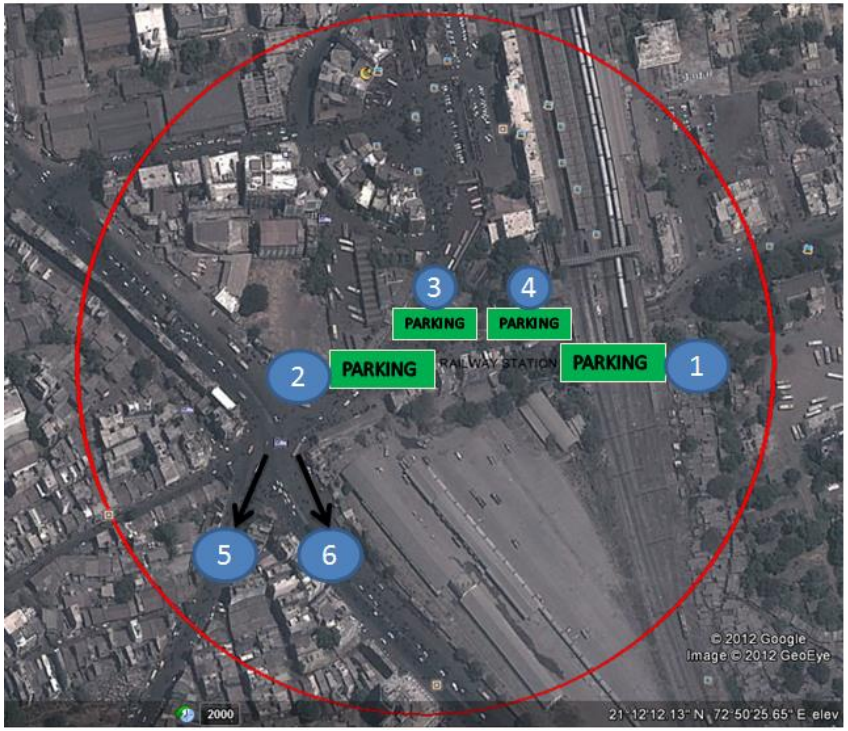
The survey was conducted at 250m radius of the Interchanges. Interchanges are defined in terms of both the (i) importance of "nodes" example Major bus terminals and the (ii) number of "modes" meeting at a place example Railway station. It includes; major bus stops, terminals and railway stations.

After selection of the interchanges to be surveyed, in 250m radius of the interchange for identification of the bicycle parking locations present in the radius of 250m. (refer figure below)
The data collected:

- Locations of cycle parking in 250m buffer
- Capacity of the cycle parking

Width and length of the cycle parking

NMV Parking Facility Available?	
Yes ✓	No
If Yes	
Area (Sq.m)	Accumulation (No.)
1) (4.90X5)=24.5, 2) (4.90X5)=24.5, 3) (3.5X4.2)=14.7, 4) 3.4X4.2)=14.7	1) 7-15, 2) 10-15, 3) 10-10, 4)7-10



1. Near GRP Mandir- Yes
2. Near Fast food Parking- Yes
3. SMC Pay Park (Near Platform No 4) –Yes
4. Print Parking (Near Platform No 4)- Yes
5. Amisha Hotel (One Way)- No
6. Daruwala Petrol Pump- No

Figure 4.3-2: NMV parking survey format

4.3.4.4 Travel speed along major corridors (Motorized & Public Transport)

SPEED AND DELAY SURVEY ALONG MAJOR ARTERIALS

Speed delay survey was conducted along the arterial roads in the city. A stop watch and GPS was used for the survey. The speed and delay survey was conducted for three modes of private vehicles namely; (i) Car (ii) 2wheeler (iii) Auto rickshaw (3Wheeler) and as for the public transport (i) City Bus service (ii) BRT.

Speed and delay survey is done on the same road network which has been selected for inventory survey as given in the Map 4.3.5. For PT, the routes have been selected where buses are plying on the same corridors used for private vehicles.

As per methodology mentioned in IRC:SP:19-2001:

The study is conveniently conducted by the "Moving Observer" method, a test vehicle runs along with the traffic stream, at approximately the perceptible average speed of the traffic stream. A separate run is taken for each direction. The average of six runs have been taken for each corridor.

Actual running time and stopped delays have been noted down while carrying out the survey, delay locations have been marked with the help of GPS.

4.3.4.5 Integrated land use transport system

LAND USE AND INTENSITY OF DEVELOPMENT SURVEY ALONG PROPOSED BRTS CORRIDOR

The purpose of this survey was to find out the proportion of non-residential properties along the BRT corridors. A buffer area of 250metre on either side of BRT corridor was taken for the study. Before going onsite the type of land use that was in that particular plot of land was studied from the land use plan acquired from the concerned authorities. In comparison to this information received the existing land use was noted. In addition to not only study the non-residential properties along the BRT corridor, the building height was also recorded. While in the case of Ahmedabad the BRTs have started in the city, other cities like Surat, Hubli-Dharwad have also been surveyed along the under construction phase. For other city with no BRTs, the major bus routes are under consideration for surveying the land use survey

BRT Corridors are divided in the grid format, to study the existing land use in individual plots. All the plots have been given one unique id, with the idea of combining collected data with the GIS files. Along with the individual grid maps, one table of all the plot numbers with existing land use is prepared. With the help of these two documents, surveyors could identify the present land use and recorded it. If the survey plots have been divided in to two to three plots, then predominant use of the parcel is recorded.

Data collected:

1) Present land use
2) Building heights

5 Data Management

5.1 Software Development

The Data collection and Reporting tool (SLB - UT) is a web browser based application accessible through internet connection. The tool delivers Urban Transport scenarios of various cities in scope covering 11 benchmarks, set for service level delivery.

This software will provide a web-based tool will hold city wise data for year wise data entry for each parameter. The tool will be available for decision-making authorities, data administrator and public. Software will provide a platform for comparison of SLBs – city-wise, parameter wise and year-wise. It will also provide a platform for management and authorization of the data through user access control.

This software will provide an easy tool for the following stakeholders:

- Central government - The ministry of Urban Development & GOI
- State Governments and its agencies
- Urban Local Bodies / Parastatal agencies
- Other decision-making/governance bodies
- External departments (for interface requirements)

The Dashboard in the software presents the data in very intuitive and easy-to-understand formats. This will help the MoUD personnel to view the snapshot of various data's within and across the Cities in scope in terms of graphs and statistics.

Dashboard for the purpose of this project has been classified under the following heads:

- Tabular reports
- Graphical Charts
- Geographical view of SLB using maps, etc.

5.2 Importance

It is important to create one platform which will help user to store the data, analyze the data to compute level of service for particular city and also to compare the results with other cities, current year results with future years. This software will also provide a tool to replicate the data for future year, modify or add completely new data for the LoS computation. In addition, it is web based tool, and has user access control. This tool will authorize permissions / rights based on the type of users i.e. data entry, ULB, State government agency and central government. It also helps in maintaining year-wise records of the data.

5.3 Benefits

- Enhanced tool to facilitate decision making on the Service Level for all the cities in scope.
- Enhanced tool for data entry with high amount of validation and ease of operations
- Enhanced ability to analyze the service level quality of all the benchmarks at city-level.
- A collaborative knowledge-oriented environment where knowledge is shared across different regions and units.
- Better co-ordination and communication with external stakeholders through implementation of electronic information exchange systems.
- Quick exchange of accurate information with the Stakeholders

5.4 System Requirements & Application

The web application is designed for Microsoft Internet Explorer 8.0 or higher, Mozilla Firefox or higher and Google Chrome 25.0 or higher. The web application will perform best on computers with a high-speed internet connection similar to digital subscriber line (DSL), cable, or faster. The screen resolution set to 1024x768.

This application will be available on CoE UT, CEPT University servers, thus making it possible to interact with complex data on nearly any computer with a web browser till a final decision on where it is hosted is taken by MoUD. *(Refer Part 4 of SLB Series)*

6 Data Formats

6.1 Primary survey formats

6.1.1 Level of Comfort in Public Transport

LEVEL OF COMFORT IN PUBLIC TRANSPORT					
City:					
Name of the surveyor			Date		
Mode	Public transport / Rapid transit		Survey time		
Route No.		Direction:			
Sr no.	Bus stops	Passengers Boarded		Passengers Alighted	
		Male	female	Male	female
Exp	*Lal Darwaja Terminus*				

6.1.2 Road inventory survey

Surveyor's Name					DATE OF SURVEY			TIME OF SURVEY					
From	To	Length (mt)	Right of way (mt)	Name of the road	Median (Width in mt)	Carriage way Left_ (Type)	Carriage way Left width (mt)	Lanes Left (no.)	Carriage way Right (Type)	Carriage way Right width (mt)	Lanes Right (no.)		

Side	Shoulder		Service Road		Grade Separation		BRTS Carriageway	Encroachment on road				Footpath		Encroachment on footpath				Cycle track		Encroachment on Cycle track				Parking Provision				No. of Street lights
	Type (BT/CC/ER/GR)	Width (mt)	Width (mt)	Length (mt)	Width (mt)	Length (mt)	width (mt)	Type	No	Width (mt)	Length (mt)	Width (mt)	Length (mt)	Type	No.	Width (mt)	Length (mt)	Width (mt)	Length (mt)	Type	No	Width (mt)	Length (mt)	Type	No	Width (mt)	Length (mt)	
L																												
L																												
L																												
R																												
R																												
R																												

1 = Bituminous 2= Cement Concrete 3=Earthen 4=Gravel	Type of Encroachment 1=Shops 2=Hawkers 3=parking 4=others	Type of Parking F=Free parking P= Paid	

6.1.3 Speed Delay Survey (Private Vehicles)

SPEED AND DELAY SURVEY

Name of Project : **Service level Benchmark for Urban Transport**

Mode:

Trial Run No.: **Date:** **Surveyor Name:**

Run Direction:

Road Name: **Day:** **Surveyor Sign:**

Test Vehicle No:

Run Starting Time: **Run Ending Time:**

UP (1st Round)

Corridor Link		Name of Road	Map No.	Length (m)	Odometer Reading		Running Time (Sec.)		Stopped Delay (Sec.)	Total Time (Sec.)	Delay location	Cause of Delay
From	To				Start	End	Start	End				
1	2											
2	**3**											

DOWN (2nd Round)

Corridor Link		Name of Road	Map No.	Length (m)	Odometer Reading		Running Time (Sec.)		Stopped Delay (Sec.)	Total Time (Sec.)	Delay location	Cause of Delay
From	To				Start	End	Start	End				
3	2											
2	1											

UP (3rd Round)

Corridor Link		Name of Road	Map No.	Length (m)	Odometer Reading		Running Time (Sec.)		Stopped Delay (Sec.)	Total Time (Sec.)	Delay location	Cause of Delay
From	To				Start	End	Start	End				
1	2											
2	**3**											

DOWN (4th Round)

Corridor Link		Name of Road	Map No.	Length (m)	Odometer Reading		Running Time (Sec.)		Stopped Delay (Sec.)	Total Time (Sec.)	Delay location	Cause of Delay
From	To				Start	End	Start	End				
3	2											
2	1											

UP (5th Round)

Corridor Link		Name of Road	Map No.	Length (m)	Odometer Reading		Running Time (Sec.)		Stopped Delay (Sec.)	Total Time (Sec.)	Delay location	Cause of Delay
From	To				Start	End	Start	End				
1	2											
2	**3**											

DOWN (6th Round)

Corridor Link		Name of Road	Map No.	Length (m)	Odometer Reading		Running Time (Sec.)		Stopped Delay (Sec.)	Total Time (Sec.)	Delay location	Cause of Delay
From	To				Start	End	Start	End				
3	2											
2	1											

6.1.4 Speed Delay Survey (Public Transport)

SPEED AND DELAY SURVEY

Name of Project : Service level Benchmark for Urban Transport
Mode:
Trial Run No.: Date: Surveyor Name:
Run Direction:
Road Name: Day: Surveyor Sign:
Test Vehicle No:

Run Starting Time: Run Ending Time:

UP (1st ROUND)

S.No.	Route No.	Node From	Node To	Running Time		Delay Time	Cause of Delay
				Start Time	End Time		
1							
2							
3							

DOWN (2nd ROUND)

S.No.	Route No.	Node From	Node To	Running Time		Delay Time	Cause of Delay
				Start Time	End Time		
1							
2							
3							

UP (3rd ROUND)

S.No.	Route No.	Node From	Node To	Running Time		Delay Time	Cause of Delay
				Start Time	End Time		
1							
2							
3							
4							
5							

DOWN (4th ROUND)

S.No.	Route No.	Node From	Node To	Running Time		Delay Time	Cause of Delay
				Start Time	End Time		
1							
2							
3							

UP (5th ROUND)

S.No.	Route No.	Node From	Node To	Running Time		Delay Time	Cause of Delay
				Start Time	End Time		
1							
2							
3							

DOWN (6th ROUND)

S.No.	Route No.	Node From	Node To	Running Time		Delay Time	Cause of Delay
				Start Time	End Time		
1							
2							
3							

6.1.5 Land use Survey

LAND USE SURVEY			
U_ID	CATEG_2011	Land use observed_2012	Building heights
1			
2			
3			
4			
5			
6			

Sr.no	Land Use Type
1	**Residential**
	Apartments / flats, row houses, tenements
2	**Mixed Use**
	Shop houses, retail/office/residential complex
3	**Commercial**
	e.g. shopping mall, dept. store, big box stores, fully-serviced office block,
4	**Industrial**
	major industry, e.g. steel plant, petrochemical, warehouses,
5	**Institutional**
	offices, legislative, executive, judicial, schools, institutes, universities, hospitals, clinics
6	**Agriculture**/forestry/aquaculture
7	**Open Space (OS)**
	Open ground
8	**Water body**
	Water (lakes, ponds) + wastewater
9	**Others**
	Recreational-gardens , Religious – temples / mosque / Church, Socio Cultural –Institutional, Crematorium, solid waste dumping side

6.2 Secondary survey formats

Secondary Data Collection					
Public Transport facility					
Department : Bus operators *i.e. AMTS, Janmarg etc.*			**City:** *i.e. Ahmedabad*		
Name Of Contact Person & Designation:					
Sr. No.	**Particulars**	**Details**		**Source date** ***i.e. Month, year***	**Data source time period** ***i.e. for a month or year***
1	**Routes**				
1.1	Total number of routes (operating)				
1.2	Routes schedule with headways				
1.3	Number of routes below <=5mins headway				
1.4	Number of routes below 5-10 minutes headway				
1.5	Number of routes below 10-15 minutes headway				
1.6	Number of routes below 15-20 minutes headway				
1.7	Number of routes below 20-25 minutes headway				
1.8	Number of routes below 25-30 minutes headway				
1.9	Number of routes below >=30 minutes headway				
2	**Bus stops**				
2.1	Total number of bus stops				
2.2	Bus stop properties i.e. poles, bus shelter				
2.3	Total number of terminals & depots	Terminals	Depots		
	Names				
	Names				
	Names				
	Names				
	Names				
2.4	Interchanges with PIS information				
2.5	Number of bus stops / interchange / terminals or Depots				

Secondary Data Collection				
Public Transport facility				
Department : Bus operators *i.e. AMTS, Janmarg etc.*			**City:** *i.e. Ahmedabad*	
Name Of Contact Person & Designation:				
Sr. No.	**Particulars**	**Details**	**Source date** ***i.e. Month, year***	**Data source time period** ***i.e. for a month or year***
	having CCTVs			
3	**Buses**			
3.1	Total number of buses – bus fleet			
3.2	Total number of buses on road (average of 30 days)			
3.3	Type of buses (standard buses, mini buses, midi buses)			
3.4	Number of buses as per UBS			
3.5	Number of buses having onboard GPS/GPRS and connected to common control center			
3.6	Number of breakdowns in a month / year			
3.7	Number of modes with integrated ticketing systems			
4	**Financial sustainability**			
4.1	Revenue collections per annum from non-fare related sources			
4.2	Non-fare revenue from advertisement on buses / bus stops			
4.3	Total revenue per annum from all the sources			
4.4	Total cost of operations (inclusive of depreciation, operation & maintenance and manpower etc)			

Secondary Data Collection				
Public Transport facility				
Department : Bus operators *i.e. AMTS, Janmarg etc.*			**City:** *i.e. Ahmedabad*	
Name Of Contact Person & Designation:				
Sr. No.	**Particulars**	**Details**	**Source date** ***i.e. Month, year***	**Data source time period** ***i.e. for a month or year***
4.5	Fare structure (fares per kilometers)			
4.6	Total boardings per annum			
4.7	Cost operated kilometers (revenue kilometers and dead kilometers)			
4.8	Total staff haired (drivers, conductors, supporting staff, administrative staff and officials for operations and maintenance)			

Secondary Data Collection				
Traffic police				
Department : Traffic police *i.e. police station name*			**City:** *i.e. Ahmedabad*	
Name Of Contact Person & Designation:				
Sr. No.	**Particulars**	**Details**	**Source date** ***i.e. Month, year***	**Data source time period** ***i.e. for a month or year***
1	**Signalised Intersection**			
1.1	Total number of major intersection in the city			
1.2	Total number of signalized intersection in the city			
1.3	Total number of signalized intersections with pedestrian phasing			
1.4	Phasing plans for the signalized intersections			

Secondary Data Collection

Traffic police

Department : Traffic police *i.e. police station name*	**City:** *i.e. Ahmedabad*
Name Of Contact Person & Designation:	

Sr. No.	Particulars	Details	Source date *i.e. Month, year*	Data source time period *i.e. for a month or year*
1.5	Number of intersections with traffic police enforcement			
1.6	Number of signals which are synchronized			
1.7	Number of intersections with CCTVs installed			
2	**Parking**			
2.1	List of on-street parking facilities			
2.2	Total available on street paid parking facilities			
2.3	Parking fees 1) In core city area 2) Whole city			
3	**Accidents**			
3.1	Total number of fatal accidents recorded in road accidents			
3.2	Total number of fatalities in road accidents			
3.3	Total number of pedestrian fatalities in road accidents			
3.4	Total number of serious injuries recorded in road accidents			

Secondary Data Collection				
Pollution control board				
Department : Pollution control board *i.e. GPCB*			**City:** *i.e. Ahmedabad*	
Name Of Contact Person & Designation:				
Sr. No.	**Particulars**	**Details**	**Source date** ***i.e. Month, year***	**Data source time period** ***i.e. for a month or year***
1	**Pollution control monitoring records**			
1.1	Total number of monitoring stations in the city			
1.2	Annual Mean Concentration Range (µg/m3) $S0_2$			
1.3	Annual Mean Concentration Range (µg/m3) NO_x			
1.4	Annual Mean Concentration Range (µg/m3) SPM / (PM_{10})			
1.5	Annual Mean Concentration Range (µg/m3) RSPM / ($PM_{2.5}$)			

Secondary Data Collection				
Regional Transport Office				
Department : RTO *i.e. RTO, Ahmedabad*			**City:** *i.e. Ahmedabad*	
Name Of Contact Person & Designation:				
Sr. No.	**Particulars**	**Details**	**Source date** ***i.e. Month, year***	**Data source time period** ***i.e. for a month or year***
1	**Regional Transport Office**			
1.1	Total number of vehicles registered			
1.2	Total number of auto rickshaws with GPS installed			

Secondary Data Collection				
Municipal corporations / Development Authorities				
Department : Municipal Authorities *i.e. AUDA/AMC*			**City:** *i.e. Ahmedabad*	
Name Of Contact Person & Designation:				
Sr. No.	**Particulars**	**Details**	**Source date** ***i.e. Month, year***	**Data source time period** ***i.e. for a month or year***
1	**Area information**			
1.1	Areas of municipal boundary			
1.2	Total number of wards / zones			
1.3	Wards/zones/villages boundaries			
1.4	Population as per current census – zone wise			
1.5	Existing Land use			
2	**Road network**			
2.1	Total length of road network			
2.2	RoWs of existing road network			
2.3	Existing classification of the road network if any.			
2.4	List of existing bridges, flyovers and railway bridges and underpasses in the city			
3	**NMT Parking**			
3.1	NMT parking facilities provided at interchanges			
	Names	Capacity		
	Names	Capacity		
	Names	Capacity		
	Names	Capacity		
	Names	Capacity		
4	**Parking**			
4.1	List of on-street parking facilities			
4.2	Total available on street paid parking facilities			

Secondary Data Collection				
Municipal corporations / Development Authorities				
Department : Municipal Authorities *i.e. AUDA/AMC*			**City:** *i.e. Ahmedabad*	
Name Of Contact Person & Designation:				
Sr. No.	**Particulars**	**Details**	**Source date** ***i.e. Month, year***	**Data source time period** ***i.e. for a month or year***
1	**Area information**			
1.1	Areas of municipal boundary			
1.2	Total number of wards / zones			
1.3	Wards/zones/villages boundaries			
1.4	Population as per current census – zone wise			
1.5	Existing Land use			
2	**Road network**			
2.1	Total length of road network			
2.2	RoWs of existing road network			
2.3	Existing classification of the road network if any.			
2.4	List of existing bridges, flyovers and railway bridges and underpasses in the city			
4.3	Parking fees 3) In core city area 4) Whole city			
5	**Integrated Land use & Transport system**			
5.1	FSI			
5.2	FSI along transit corridors			

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