



Ministry of Housing and Urban Affairs  
Government of India



# Availability of Public Transport

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## TRAINING MANUAL



**ClimateSmart Cities Assessment Framework**  
**Mobility and Air Quality**





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Mobility and Air Quality

## **Availability of Public Transport**

Training Manual

### **Developed by**

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# Executive Summary

On one hand, cities are a significant contributors of carbon emissions aggravating climate change and on the other, cities are considerably impacted by climate disasters. The recently released Global Climate Risk Index 2021 ranks India as the 7th most affected country from climate related extreme weather events (storms, floods, heatwaves etc.). Further, studies indicate that poor planning and urban management are expected to cost Indian cities somewhere between \$2.6 and \$13 billion annually.

Cities are increasingly at the forefront of addressing both urbanization and climate change and to strengthen climate-sensitive urban development, a holistic understanding of the urban development from a climate lens is crucial. The ClimateSmart Cities Assessment Framework (CSCAF) launched in 2019 by the Ministry of Housing and Urban Affairs (MoHUA), Government of India aimed to address this gap. This first-of-its-kind assessment with 28 progressive indicators across 5 thematic areas helps cities to benchmark their development, understand the gaps and further prioritize climate relevant development.

With a focus on building local capacities to develop and adopt climate measures, the Climate Centre for Cities (C-Cube) at the National Institute of Urban Affairs (NIUA) initiated a series of training aligned to the thematic areas of CSCAF - Energy and Green Buildings, Urban Planning, Green Cover & Biodiversity, Mobility and Air Quality, Water Management, Waste Management. The focus of the training is to provide a step-by-step approach of conducting studies, assessments, and stakeholder consultations, establishing committees, developing action plans, and implementing relevant measures that not only makes the cities climate resilient but also helps them progress across the assessment of CSCAF. The training on the '**Availability of Public Transport**' under the thematic areas of Mobility and Air Quality in the CSCAF is developed in association with the World Resources Institute, India.

Mere presence of Public Transport Systems in a city does not guarantee equitable opportunity of its use to city residents. Public Transport Availability indicator is a tool which can be used to assess whether the existing system is adequate for the city. This indicator may also be leveraged to determine exactly what magnitude of public transport presence is required for making transport available to all.



Quantifying benchmarks for Public Transport (PT) availability can be challenging for individuals not well versed with the technical side of transportation. Especially in India, terminologies inherent with PT systems' design are not translated down to operations. This may largely be due to a lack of technical capacity building in the entities which are authorized to overlook PT networks in Indian cities. Due to this people who are intended to monitor PT operations remain unaware of technical tools needed to perform their duties.

This manual's objective is 4-fold,

- To familiarize the readers with the concept of "Availability of Public Transport" and its calculation,
- To showcase data sources from which required data can be acquired or inform the methods which can be used to calculate the required data,
- To demonstrate how "Availability" metric can be leveraged to calculate fleet size required to service the community better,
- To acquaint the readers with the opportunities which can be accessed for increasing Availability in their respective cities.

This manual intends to equip the readers with the knowledge they require to assess availability of PT in their cities. It attempts to familiarise the readers with the concepts of Public Transport Availability, Passenger Transit Unit (PTU), PTU conversion factors, population growth rate calculations, and population forecasting. On the successful consumption of information available in this manual, the reader shall be able to:

- Calculate the current or previous PT availability in their respective cities.
- Predict the required PT fleet size to successfully cater to the current or future travel demand in their city.

The manual uses simple, relatable examples and sets up an easy-to-follow step-by-step guide for calculating availability. A visual basic enabled Microsoft Excel tool will also be made available to the reader for making faster calculations.





Who is the training manual designed for?



What is the focus of the training manual?



How to make use of this manual?



What are the Learning outcomes of the training?



Scope and limitations of the training



This training manual will inform officers of Urban Local Bodies, (Various government departments in the city like the Collectorate, Unified Metropolitan Transport Authorities, State Road Transport Undertakings, Town and Country Planning, Smart City Mission, Municipal corporation etc.) who are tasked with operating public transport services in their respective cities. However, following stakeholders can also refer to the manual for calculating public transport availability:

- Field experts
- Transport Planners/ Students
- Academic institutions

This manual attempt to inculcate the following skills to the reader,

1. Identifying available PT in a city,
2. Gathering data pertaining to the PT network and the city demographics,
3. Calculating PTU scores for CSCAF to understand the performance of cities,
4. Calculating the fleet size for the current and future population.

The readers may use this manual as a step wise guide for understanding concepts related to Public Transport availability calculation

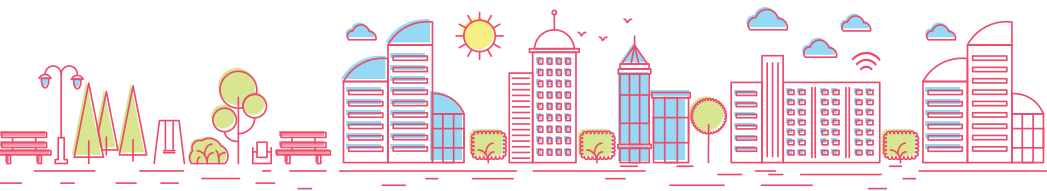
Ministry of Urban Development (now Ministry of Housing and Urban Affairs, MoHUA) had laid down clear guidelines for the Service Level Benchmarks (SLB's) for Urban Transport in India. This manual will help the reader familiarize themselves with one of the SLB's recognized by MoHUA. Using the knowledge available in this manual the reader will be able to foresee the PT service supply required over a period of their choosing and make informed decisions on how to achieve it.

The PTU calculation methods presented in this manual are limited to the PT modes available in the country as of the publishing date. Conversion factors for any PT modes introduced after its publication shall be outside of the scope of this manual.



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# Abbreviations

C-Cube	Climate Centre for Cities
CAGR	Compound Annual Growth Rate
CMP	Comprehensive Mobility Plan
CSCAF	ClimateSmart Cities Assessment Framework
DPR	Detailed Project Report
EIA	Environment Impact Assessment
GoI	Government of India
IMP	Integrated Mobility Plan
IPT	Intermediate Para Transit
ITS	Intelligent Transportation System
MoHUA	Ministry of Housing and Urban Affairs
NIUA	National Institute of Urban Affairs
NUTP	National Urban Transport Policy
O&M	Operation and Maintenance
PCU	Passenger Car Unit
PT	Public Transport
PTU	Public Transit Unit
SLA	Service Level Agreement
SLB	Service Level Benchmark
SPV	Special Purpose Vehicle
SRTU	State Road Transport Undertakings
TOD	Transit Oriented Development
UBS	Urban Bus Specifications
ULB	Urban Local Body



# 1

## Introduction

As per Constitution (*Government of India, 2017*), transportation is a fundamental right of individuals. Transportation needs of an individual can be local, national, or international. All the forms of transportation can be accomplished via two modes, private or public. Any individual travelling nationally or internationally i.e., across cities or states or countries can use private modes of transport such as privately owned vehicles or vehicles for hire, while public modes that can be used are trains, airways, waterways, or buses. Local transport needs are also fulfilled through either private vehicles (*both motorised and non-motorised*) or paratransit like auto rickshaws and shared rickshaws or public modes like ferries and most importantly buses. This manual focuses on availability calculations of intra-city modes of public transport available in India.

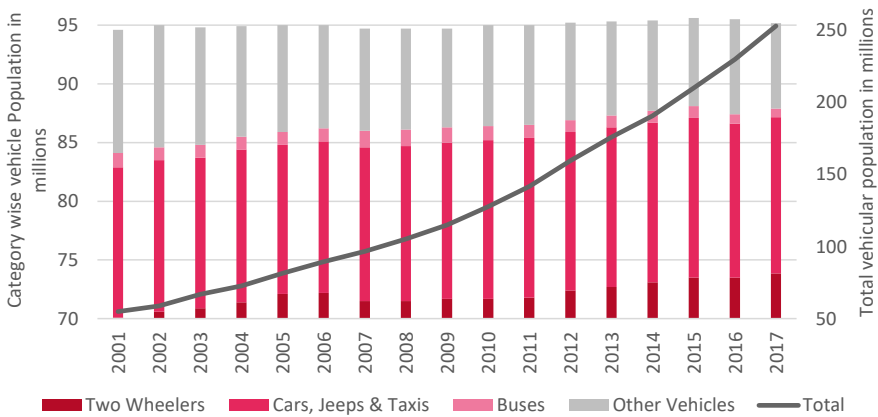
### 1.1 Urban Transport in India

India's transportation sector contributes about 10 per cent of total national greenhouse gas (GHG) emissions and road transportation contributes about 87 per cent of the total emissions in the sector. CO<sub>2</sub> emissions from the transportation sector will continue to grow by 4.1 to 6.1 per cent per year, leading to an increase by seven times in 2050 relative to 2010. ((*Paladugula et al, 2018*))

India has also seen a continuous increase in the number of registered motor vehicles over the last several decades. This is evidenced by the fact that registered vehicles in the country grew at a Compound Annual Growth Rate (CAGR) of 10.11 per cent between 2007 and 2017 alone (Figure 1) (*Ministry of Road Transport and Highways, 2017*). As a result of this tremendous growth, registered motor vehicles increased from about 0.3 million in 1951 to 253 million in 2017 (*Ministry of Road Transport and Highways, 2017*).

However, the number of registered buses in India in 2017 was just 0.74% of the total registered vehicles as compared to 11.1% in 1951. This is a steep decline in the availability of buses in India and speaks volumes about the PT systems' current standing.

**Figure 1: Growth in number of all registered vehicles (private and public) in India, 2001 to 2007(Ministry of Road Transport and Highways, 2017)**



Indian metropolitan cities are suffering from severe congestion today. A survey found that 4 Indian cities Bengaluru, Mumbai, Pune, and New Delhi stood first, fourth, fifth and eighth respectively among 146 other cities with 8% or more congestion levels around the world (TOMTOM, 2020). In these cities a commuter spends 60% more time stuck in traffic compared to commuters in other Indian cities. The time spent in traffic in India is also significantly higher than cities in other Asian countries averaging 149%. In monetary terms Delhi, Kolkata, Bengaluru, and Mumbai lost close to USD 22 Billion due to congestion in 2018 alone of which USD 9.6 Billion was incurred by Delhi in fuel waste, wasted productive hours, pollution, and accidents. According to Chin et al., if ridesharing is made cost equivalent to a private car ownership in terms of availability and affordability then

congestion in these four cities can be reduced by 17% to 31% and private car ownership can be reduced by up to 68%. The report also suggests that if achieved this scenario will save up to 22,000 acres of land needed for creating parking spaces (Chin et al., 2018).

The presence of Public Transport (PT) in a city is necessary to provide a means of transport to not only those who choose to travel through it but much more importantly to those who have no other option at their disposal. Such users are termed as Captive Users. PT for captive users is their only means of access to opportunities such as jobs, education, health care etc.

In a growing economy such as India, it is imperative that easy and safe access to PT is made available to the captive users (i.e., individuals who do not own any vehicle and are dependent on PT for transport) all the while keeping its affordability in mind. In the past, Indian government has taken steps to reinforce PT capacity in India through various schemes such as Jawaharlal Nehru National Urban Renewable Mission (JNNURM), 'National Urban Transport Policy' (NUTP), Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME 1 and FAME 2). Some of these schemes provided funding to ULB's for purchasing buses or provided buses themselves to bolster city PT fleets. FAME schemes have been launched in recent years to drive a shift from buses with internal combustion engine in city fleets to a much greener alternative, electric buses. Not only this, but India had also allocated a sum of USD 221 Billion for transport infrastructure related projects till 2018 and more recently in 2021 Government of India (GoI) launched a scheme aimed at augmenting public bus services in India with incentives close to USD 2.5 Billion.

There is a significant possibility that increasing availability of PT to all citizens captive or otherwise, and reducing travel time encourages mode shift from private to public modes of transport (C40 Cities & C40 Knowledge Hub, 2019; Gunay et al., 2016). Recent steps taken by GoI look to be in the right direction, but these must be backed up with policy reforms as well.



## 1.2 Public Transport (PT) Presence

### What is Public Transport

There is a lack of awareness in Indian spheres relating to which transport modes can be deemed as PT. It is generally assumed that any means of travel which is not owned by its passengers is a PT. This notion is not correct. For any mode of transport to be deemed as PT it must fulfil the following criteria<sup>1</sup>,

- Fixed route – The transport mode must have a fixed route up on which it provides its services.
- Fixed schedule – The transport mode must follow a predefined schedule which the public can refer to when they want to travel using the said transport mode.
- Established fare – Any journey on the transport mode in question must be charged according to the predefined, publicly disclosed fare chart
- Regulation framework – The transport mode must have a regulating body (SRTU, SPV, ULB etc.) which defines the operational elements for the transport mode.

If any mode of transport does not fulfil all the above-mentioned criteria, then it cannot be considered as a PT service. Rather it can be termed as a para transit.<sup>2</sup>

### Buses

Buses are the predominant mode of PT in intercity and intra city travel in India. In 2015, close to 70 million trips per day were being catered to by 1,40,000 buses operated by ULB's in the country (*Ministry of Road Transport and Highways, 2015*). It has been estimated that among other PT modes additional 4,60,000 buses are needed to cater to the urban travel demand by year 2031 (*KPMG India, 2017*).

The law enabling State Road Transport Undertakings (SRTU) dates to 1950. Through this law SRTU's were empowered in the states to provide bus-based PT services. In 2017 there were 62 SRTUs the performance of many of which reveals that they have not been able to positively augment their operations since nationalisation. Also, the fleet held and operational fleet in 2017 across the SRTU's increased from 2016 but the magnitude for both the metrics was below 2%. Fleet utilization also saw a decline of 0.41% from 2016 to 2017 but the most alarming statistic reported was that of the total 1,49,095 buses owned by state authorities, Maharashtra, Karnataka, and Tamil Nadu held 17.35%, 15.87% and 15.04% buses, respectively. This means that the rest of the SRTU's across the country only held 77,000 buses leading to an abysmal availability of government run buses in the rest of the country.

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<sup>1</sup> *Types of Transit Systems – RHlhub Transportation Toolkit (ruralhealthinfo.org)*

<sup>2</sup> *A transportation service that supplements larger public transit systems by providing individualized rides without fixed routes or timetables. Auto rickshaws, shared rickshaws, 6-seater vans tata magics etc. are examples of para transit prevalent in India.*

Such a situation leads to commuters' dependence on Intermediate Para Transit (IPT) for fulfilling their travel demand. IPT's are omnipresent in Indian cities and come in various forms, from three-wheeler autos to six-seater vans/ jeeps/ magics and many more. Most of the IPT are privately owned vehicles and run mostly on contract carriage permits as the National Urban Transport Policy (NUTP) does not recognise IPT as a PT mode. However due to lack of oversight and enforcement; among other reasons IPT's operate unregulated and act as a pseudo-PT system in most small cities. With little to no standard enforcements, competitive fares, and lower travel times, IPT's become ideal modes of transport for trips under 5km and attract consistent patronage. This encourages illegal vehicles to ply alongside legitimate IPT vehicles and disrupt the commuter pool for bus-based PT. If operated correctly, a regularized IPT used as a feeder service can prove to be a boon for the commuters and the city alike, but this requires extensive planning and effective policy implementation.

A natural and straightforward method for tackling this situation seems to be acquiring more buses across India to offset the high vehicle ownership. But it must be noted that the basic problem is NOT the overall number of vehicles in the country but their concentration in a few selected cities, particularly in metropolitan cities. While the metropolitan cities contain close to 29% of all registered vehicles (*which have 78% of all two-wheelers and 20% of all cars registered in India*) they only have 5.17% buses operating in their limits.

Figure 2: Alternate PT modes in India



This includes contract carriages, private service and other buses as well. Therefore, the number of stage carriages available to the public diminishes even further.

The urban bus toolkit developed by World Bank suggests the presence of 1.2 buses per 1000 population in an urban environment, India falls very short of this number in its metropolitan areas (*Number of Buses per 1,000 Population, 2006.*).

### **Other modes of PT**

Apart from buses, National Urban Transport Policy (NUTP) recognises the following modes of transport as PT,

- Metro
- Mono-rail system
- Sub-urban rail system
- Tram
- Ferries
- Ropeways

These modes of PT command a very small amount of national commuter patronage as they are limited in their scope due to reasons such as high implementation costs (*Metro, monorail*), operation specification (*ferries and other waterway modes can be used in specific areas only*) etc. Availability of these modes is examined by converting them into their equivalent PTU. Converting these modes into equivalent bus fleets is discussed further down in this manual.

### **1.3 PT Availability as a Concept**

In 2010, MoHUA released a set of SLB's (*MoHUA, 2010*) detailing the metrics which must be used to assess the performance of the following,

- PT facilities
- Pedestrian infrastructure facilities
- Non-Motorised Transport (NMT) facilities
- Level of use of Intelligent Transportation System (ITS) facilities
- Travel speed along major corridors
- Availability of parking spaces
- Road safety
- Pollution levels
- Integrated land use transport system
- Financial sustainability of bus PT

In this document one of the SLB’s for measuring effectiveness of PT is “Extent of Supply Availability of Public Transport”. This is later defined in the document as presented in Table 1.

As mentioned clearly, there are only two components required for calculating PT availability,

- Fleet size of PTs available in the city.
- Current population of the city

Both components are discussed in detail in subsequent chapters of this manual.

**Table 1: PT Availability as per CSCAF**

S. No	Data required for calculating the indicator	Unit	Remarks
a)	No of Buses/ train coaches/ metros/ferries available in a city on any day	Numbers	Number of public transport vehicles operating in the city, which may be lower than the number of vehicles owned by the utility or that authorized to ply. Daily average values over a time of a month may be considered. (1 train coach is equivalent to 3 buses).
b)	Total Population of the city	Numbers	Current population should be considered. Past census figures should be used as base, and annual growth rate should then be used to arrive at current population.
c)	Availability of Public transport /1000 population.	Ratio	Calculate= [a / b]. Compute LoS as mentioned in indicator 2 i.e., Availability of Public Transport

Figure 3: Climate Smart Cities Assessment Framework



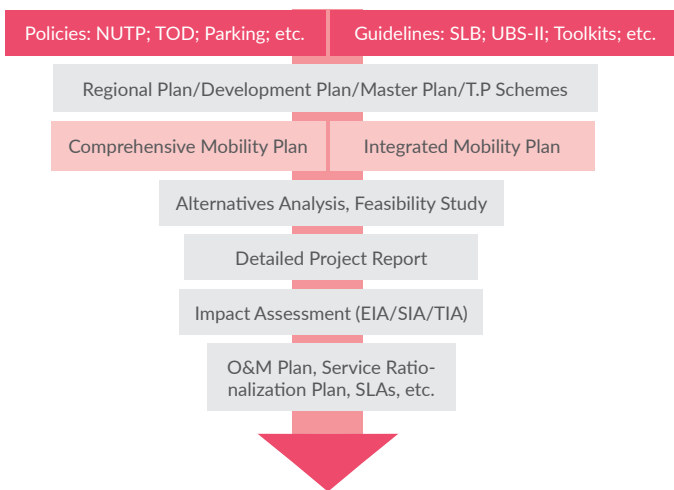
# 2

## Regulatory Framework

Ideally a PT infrastructure project is a long-term solution for problems related to movement of people as experienced by the city. These problems may be congestion, pollution, or even equity in transport opportunities. Such projects generally involve a large investment of public money among other things; therefore, it becomes of paramount importance that they are planned and executed with utmost diligence. There are multiple levels of engagement which need to take place for a PT infrastructure to be able to fulfil its intended purpose. The level of engagements is,

- Policy/ guideline for PT
- Integrated approach towards planning
- Project specific planning

Figure 4: Institutional framework required for sustainable PT environment



In 2017, MoHUA published guidelines for appraisal of metro rail projects which contain specifics of each of the plans mentioned in Figure 3. It also elaborates on the data, criteria, and other requirements for appraisal of metro projects. It is highly advisable for all the city officials to go through this document before applying for any funding opportunities or planning a PT project in general (*MoHUA, 2017a*). This section of the manual delves into the necessary steps/ practices which need to be followed to make a PT infrastructure a success.

## 2.1 Policy/ Guidelines for PT at Central Level

This engagement is one that happens at the central level. Policies at this level have far reaching impact spatially and temporally. A national policy and guideline will not only affect projects across the country, but it will have consequences over a long term until such time that it is either amended or replaced completely. Thus, these policies must be well thought out, informed, and should be accommodating to future trends and possibilities.

India has enacted both policies and guidelines and other undertakings in the past which have shaped its current PT environment. The NUTP was brought about in 2006 and was re-released after revisions in the year 2014. It was aimed at providing clear recommendations to Indian cities on how to bolster their PT services and infrastructure. It also provided recommendations for reducing pollution and ramping up adoption of non-motorised transport (*Ministry of Urban Development, 2006*).

Another policy was developed by the GoI for tackling rapid urbanisation. It highlighted the importance of transport for all and promoted a “Public Transport First” framework wherein urban sprawl in rapidly growing cities was encouraged to follow high capacity PT infrastructure development rather than the other way around (*MoHUA, 2017b*). Metro policy as well as Green Urban Mobility Scheme are offshoots of this policy.

Policies and guidelines go hand in hand for a holistic approach towards building a narrative that the country can follow. As mentioned earlier MoHUA had released the service level benchmarks for assessing performance of various PT infrastructure projects. Urban Bus Specification 1 and 2 have been released by MoHUA to provide clear norms to be followed by the city administration when procuring buses for operations in their regions. These policies and guidelines create the foundation for an environment in the country which can support the current as well as the future public transport requirement in the country.

## 2.2 Integrated Planning at State Level

At State level, authorities are supposed to plan PT projects drawing from the directive provided by central policies and guidelines. Some effective tools that should be leveraged by the state administration are master plans, comprehensive mobility plans, integrated mobility plans to name a few (Figure 4).

The World Bank defines a master plan as “a dynamic long-term planning document that provides a conceptual layout to guide future growth and development”. A master plan includes analysis, recommendations, and proposals for a region’s population, economy, housing, transportation, community facilities, and land use. It draws from public input, surveys, existing development, physical characteristics, and social and economic conditions of a region (*The World Bank, 2015*).

A comprehensive mobility plan (CMP) is a document which incorporates short-, medium- and long-term goals and strategies to tackle developing and forecasted mobility patterns in a city. This document must follow policies like NUTP for formulating measures against foreseeable challenges.

An Integrated Mobility Plan (IMP) is like a CMP in the sense that it creates a vision for mobility around a city and helps direct investments in transportation demand management, PT, and the roadway. This plan draws from the regional plan put in place by the state administration or the ULB’s for integrated PT, land use, community-based transit, pedestrian infrastructure etc. The above-mentioned plans combine to form a regional strategy for integrated planning.



## 2.3 Project Specific Planning at City Level

The third level of engagement involves ULB's, SRTU's, SPV's and other stakeholders of individual PT projects. Planning for projects necessitates drawing of the following plans as required.

Figure 5: Required project planning activities for a successful implementation



An alternate analysis can be a part of the feasibility itself or it can be a standalone document. The purpose of this document is to compare all the available options for addressing the challenge at hand and inform the best suited option for overcoming the said challenge.

The next step towards planning a PT project is the feasibility study. Through this study the authorities must make an assessment whether the best alternate chosen will fulfil the project's intended purpose upon completion. This kind of study generally has various facets to it like technical feasibility, economic feasibility, financial feasibility etc.

Once a feasibility study and alternate analysis has been performed, a Detailed Project Report (DPR) is prepared. A DPR is a document which contains the basic programme, roles and responsibilities, all the activities to be carried out with timelines and the resources required, possible risks with recommended measures to counter them. In this sense DPR is one of the most crucial documents for any infrastructure project. The central government has emphasised upon preparation of DPR for any grant proposal it receives.

Often an impact assessment is a part of the DPR itself. This document assesses the impact of the proposed project on various aspects of the site, for example environment, economic, ecological, social impacts. Lately, carrying out an Environmental Impact Assessment (EIA) has been made compulsory by the central government for granting incentives for PT projects.

Once all the above-mentioned plans have been put in place, operational plans must be drafted along with service optimization plans and service level agreements. These plans must be realistic, logical, and actionable. The crux of these plans should be to make the project viable and sustainable by the virtue of the service it provides to the public. These plans have the highest potential to be creative in their approach and be experimental to certain extents.

# 3

## Calculating PT Availability as per ClimateSmart Cities Assessment Framework

As mentioned in the previous chapter there are only two components employed for calculating PT availability. These data are largely secondary data i.e., these can be acquired from relevant authorities or can be calculated by an individual on their own. This chapter presents the potential data sources for these components and their calculation techniques.

### 3.1 PT Fleet

PT fleet calculation can be misinterpreted as total fleet size of PT operational in the city. This can be true only if the city PT fleet consists entirely of standard buses (12m length, (*Ministry of Urban Development Government of India, 2013*)). Fleet numbers of all other PT modes available in the city must be converted to their equivalent Passenger Transit Unit (PTU).

#### Data Sources for PT Fleet

The number of available PT fleet in a city can be determined from the following entities,

- SRTU's – For services governed by state bodies. Example Andhra Pradesh State Road Transport Corporation.
- City Special Purpose Vehicles (SPV) – For services governed by special bodies constituted at city level. Example, Atal Indore City Transport Services Limited.
- ULB – For services governed by city municipal corporations, relevant smart city missions etc.

### Conversion of Available Fleet to PTU

Concept of PTU is almost identical to that of Passenger Car Unit (PCU). A PCU is a unit of highway capacity expression where one car is considered as 1 unit, bicycle, and motorcycle as 0.5 unit each. Similarly, a PTU is a unit of PT capacity expression with one standard 12m bus considered as 1 unit, a 9m midi bus considered as 0.7 unit. Any PT fleet can be converted to its equivalent PTU using the predefined conversion factors as discussed in Table 2.

Table 2: PTU conversion factors

#	Fleet Type	PTU per Unit Conversion
1	Articulated Bus (18m)	1.50
2	Standard Bus (12m)	1.00
3	Midi Bus (9m)	0.70
4	Mini Bus	0.55
5	Metro Coach	3.00
6	Sub-Urban Rail Coach	4.50
7	Metro Neo Coach (25m)	3.80
8	Metro Neo Coach (12m)	1.00
9	LRT Coach (12m)	1.00
10	Ferry (200 pax)	3.00

Also, for the purpose of calculation of PT fleet only those transport modes should be considered which fulfil the criteria presented in section 1.2.1 of this manual.

### 3.2 City Population

Population of every city is ever changing and thus is impossible to make an exact assessment of at any given point of time. Therefore, population size can only be an estimate or a reference from the last known census. This section of the manual deals with estimation of a city population for the purpose of assessing PT availability.

Population assessment can be done in two ways,

- Secondary data collection from relevant sources
- Estimate calculation from known populations in the past

#### Data Sources for Urban Population

Population of any urban area can be ascertained from the following sources,

- Census of India (Office of the Registrar General & Census Commissioner, 2011a, 2011c, 2011b)
- Respective District Collector's office
- Respective Smart City Mission office
- Respective City master plan

#### Calculating Current Population

If the population data is not readily available from the sources listed above, then it can be calculated in three simple steps.

- Determine city's population in the year 2001 and 2011 from Census data
- Calculate growth factor using the Census data
- Forecast population for the desired year

#### Growth Rate Calculation

Population growth rate can be calculated using the Equation 1,

$$G = \left( 100 \times \ln \left( \frac{P_{Pr}}{P_{Pa}} \right) \right) \div (Y_{Pr} - Y_{Pa})$$

Where,

- $G$  is the growth rate
- $Y_{Pr}$  is the present year
- $Y_{Pa}$  is the past year
- $P_{Pr}$  is the city population in year  $Y_{Pr}$
- $P_{Pa}$  is the city population in year  $Y_{Pa}$

Once relevant data is input in the equation, growth rate can be calculated in percentage

terms. For example,

If we want to calculate population growth rate for city X between 2010 and 2020 when the populations in these years were 15,00,000 and 30,00,000 respectively.

Then,

- $Y_{Pr} = 2020$
- $Y_{Pa} = 2010$
- $P_{Pr} = 15,00,000$
- $P_{Pa} = 30,00,000$

Therefore, using Equation 1,

$$G = \left(100 \times \ln\left(\frac{P_{Pr}}{P_{Pa}}\right)\right) \div (Y_{Pr} - Y_{Pa}) = \left(100 \times \ln\left(\frac{30,00,000}{15,00,000}\right)\right) \div (2020 - 2010)$$

$$G = (100 \times \ln(2)) \div (10) = (100 \times 0.69) \div 10 = 6.9\%$$

Thus, the population growth rate for city X between 2010 and 2021 was 6.9%.

### **Population Forecast**

Once the growth rate has been determined, city population in a desired year can be forecasted using Equation 2,

$$P_F = P_{Pr} \times 2.71828^{[(G/100) \times (Y_F - Y_{Pr})]}$$

Where,

- $P_F$  is the city population in the desired year
- $Y_F$  is the year for which population is to be forecasted
- $Y_{Pr}$  is the present year
- $P_{Pr}$  is the city population in  $Y_{Pr}$
- $G$  is the population growth rate calculated using Equation 1 (to be used in decimals and not percentage)

For example,

If we want to forecast population for city Y in the year 2030 in base year 2021, with a growth rate of 7% and base year population of 20,00,000.

Then,

- $Y_F = 2030$
- $Y_{Pr} = 2021$
- $P_{Pr} = 20,00,000$
- $G = 7\%$

Therefore, using Equation 2,

$$P_F = P_{Pr} \times 2.71828^{[(G/100) \times (Y_F - Y_{Pr})]} = 20,00,000 \times 2.71828^{[(7/100) \times (2030 - 2021)]}$$

$$P_F = 20,00,000 \times 2.71828^{[0.07 \times 9]} = 20,00,000 \times 1.877611 = 37,55,221$$

Thus, the population in city Y in the year 2030 can be forecasted as 37,55,221.

### 3.3 PT Availability

As mentioned in section 1.3 of this manual, PT availability is defined as –

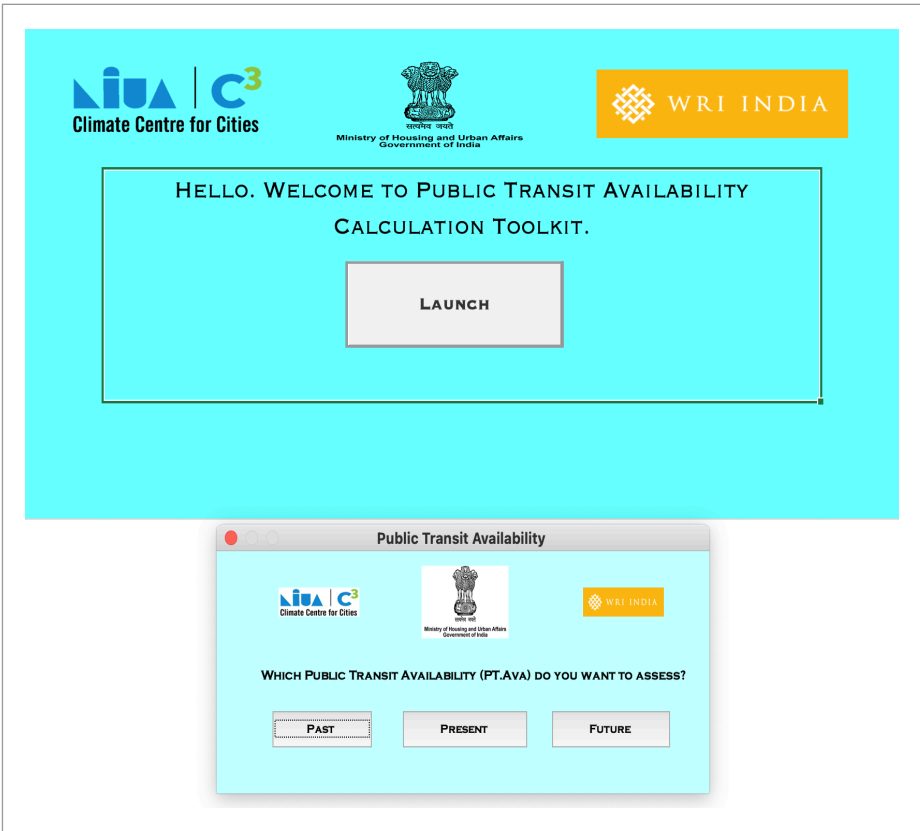
$$PT \text{ Availability Index} = \frac{\text{Fleet Size in PTU} \times 1000}{\text{Estimated existing population of the city}}$$

Once fleet size in PTU and population figures have been determined, using Equation 3 gives a value which needs to be interpreted (MoHUA, 2010). This can be achieved using Table 3 below.

**Table 3: PT Availability Index interpretation**

Availability Index	Availability Score
PT is not available	0
$0.01 \leq PT.Ava < 0.2$	25
$0.2 \leq PT.Ava < 0.4$	50
$0.4 \leq PT.Ava < 0.6$	75
$PT.Ava \geq 0.6$	100

# Public Transport Availability Tool Kit



Public Transport Unit (PTU) Calculator is excel based tool which help cities with calculation of current and future PT demand based on population. Additionally, the tool helps calculation of population projections.

For more information Visit <https://www.niua.org/c-cube/content/public-transport-unit-calculator>

# 4

## Exercise

The exercise designed for this training is a simple tutorial of the various algebraic calculations which need to be performed to obtain a PT availability score for a city. For the purpose of this tutorial, we shall be calculating the available PTU, population growth rate in the past 10 years and forecast population for the coming 10 years for a hypothetical city “Best City”.

### 4.1 Calculation of PTU

Using the conversion factors listed in Table 3-1, calculate the equivalent PTU for the following fleet sizes,

Example,

- 100 Standard Bus =  $100 \times 1$  = 100 PTU
- 50 Metro Coach =  $50 \times 3$  = 150 PTU
- 50 Standard + 50 Midi Bus =  $(50 \times 1) + (0.7 \times 50)$  = 85 PTU

Now, we calculate the available PTU in *BEST CITY* if the available fleet consists of,

- 10 Standard, 20 Midi, 40 Minibuses  
OR
- 100 Metro coaches and 500 Standard buses



## 4.2 Estimation of Population

### Growth rate calculation

Using the present year's population and the population from 10 years ago, we will calculate the population growth rate for *BEST CITY* using the formula presented in Figure 1.

$P_{Pr}$ = Present population = 15,00,000 $P_{Pa}$ = Past population = 8,00,000 $N$ = Number of years = 10 $G = \left( \frac{(P_{Pr} - P_{Pa})}{P_{Pa}} \times 100 \right) \div N$
---

Figure 5: Data for Growth Rate Calculation Exercise

### Population forecast

Using present population and population growth rate calculated in the section 4.2.1 we will calculate *BEST CITY*'s population 10 years from now using formula presented in Figure 6. Remember to use the growth rate as a decimal value and not as a percentage value.

$P_{Pr}$ = Present population = 15,00,000 $n$ = Number of years = 10 $G$ = Growth Rate = 0.875 $P_F = P_{Pr} \times (1 + G)^n$
---

Figure 6: Data for Population Forecast Exercise

### 4.3 PT Availability Calculation

Once we have calculated the available PTU (800) and the future population (34,70,436) for BEST CITY, now we are able to calculate PT availability in 3 scenarios

- Current availability
- Availability 10 years in the future if no more PTU's are added, also called a "Do nothing scenario".
- Availability 10 years in the future if PTU's are doubled

#### Current availability

Using the data from Figure 7, we calculate the availability in the current year.

$$\begin{aligned} P_{Pr} &= \text{Present population} = 15,00,000 \\ PTU &= 800 \\ \text{Availability} &= \left( \frac{PTU}{Population} \right) \times 1000 \end{aligned}$$

Figure 7: Availability Calculation Exercise for Current Year

#### Availability in a do-nothing scenario

If no PTU is added in BEST CITY in the next 10 years, then the new availability can be calculated from the data in Figure 8.

$$\begin{aligned} P_F &= \text{Future population} = 34,70,436 \\ PTU &= 800 \\ \text{Availability} &= \left( \frac{PTU}{Population} \right) \times 1000 \end{aligned}$$

Figure 8: Future Availability Calculation Exercise in Do-Nothing Scenario

#### Availability if PTU are doubled

If PTU in BEST CITY are doubled in the next 10 years as compared to current year, then the new availability can be calculated from the data in Figure 9.

$$\begin{aligned} P_F &= \text{Future population} = 34,70,436 \\ PTU &= 800 + 800 = 1,600 \\ \text{Availability} &= \left( \frac{PTU}{Population} \right) \times 1000 \end{aligned}$$

Figure 9: Future Availability Calculation Exercise with PTU Doubled

## 4.4 PT Availability Interpretation

Table 4-1 below presents the availability scores for *BEST CITY* at two different time points in two different scenarios. In its current state *BEST CITY* gains a score of 75 which is acceptable. However, if PTU is not added, then in the coming 10 years its availability score will drop down to 50 which is not ideal. Also, even if PTU is doubled in *BEST CITY* in the next 10 years, it can only just retain its current availability score but not improve upon it.

**Table 4: Calculated Availability Interpretation**

S. No	Scenario	Availability Index	Availability Score
1	Present year	0.53	75
2	Future year with do-nothing scenario	0.23	50
3	Future year with doubled PTU	0.46	75

## 4.5 Calculating PTU Required for 100 Availability Score

We can determine the minimum number of PTU required for *BEST CITY* to achieve a 100-availability score (at least 0.6 Availability Index value) in the next 10 years. For this we use a modified Equation 3.

$$PTU \text{ for } 100 \text{ Score} = \frac{\text{Availability Index} \times \text{Estimated population of the city}}{1000}$$

Therefore, PTU required comes to be,

$$PTU \text{ for } 100 \text{ Score} = \frac{0.6 \times 34,70,436}{1000} = 2,082.26 \sim 2,083$$

Thus, *BEST CITY* administration needs to deploy a minimum total of 2,083 PTU to be able to achieve 100 availability score. For doing such determinations Table 4-2 can also be referred.

**Table 5: Required PTU Lookup Table**

Availability Score		100	100	100	75	50	25
Sr	Availability Index	1	0.8	0.6	0.4	0.2	0.1
	Population						
1	1,00,000	100	80	60	40	20	10
2	2,00,000	200	160	120	80	40	20
3	5,00,000	500	400	300	200	100	50
4	10,00,000	1,000	800	600	400	200	100
5	15,00,000	1,500	1,200	900	600	300	150
6	20,00,000	2,000	1,600	1,200	800	400	200
7	30,00,000	3,000	2,400	1,800	1,200	600	300
8	40,00,000	4,000	3,200	2,400	1,600	800	400
9	60,00,000	6,000	4,800	3,600	2,400	1,200	600
10	80,00,000	8,000	6,400	4,800	3,200	1,600	800
11	1,00,00,000	10,000	8,000	6,000	4,000	2,000	1,000
12	2,00,00,000	20,000	16,000	12,000	8,000	4,000	2,000

# 5

## Moving Forward

Once the city officials have estimated PT availability in their respective cities, they should undertake activities which will aid them in winning grants/ funds for implementing PT projects. Figure 5 below presents a list of activities for cities falling in different tier categories as defined by the central government.

Figure 6: Tier wise activity list for cities

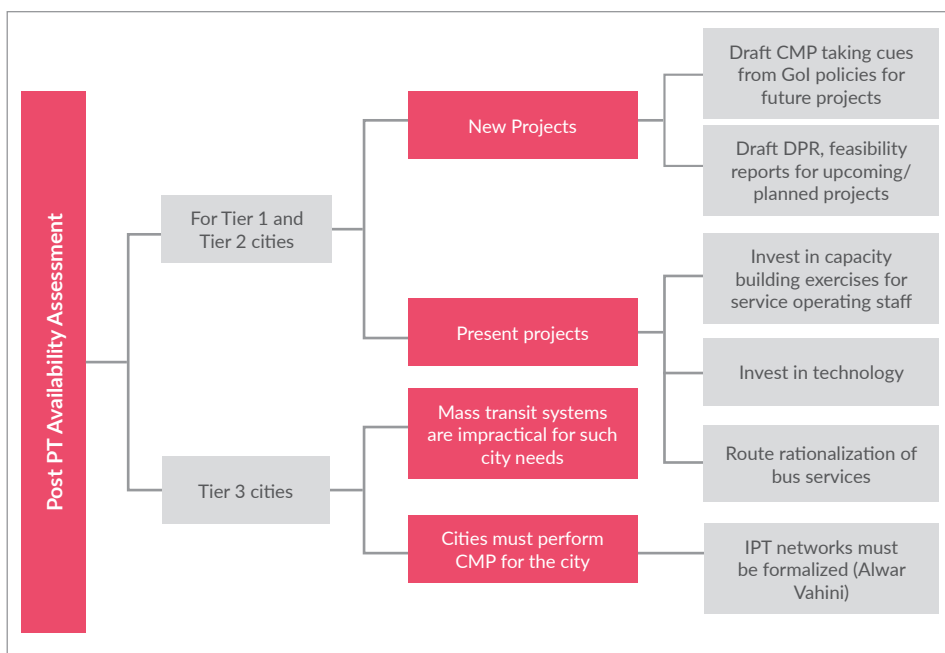
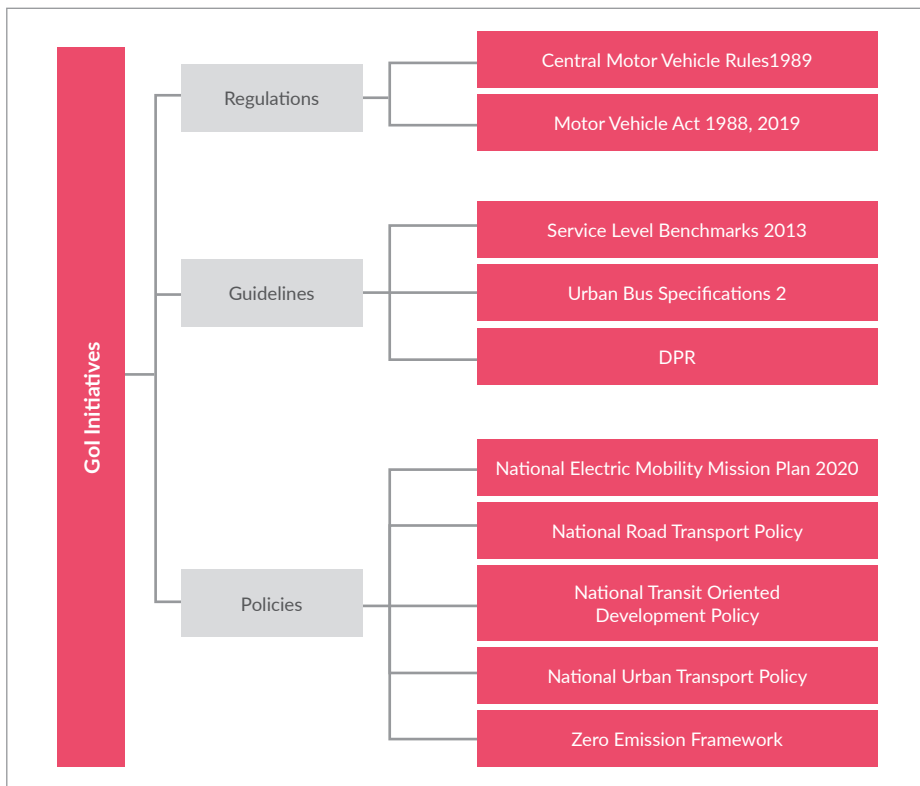
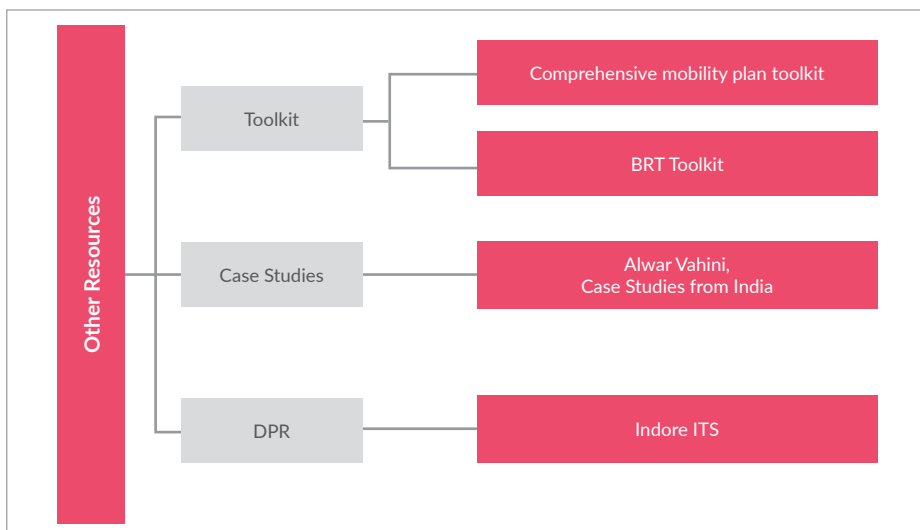


Figure 7: Resources and reading materials



\*Click the text to access the document



\*Click the text to access the document

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*Image source: Shivendu Shukla/unsplash*













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