

Subject: Note regarding the facts and status on action taken in the matter of the Order of the Hon'ble National Green Tribunal (NGT) dated 26-2-2020 in O.A. No. 773/2018 in the matter of Metro Transit Private Limited vs. South Delhi Municipal corporation & ors- reg.

Hon'ble NGT's order dated 26-2-2020 in O.A. No. 773/2018 on the subject mentioned above, in the light of the reply dated 21.10.2019 of Ministry of Road Transport & Highways, observed interalia that;

“5. *The above stand is hardly of any assistance in dealing with the serious problem of encroachment on roads by illegal parking and causing of higher vehicular pollution impacting public health. Response of the Ministry shows apathy and lack of concern which can hardly be appreciated. This Tribunal expects responsible behaviour from the officers dealing with the matter which is clearly missing as shown by proceedings of the matter.*

6. *Having regard to the seriousness of the issue and repeated failure of the authorities in properly responding to the orders of this Tribunal, we direct the concerned Joint Secretaries of Ministry of Road Transport & Highways as well as Ministry of Housing and Urban Development, Govt. of India and Member Secretary, CPCB to remain present in person after acquainting themselves fully on the subject. It is made clear that any default will result in coercive measures being taken by this Tribunal personally against the concerned Joint Secretaries including stopping their salary.*

7. *A copy of this order be sent to the concerned Secretaries of Ministry of Road Transport & Highways as well as Ministry of Housing and Urban Development, Govt. of India and Member Secretary, CPCB by e-mail for compliance.*

8. *The applicant may furnish a set of papers to the concerned Secretaries of Ministry of Road Transport & Highways as well as Ministry of Housing and Urban Development, Govt. of India and Member Secretary, CPCB and file an affidavit of service within one week.*

List again on 17.04.2020.”

2.0 In the light of the above order of the Hon'ble Tribunal the following lines are submitted.

2.1 The Hon'ble National Green Tribunal (NGT) in their order dated 26.10.2018 (O.A. No. 568 of 2016, *Ajay Khera Vs. Container Corporation of India & Ors.*) directed to carry out a study for assessment of carrying capacity for NCT of Delhi as well as other major cities particularly 102 “non-attainment cities” as under:

i) To carry out a study for assessment of carrying capacity for NCT of Delhi as well as other major cities particularly 102 “non-attainment cities” within reasonable time preferably in one year. The study can be in phases depending on priority areas having pollution hot spots.

The assessment must study capacity in terms of number of vehicles, extent of population, extent of different nature of activities – institutions, industrial, commercial etc.

ii) The study would be undertaken in coordination with Central Pollution Control Board, Ministry of Road Transport and other concerned Ministries, the authorities such as Planning Commission as well as the States, with the assistance of experts in the field. Methodology to do so may be worked out within two months.

iii) As a result of such study, further policy decision may be taken by the concerned authorities for comprehensive action for checking air pollution in the interest of public health. This may also result in regulation of logistic and infrastructure. The CPCB may act as nodal agency.

2.2 In regard to the above directions, it is submitted that Urban Planning/ Development including Urban Transport is a State subject under the Constitution of India and accordingly all the actions relating to Urban Development and Planning are to be done by the respective State Governments/ULBs. Since land as a subject for Delhi is under the Central Government, the Ministry of Housing and Urban Affairs does the Urban Planning for NCT of Delhi through the Delhi Development Authority. Therefore, the assessment of Urban Carrying Capacity plan/study for cities other than Delhi are to be done by the respective State Governments/ ULBs.

2.3 As regards the directions to carry out a study for assessment of carrying capacity for NCT Delhi as well as other major cities particularly 102 "non-attainment cities", the matter related to transport studies was discussed and deliberated upon in a meeting held in Ministry of Housing and Urban Affairs on 14.01.2019 with the representatives of the concerned Ministries namely Ministry of Road Transport & Highways (MoRTH), Ministry of Environment & Forests & Climate Change (MoEF&CC), Ministry of Railways (MoR), NITI Aayog, Central Pollution Control Board (CPCB), IIT Delhi and other organizations namely, Urban Mass Transport Company (UMTC) and Institute of Urban Transport (IUT).

2.4 There were some studies done by the Ministry in the transport sector, which could be relevant in a study for assessment of carrying capacity with reference to the transport infrastructure. After detailed consideration of the issue and the existing global/ national practices available and also in view of the fact that, access to all other physical and social infrastructure is dependent on the robustness of transport infrastructure, it was noted that carrying capacity of city has greater correlation with the carrying capacity of transport infrastructure of the city. After

extensive deliberations in the meeting, it was agreed that, the study on the aforesaid line can be done in phases depending on pollution priority areas and a methodology would be developed for determining the carrying capacity of the city with reference to transport in the first phase. It was decided that, this would be done using existing studies of the Ministry of Housing and Urban Affairs on Service Level Benchmarks (SLBs) in Urban Transport and Liveability Index. M/s Urban Mass Transit Company Ltd. (UMTC) was accordingly asked to formulate an appropriate methodology for the proposed study for assessment of carrying capacity in cities and also to conduct a pilot study in respect of Faridabad, which is in NCR of Delhi, and to come out with a report on carrying capacity for urban transport infrastructure in Faridabad and also the methodology to take it forward for the other non-attainment cities. CPCB was requested to appraise the Hon'ble NGT about the same vide this Ministry's letter dated 21-1-2019.

2.5 The Draft Interim Report submitted by the UMTC initially and, later the Draft Final Report as well, was circulated among the Ministries for comments/views. The Report was revised by UMTC taking into account the comments received from CPCB.

2.6. The UMTC's Draft Report/Guidelines sought to develop an approach for assessment of carrying capacity of the transport infrastructure on the following principles;

- i. Carrying capacity for transport denotes the ability of the whole transportation system to accommodate trip volume, when the satisfactory / reasonable level of service is maintained.
- ii. Capacity standards are fixed normally in relation to the Level of Service (LOS) of the design. Level of Service is defined as a qualitative measure describing operational conditions within a traffic stream, and their perception by drivers/passengers and in terms of factors such as speed and travel time, freedom to maneuver, traffic interruptions, comfort, convenience, safety and Pollution.
- iii. Six levels of service are recognised commonly, designated from A (best operating conditions of free flow) to F (worst or break down of system). Study recommends Level of service B, equivalent to good (but not best) as practical or desired operating conditions for the urban area transport.

2.7 The Report was taken up for comments with three domain experts belonging to (i) World Resources Institute (WRI) India (ii) School of Planning and Architecture, and (iii) IIT Delhi and their comments on the Report, both on the methodology and that of the carrying capacity of transport infrastructure of Faridabad were sent to UMTC. The comments of the Experts point that the Report needs to be extensively revamped covering additional aspects and indicators in order to be full-fledged and comprehensive in nature to serve as a study containing the detailed

methodology that can be adopted for assessing urban carrying capacity for transport sector in respect of the non-attainment cities.

2.8 The UMTC has indicated that revamping of the study/report on the lines of the comments/recommendations of the Experts would involve further collection of Primary and secondary data, conduction of field surveys, development of parameters/ thresholds and their validation by continuous observation/analysis etc. It has been added by UMTC that considering the present movement restrictions due to Covid-19 and related issues, preparation of such a Report containing the detailed methodology for adoption for assessment of urban carrying capacity for transport sector in respect of the non-attainment cities and assessment of carrying capacity transport infrastructure of Faridabad would involve mobilisation of additional experts and resources and their deployment in the study area, carrying out of activities and monitoring etc. and thus would take a minimum of 10-12 months further.

3.1 It is submitted in this regard that the National Urban Transport Policy, 2006 as well as the Transit Oriented Development Policy, 2017, encourage an integrated approach towards Urban Transport Planning. Keeping this in view, for the cities aspiring to have mass transit systems with central assistance, the extant policies prescribe development of a city specific Comprehensive Mobility Plan (CMP). The methodology/guidelines for assessment of the carrying capacity of transport infrastructure that would emerge from the present Study could serve as one of the key ingredients in preparation of the CMP for the respective cities. The components/ basket of indicators in the CMP tool kit is currently under review. The parameters/guidelines developed in the Study, in conjunction with other inputs would help preparation of a holistic CMP by the cities/ULBs and enable an integrated approach towards urban transport planning. It is relevantly submitted that UMTC is presently preparing a CMP for Faridabad in Delhi NCR, and the revamped Urban Transport Carrying Capacity Report for Faridabad can be presented along with the CMP for the city.

3.2 National Clean Air Programme (NCAP) is being implemented by the Central Pollution Control Board (CPCB)/MoEF&CC for comprehensive action for mitigation of air-pollution in the country with a delineated Action Plan, control/mitigation measures, institutional strengthening, knowledge and database augmentation and corresponding budget allocation to States. Metropolitan cities/Urban Local Bodies have the mandate and responsibility of preparation of Master Plans with a timeline for the respective cities/ULBs with a sustainable development

approach. Study for comprehensive/ multidimensional assessment of Carrying capacity transcending the realm of transport infrastructure with a perspective of promotion of 'clean-air' could be done by the city/ULB administration as an enabling/ supportive exercise for development of a holistic Master Plan for the city/ULB. This Ministry would extend its full cooperation to CPCB in such an initiative.

4.1 As submitted in the preceding paragraphs, the report/Study of UMTC on Faridabad requires to be revamped taking into account the views of the Experts in the transport sector in order to be comprehensive and full-fledged which will take 10-12 months' time. Subsequently, DDA may take up study for assessment of carrying capacity of NCT of Delhi. For other non-attainment cities the study for assessment of carrying capacity should be conducted by respective State Governments as urban planning/development is a State subject.

4.2 The above facts/submissions are brought to the notice of the Hon'ble NGT for kind consideration.



UMTC/SM/2020-21/001

Date: 20/04/2020

To,
 Shri. Jaideep
 OSD (UT) & Ex. Officio Joint Secretary
 Ministry of Housing & Urban Affairs, Govt. of India
 Room No. 1, Ground Floor, C-Wing, Nirman Bhawan,
 Maulana Azad Road
 Ministry of Housing & Urban Affairs, Govt. of India
 New Delhi - 110011

Subject: Way forward for the Urban Transport Carrying Capacity study – brief for NGT hearing

Dear Sir,

As per the Minutes of the meeting held on 14th January, 2019 at 5:00 PM under the Chairmanship of the then OSD (UT) & Ex-Officio Jt. Secretary to discuss the directions of the National Green Tribunal (NGT) in their order dated 26.10.2018 vide O.A. No. 568 of 2016, Ajay Khera Vs. Container Corporation of India & Ors. it was agreed that, “the study on the aforesaid line can be done in phases depending on pollution priority areas and a methodology would be developed for determining the “carrying capacity of the city”. It was decided that, this would be done using existing studies of the Ministry of Housing and Urban Affairs on Service Level Benchmarks (SLBs) in Urban Transport and Liveability Index. M/s UMTC would accordingly be asked to formulate an appropriate methodology for the proposed study for assessment of carrying capacity in cities during the given time frame as per the direction of the Hon’ble NGT. To begin with, under MoHUA funding, **M/s UMTC would undertake a pilot study in Faridabad to come out with a report on carrying capacity for urban transport infrastructure in Faridabad and also the methodology to take it forward for the other non-attainment cities.”**

As per this understanding, UMTC has prepared a report for developing a methodology for assessing carrying capacity for urban transport infrastructure, using Faridabad as a pilot city. However, from the comments received by CPCB, IIT-D, WRI and SPA, it seems that the expectation from this report was to assess urban transport carrying capacity across mutli-disciplinary fields of urban planning, with view of their effect on the environment.

UMTC can certainly prepare a further and more comprehensive, revamped and extensive report for assessing the Urban Transport Carrying Capacity, in light of the comments received from the Experts. The report that we already prepared was an attempt to come up with a framework for assessing Urban Transport Carrying Capacity, based on MoHUA’s Service Level Benchmarks (SLBs) in Urban Transport and Liveability Index (as mentioned above in this annexure). However, the comments of the Experts point that the Report needs to be extensively revamped to cover additional aspects and indicators, in order to be full-fledged and comprehensive in nature and to serve as a study containing the detailed methodology that can be adopted for assessing Urban Transport Carrying Capacity in respect of the non-attainment cities. In short, the study cannot be based on available secondary data and will need to calculate threshold values for additional indicators. Many additional indicators have already been identified in the current report, however, for making it extremely comprehensive

we will need to explore the possibility of formulating more new indicators, based on meetings with Experts and extensive field surveys. The calculation of the threshold values would involve further collection of primary and secondary data, across several cities and the data will then have to be analysed, normalised and standardized to come up with rational numerical thresholds. These thresholds would then be analysed and compared to values in Faridabad by collecting all such required data, specific to Faridabad, through conduction of field surveys and their validation by continuous observation/analysis etc.

We also propose that since each city must prepare the Comprehensive Mobility Plan (CMP), as a mandatory vision document of transport planning, the methodology for assessment of Urban Transport Carrying Capacity that would emerge from the present Study could serve as a key ingredient in preparation of the CMP for the respective cities. The components/ basket of indicators in the CMP tool kit is currently under review. The parameters/guidelines developed in the Study, in conjunction with other inputs would help preparation of a holistic CMP by the cities/ULBs and enable an integrated approach towards urban transport planning. Updation of the CMP toolkit, with the urban transport carrying capacity methodology, therefore becomes an additional and important task of this exercise. Also, UMTC is already preparing a CMP for Faridabad, and our Urban Transport Carrying Capacity report can be presented along with the CMP for a complete picture of the city.

It must be noted that considering the present movement restrictions due to Covid-19 and related issues, preparation of the more comprehensive and full-fledged Report that develops the detailed methodology for assessing Urban Transport Carrying Capacity for non-attainment cities and its application for case study of Faridabad would involve mobilisation of additional experts and resources and their deployment in the study area, carrying out of activities and monitoring etc. and thus would take a minimum of 10-12 additional months.

Yours sincerely

Regards,



Shruti Mahajan
Sr Advisor,
Corporate Office Tower,
Ambience Mall Complex, NH 8,
Gurgaon, Haryana, India -122002
Tele (Board) +91 1244716300
Tele Direct +91 1244716331
Fax +91 1126410763
Mob +91 9971196492
shruti.mahajan@umtc.in
www.umtc.co.in

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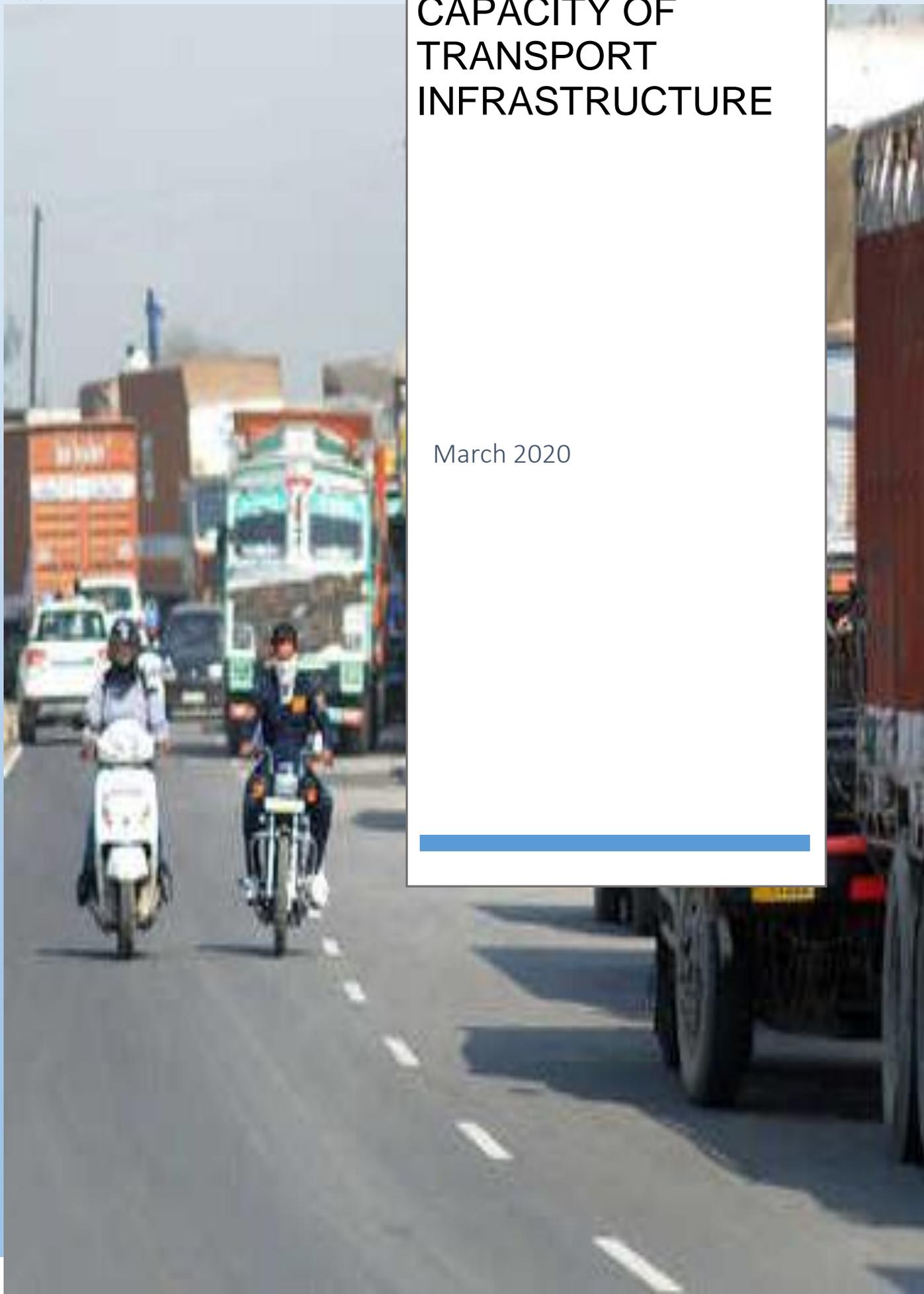


**Ministry of Housing
and Urban Affairs**

Government of India

GUIDELINES FOR ASSESSING URBAN CARRYING CAPACITY OF TRANSPORT INFRASTRUCTURE

March 2020



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Executive Summary

Carrying capacity has many definitions, concepts and methodologies for calculations. The widely accepted definition is based on the ecological concept of a threshold beyond which the environmental damage is irreversible.

In line with the National Green Tribunal (NGT) order to the Ministry of Housing and Urban Affairs (MoHUA), this study develops an approach for assessment of carrying capacity of the transport infrastructure for 102 major 'non-attainment' cities.

Carrying capacity for transport is defined as the ability of the whole transportation system to accommodate trip volume when the satisfactory / reasonable level of service is maintained. Capacity standards are fixed normally in relation to the Level of Service (LOS) of the design. Level of Service is defined as a qualitative measure describing operational conditions within a traffic stream, and their perception by drivers/passengers and in terms of factors such as speed and travel time, freedom to manoeuvre, traffic interruptions, comfort, convenience, safety and Pollution. Six levels of service are recognised commonly, designated from A (best operating conditions of free flow) to F (worst or break down of system). Study recommends Level of service B, equivalent to good (but not best) as practical or desired operating conditions for the urban area transport.

Study suggests an approach with following key steps and considerations –

1. Developing robust population estimates using latest available census data and the other data from ULBs (such as influence of birth rate, death rate and migrating population deduced from local labour demand and supply) for the study year (current or baseline) as well as for the horizon year and for all the years in between, under the different scenarios. For simplification – most probable scenario and projections can be adopted for detailing.
2. Collecting transport infrastructure and traffic data using commonly adopted transport sampling and data collection techniques for identified indicator list. For the sake of simplicity these obvious methodologies are not mentioned in report and are readily available with practitioners, in form of various toolkits and industry standards.
3. Combining the indicators to develop 14 key parameter categories covering various aspects such as capacity of public transport, active travel, urban freight, parking, ITS, road and related infrastructure and other personal modes. The total volume or traffic assignment is done using the 4-step modelling which integrates the 4 steps of trip production and attraction, trip distribution across zones, modal share (all modes



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including private transport and modes) based on preferences and affordability etc and finally traffic assignment on different roads. This is further calibrated using the traffic volumes collected during the primary survey of traffic studies. The 4-step transport model essentially include transport infrastructure details, traffic operations characteristics, as well as the land use and other influencing parameters. Public perceptions and human choices / preference are usually dealt using discrete choice models used in modal choices. While traffic assignment subsumes delay and other similar friction factors on transport infrastructure.

4. The parameter list includes environment safety and policy, institutional and financing related aspects. These are the intangible and rather subjective aspects but very important from the perspective of the futuristic planning, coordination with urban land use department and integrated interventions for efficient implementation and desired impacts.
5. Further the approach includes aggregation of these parameters in simplified matrix for easy interpretation and development of suitable interventions. One set of interventions need to be short term – to provide for immediate capacity gaps; while the other set of recommendations are for the longer term comprising of institutional and policy issues to plan effectively for the horizon year.
6. Further the study develops a composite index for comparing of the transport carrying capacity across similar type of cities. This is inspired by the UNESCAP SUTI index (2018) but adapted to Indian context across 14 key parameter categories.

The reports end with application of the transport carrying capacity on the case city of Faridabad. The study presents key results and estimations in the report for ease of use. More details can be referred in the submitted CMP. The interim experience shows robustness of the methodology. However, it can be better using the holistic data collection exercise across sectors such as urban planning, socio-economic agencies, establishment and commerce management agencies and other allied departments for more accurate and complete estimations of the recommended index.

Chapter 1. Introduction

1.1 Structure of the Report

The inception report contains five sections. Description of each section is given below:

- i. **Introduction:** This section indicates need and scope of the present study.
- ii. **Literature Review:** A brief **description** of the various definitions, components and sectors of urban carrying capacity assessed through various secondary literature study.
- iii. **Urban Carrying Capacity Assessment Framework:** Based on set criteria for determining the list of indicators **and** thresholds to form the evaluation matrix. This evaluation matrix shall be used to assess a city's urban transport carrying capacity.
- iv. **Case Study – Faridabad City:** Using the above evaluation matrix, assessing Faridabad city's condition of urban transport for **catering** to its inhabitants.
- v. **Way Forward:** List of 102 non-attainment **cities** to be evaluated using the above evaluation matrix.

1.2 Need of the Study

Human carrying capacity (of earth), a term coined by Thomas Malthus (demographer and political economist) in 1798, proposed that earth at a given time can only sustain definite growth of human population. Beyond which, the earth starts making its own corrections to check un-sustained population growth through measures of floods, droughts, famines, climate change etc. Carrying capacity is an ecological concept., Primary factors impacting capacity are pattern and extent of resource usage and socio-economic status of the people.

Rapid urbanization across the world have introduced a host of diverse urban problems in many megacities. Some of these problems include housing shortage, traffic congestion, environmental pollutions, lack of amenities, etc.

Expansion of urbanization throughout the world has given rise to numerous ecological problems such as deteriorating quality of air and water, surge of heat waves resulting from climate change, etc. With lack of proper facilities and infrastructure in place to support the growing population, the deterioration of quality of life in these urban areas is inevitable. It may even be irreversible in some cases.

In line with above, the National Green Tribunal (NGT) has ordered the Ministry of Housing and Urban Affairs (MoHUA) to carry out a study for assessment of carrying capacity for NCT of Delhi as well as other major cities particularly 102 'non-attainment' cities.

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Further, MoHUA has requested Urban Mass Transit Company (UMTC) to furnish a report on the study of a detailed methodology to be adopted for assessing urban carrying capacity for transport sector for these 102 'non-attainment' cities.

1.3 Scope of Work

1.3.1 Aim

The principle aim of the study is to assess the carrying capacity of the transport infrastructure for any Indian city.

1.3.2 Objectives

In light of the aim identified above, the objectives are:

1. Identification of various components of urban transportation that relates to carrying capacity based on existing literature;
2. Identify parameters and indicators to quantify urban transport infrastructure as per population;
3. Development of thresholds for the indicators based on best practices from international and national case studies;
4. Validating the indicators for Faridabad city based on primary and secondary data collection.

1.3.3 Approach

Approach to this study has three tenets

1. **Secondary Research:** This shall include literature search on the various available studies on urban carrying capacity for national or international cities.
2. **Methodology finalisation:** Different methodologies have been accepted as basis for calculation of urban carrying capacity for transport infrastructure in different countries for example Beijing and UK. MoHUA in India has the Service level benchmarks for transport Infrastructure that form the basis for assessment transport infrastructure in the country. This report lists out a few of the relevant studies. Final methodology for calculation of Urban carrying capacity is based on derived learning from these studies.
3. **Data collection, Field Investigations, and calculation of the transport carrying capacity for Faridabad city:** The city of Faridabad shall be ranked based on primary data collection against the identified indicators in the methodology. These will be compared with thresholds of best practices to understand where Faridabad stands today in terms of provision of urban transport infrastructure. Areas of improvement in the urban transport infrastructure will also be identified.

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1.3.4 Methodology

Methodology for study has following steps:

1. Establishing the parameters for evaluation of urban carrying capacity for transport infrastructure.
 - a. Review the various components of urban transport.
 - b. Listing all the parameters that impact mobility of each component of urban transport.
2. Establishing key quantifiable and specific indicators for the parameters identified.
3. Establishing thresholds for the identified indicators
 - a. Research and review of various best practices case studies of the urban transport components defined above across the nation and globally.
 - b. Comparative analysis of the best case.
 - c. Based on best case, assessment of the thresholds of each indicator.
4. Calculation of the composite matrix for urban carrying capacity of cities.
5. Assessment of urban carrying capacity of urban transport infrastructure for Faridabad city.
 - a. Collection of data from secondary and primary sources for Faridabad against the evaluation matrix established above.
 - b. Assessment of Faridabad's urban transport carrying capacity.

Chapter 2. Literature Review

Transport infrastructure has manifold impact, both intended and unintended, on the survival of a population. These impacts are sometimes irreversible, which has created the necessity to calculate urban carrying capacity. The concept of urban carrying capacity has many diverse definitions. The most common accepted definition of urban carrying capacity is - a 'sustainable threshold' to measure the conditions of urban sustainability. Once this threshold is exceeded, adverse impact of transport infrastructure would lead to irreversible deterioration in urban environment. Urban carrying capacity serves as a gauge to determine the optimal population size an urban area can sustain.

Despite being a widely discussed topic, urban carrying capacity lacks a widely accepted definition with a standardized assessment method. In this section some of the definitions and methodologies used in different countries are listed and discussed.

2.1 Definition of Urban Carrying Capacity

Urban carrying capacity is a very vast concept and has many different perspectives like social, cultural, political, ecological, etc. Following are some definitions cited from various studies:

- 'The urban carrying capacity can be defined as the level of human activities, population growth, patterns & extent of land use, physical development, which can be sustained by the urban environment without causing serious degradation and irreversible damage.' (Oh et.al., 2002)
- 'The carrying capacity of an area can be defined as the maximum number of people that can be supported by the environment of that area through optimum utilization of the available resources.' (Urban Carrying Capacity, IIT Guwahati, 2012)
- 'Urban carrying capacity refers to the limit of population growth, urban physical development, and socio-economic activities that can be perpetually supported by the urban supporting systems and they will not incur apparent degradation and irrevocable damage.' (Using UCC as a Benchmark for Sustainable Urban Development: An Empirical study of Beijing, Sustainability, 2015)

Accordingly, in transportation terms, the carrying capacity could also be defined as the ability of the whole transportation system to accommodate trip volume at the level in which a reasonable level of service is maintained. Since land use development implies the additional traffic volume, the carrying capacity of a city has direct correlation with the transportation capacity of the city.

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Capacity standards are fixed normally in relation to the Level of Service (LOS) adopted for the design. Level of Service is defined as a qualitative measure describing operational conditions within a traffic stream, and their perception by drivers/passengers and in terms of factors such as speed and travel time, freedom to manoeuvre, traffic interruptions, comfort, convenience, safety and Pollution.

Six levels of service are recognised commonly, designated from A to F, with Level of Service A representing the best operating condition (i.e. free flow) and Level of Service F the worst (i.e. forced or break-down flow). Sometimes 1 (best) to 4 (worst) are also defined as the level of service in similar context.

2.2 Components of Urban Carrying Capacity

Six components have been identified from various literature for evaluating the carrying capacity of an urban area:

1. Infrastructural capacity level
2. Institutional capacity level
3. Perceptual capacity level
4. Environmental capacity level
5. Sustainable capacity level
6. Bio-centric capacity level

[Infrastructural capacity level](#)

Here, the main focus is the amount of resources utilised for the development of infrastructure. Infrastructure includes, water supply system, sewage system, transportation system and water disposal system. It is linked with the supply of infrastructure and urban services available to sustain to a given size of inhabitants.

[Institutional capacity level](#)

It includes the various legal, political, regulatory and administrative framework that have been made to limit urban activities to achieve its goal of sustainable development. The level of enforcement of various acts like Environment protection acts, Biodiversity conservations act, as well as zoning regulations, building permits, land-use ordinances etc. are assessed to evaluate the carrying capacity.

[Perceptual carrying capacity](#)

It is evaluated on the basis of social surveys in which the idea of a common man towards its environment is judged. It is basically based upon the perception of a common man.

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Due to restrictions of collection of data being limited to secondary sources, no primary survey for assessing perceptions of common man will be evaluated in this study.

Environmental capacity level

At this level present state of environment is judged with respect to its productivity. The productivity can be in terms of agricultural productivity or it can be assessed on the basis of quality of air and water and present pollution levels.

As CPCB has already covered this aspect in their report, this component shall not be taken into consideration in this study.

Sustainable capacity level

It is basically based upon a long-term approach in which the resources are measured, on how long they will be able for the usage. The critical ones are identified and henceforth critical measures can be taken to sustain them.

Bio-centric capacity level

Unlike the other capacity level, it judges the requirements of all forms of life on earth and their needs from the environment. It detects all forms of threats which shall be harmful to maintain the stability, integrity of the biotic community of an urban area.

Many of these definitions and components are widely debated in the transport fraternity. Data availability on all the components is also a challenge. Considering the fact that the methodology is to be quickly replicated in 101 urban this study the only calculated the urban carrying capacity for infrastructure component,

2.3 Case studies of Urban Carrying capacity

2.3.1 UNESCAP Sustainable Urban Transport Index (SUTI)

UNESCAP has developed the Sustainable Urban Transport Index (SUTI), an Excel based tool that can help summarize, track and compare the performance of sustainable urban transport systems in cities. SUTI is a framework of indicators to assess urban transport systems and services. The index is based on ten indicators representing, transport system, social, economic, and environmental dimensions of sustainable urban transport. The indicators and SUTI can reflect state of urban transport performance in a city. The carefully selected ten SUTI indicators covers elements of planning, access, safety, quality and reliability, affordability, and emissions. Indicators on different scales are normalized and performance of each indicators is compared on a scale of 1-100 and illustrated in a spider diagram. SUTI is derived by geometric aggregation of ten indicators, based on equal weighting. SUTI tool can help cities to assess the achievement of the SDG target 11.2 and

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support implementation of the New Urban Agenda. (Source: <https://www.unescap.org/announcement/sustainable-urban-transport-index-suti>)

The 10 parameters used by the SUTI framework of UNESCAP are:

S. No.	Indicators	Units
1.	Extent to which transport plans cover public transport, intermodal facilities and infrastructure for active modes	0 - 16 scale
2.	Modal share of active and public transport in commuting	% of trips
3.	Convenient access to public transport service	% of population
4.	Public transport quality and reliability	% satisfied
5.	Traffic fatalities per 100,000 inhabitants	# fatalities
6.	Affordability – travel costs as share of income	% of income
7.	Operational costs of the public transport system	Cost recovery ratio
8.	Investment in public transportation systems	% of total investment
9.	Air quality (pm10)	µg/m3
10.	Greenhouse gas emissions from transport	Tons/cap

Table 1: Parameters used by the SUTI framework of UNESCAP

Indicators on different scales are normalized and performance of each indicators is compared on a scale of 1-100 and SUTI is derived by geometric aggregation of 10 indicators, based on equal weightages.

2.3.2 UK National Infrastructure Commission's Urban Transport Analysis: Capacity and Cost (NIC. Steer Davis Gleeves. 2018)

National Infrastructure Commission (NIC) UK, commissioned a study titled Urban Transport Analysis: Capacity and Cost. This study report (2018), provides an order of magnitude estimate of peak hour transport network capacity to the centre of large towns and cities in England. For a number of scenarios, it also establishes order of magnitude costs for increasing that capacity. This study forms part of a suite of three parallel studies, which taken together are seeking to understand the cost of increasing transport capacity into city centres and the likely economic benefits of doing so. The study approach to calculate the order of magnitude estimate for carrying capacity of transport infrastructure, for twenty case study town and city centres.

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2.3.3 Urban Carrying Capacity Study Beijing (Sustainability 2015)

This study provides a quantitative based UCC assessment framework. This framework is a set of measurable indicators and benchmarks for city managers to conduct routine monitoring on progress toward urban sustainability, and helps identify deficient areas, which urgently need resource allocation to improve UCC. The study list five categories of indicators. Each category is further divided into measurable indicators and their threshold value is provided.

Components	Meaning and Definition
Environmental impacts and natural resources	It refers to the size of population and human activity of a region, where waste and pollution can be adequately assimilated and sufficient resources can be provided by the environment without scarifying urban residents' living quality and the environment's endurance. This concept consists of two key components, namely, assimilative capacity and resources production capacity of the environment.
Infrastructure and urban services	It refers to the size of human activity that the infrastructure and urban services of a specified area can satisfactorily sustain without incurring living quality degradation. The efficiency and intensity of infrastructure and urban services should be accurately assessed, such as healthcare, housing, amenity, transport, pipeline, etc.
Public perception	It refers to the degree of visual or psychological changes that can be perceived by the public with apparent betterments than previously observed.
Institution setting	It refers to the political, regulatory, administrative, and sociological conditions of a city toward achieving its goal of sustainable development. Social equity, governance transparency, and cultural diversity are the primary components of institutional setting.
Society supporting capacity	It refers to the economic, technological, and fiscal capacity of a city to proactively promote carrying capacity. It is the most manageable and proactive parameter for UCC building. The associated indicators can be roughly represented by fiscal income of the local government, GDP, employment rates, portion of investment on environment protection to GDP, etc.

Table 2: Determinative Components of UCC from Beijing Study

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2.3.4 Carrying Capacity of Urban Roads by IRC (Indian Road Congress)

Urban Transport Capacity as per IRC 106-1990 provides the basis for determining the number of traffic lanes to be provided for different road sections having regard to volume, composition, and other parameters of traffic, in Indian context. Alternatively, for an existing road network, the capacity analysis provides a means of assessing the traffic carrying ability of the number of traffic lanes provided for a given road link under the prevailing roadway and traffic conditions.

The code IRC 106-1990 provides the details on the passenger car units (PCU) equivalents of all the modes depending upon their presence in the traffic (5% or greater than 10% in total volume) from slow (NMT including animal carts) to fast (cars, trucks, tractors etc.). Additionally, it provides the average lane capacity estimates for arterial, sub-arterial and collector roads for the 2 lane to 8 lane roads that are one way, two way and divided or undivided.

While the code provides for the critical values for the lane capacity estimates, it did not provide for the LOS description and estimation methodology in Indian context. However, the document highlighted several potential interventions ranging from the NMT lanes to dedicated PT lanes and parking management to increase the system capacity. Only recently, MoHUA provided the LOS description, benchmarks and knowhow of these estimates, as discussed below.

2.3.5 MoHUA Service level benchmarks

Ministry of Housing and Urban affairs has developed a very comprehensive Service Level Benchmark (SLB) document after extensive consultation with sector experts. MoHUA's SLB framework list out a comprehensive methodology for calculating service levels for transport infrastructure on the basis of more than 30 parameters that impact the performance of urban transport infrastructure. These parameters are categorised into 10 categories. Methodology for calculation of consolidated service level for each category is also provided in the MoHUA's Service level benchmark document.

List of Service level benchmark categories as per MoHUA report are:

S. No	MoHUA SLB Indicator Categories
1.	Public Transport Facilities (6 sub-parameters)
2.	Pedestrian Infrastructure Facilities (4 sub-parameters)
3.	Non-Motorized Transport (NMT) Facilities (3 sub-parameters)
4.	Level of Usage of Intelligent Transport System (ITS) facilities (5 sub-parameters)
5.	Travel Speed (Motorized and Mass Transit) Along Major Corridors (2 sub-

	parameters)
6.	Availability OF Parking Spaces (2 sub-parameters)
7.	Road Safety (2 sub-parameters)
8.	Pollution Levels (4 sub-parameters)
9.	Integrated Landuse-Transport System (6 sub-parameters)
10.	Financial Sustainability of Public Transport by Bus (3 sub-parameters)

Table 3: Service level benchmark parameters as per MoHUA report

2.4 Parameters of Urban Carrying Capacity

Different parameters on which the urban carrying capacity should be judged were discussed in the MOHUA's report on "Service Level Benchmark for urban transport for Indian cities". This study was extensively debated and is now widely accepted basis for calculation of service levels of transport infrastructure in an urban area. Therefore SLB parameters forms the basis for identification of parameters for calculation of the urban carrying capacity of transport infrastructure.

Market conditions have changed from when the SLB framework was developed by MoHUA. For example, e-commerce delivery trips have become a significant component of urban transport. Private vehicles were also not covered in the SLB framework. This study therefore, suggests addition of few parameters in the SLB framework in the following categories - Intermediate Para Transit, Urban Freight transport, Utilities trips, Road transport infrastructure.

The following components of urban transport infrastructure have been identified for calculation of urban carrying capacity:

2.4.1 Parameters for calculating urban carrying capacity, that are covered in MoHUA SLB framework

1. Public Transport (Bus and Metro)
2. Pedestrian Infrastructure
3. Non-Motorised Transport
4. Intelligent Transport System
5. Travel speed
6. Parking management
7. Road safety
8. Environmental parameters
9. Integrated land use transport system
10. Financial sustainability

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2.4.2 Parameters for calculating urban carrying capacity that are not covered in MoHUA SLB framework

11. Intermediate Para Transit

12. Urban Freight transport

13. Utilities trips

14. Road

transport

infrastructure



Chapter 3. Urban Carrying Capacity Assessment Framework for Transport Infrastructure

3.1 Population - Current and Projection

The first key aspect of the framework is to calculate the current population of the city. Census of India only provided data on city population every 10 years. However, city development plans project data on city population for next 20 years. These phase wise projections should be used for estimating the current population, if the year of estimating the urban carrying capacity is different from the census year. Further, the projections of the city development plans may be used for future estimate of carrying capacity.

3.2 Identified Relevant Indicators Data Collection

The comprehensive list of parameters, their formulae, their unit, their threshold, and source for calculation of the urban carrying capacity is presented below.

S. No	Indicator	Formulae	Units	Lower threshold ¹	Upper threshold ¹	source
1.	PUBLIC TRANSPORT FACILITIES					
1.1	Presence of Organized Public Transport System in Urban Area	= Total number of buses operating on Road / total number of buses under the ownership of STU/SPV or under concession agreement. ((All AC, non-AC midi, mini and standard buses to be considered)	%	40	60	MoUD_Service Level Benchmarks_LOS B
1.2	Extent of Supply / Availability of Public Transport	= No of Buses/ train coaches available in a city on any day /	Ratio	0.4	0.6	MoUD_Service Level Benchmarks_LOS B

¹ Service level 2



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		Total Population of the city				
1.3	Service Coverage of Public Transport in the city (Bus route network density):	= Total length in road kms of the corridors on which public transport systems ply in the city / Area of the urban limits of the city	Road kms / Sq. km.	0.7	1	MoUD_Service Level Benchmarks_LOS B
1.4	Average waiting time for Public Transport users.	Follow methodology as per page no 21	mins	4	6	MoUD_Service Level Benchmarks_LOS B
1.5	Level of Comfort in Public Transport (Crowding)	Follow methodology as per page no 22	number	1.5	2	MoUD_Service Level Benchmarks_LOS B
1.6	Percentage Fleet as per Urban Bus Specifications	= Total number of buses in the city / % of Fleet as per Urban Bus Specifications	%	50	75	MoUD_Service Level Benchmarks_LOS B
1.7	Transit accessible area (% built up area within 500m of PT plying)	500 meters buffer drawn around the PT routes and area (sq km) measured / total habitable area of the city	%	*TBD	*TBD	Composite Sustainable Urban Transport Index (CEPT, 2013)
1.8	High frequency transit accessible area (% area with transit access 10 min or less headway)	500 meters buffer drawn around the PT routes served with 10 min average headway and area (sq km) measured / total habitable area of the city	%	*TBD	*TBD	Composite Sustainable Urban Transport Index (CEPT, 2013)
1.9	Total boarding / 1000 Population	no of trips (ticketed, passes, etc) catered by public transport per 1000 population	Ratio	*TBD	*TBD	Composite Sustainable Urban Transport Index (CEPT, 2013)
1.10	Affordability of PT	= farebox revenue / passenger kilometers (note: shall be averaged)	INR/km (Average)	*TBD	*TBD	Composite Sustainable Urban Transport Index (CEPT, 2013)
1.11	Travel speed of Public Transport along key corridors	average travel speed for PT mode (on high volume and high frequency routes)	Kmph	*TBD	*TBD	Composite Sustainable Urban Transport Index (CEPT, 2013)
1.12	Breakdown of public Transport Vehicles	total no of breakdowns annually / total effective kilometers annually	No.	*TBD	*TBD	Composite Sustainable Urban Transport Index (CEPT, 2013)
1.13	Vehicle (bus) Utilization	total buses operated as	%	*TBD	*TBD	Composite Sustainable



		scheduled / total buses planned to be deployed (Note: Avg for the year)				Urban Transport Index (CEPT, 2013)
1.14	Interchanges having Multi-modal Facilities	No. of interchanges with multimodal facilities *100000/ total population	No. / Lakh Population	*TBD	*TBD	Composite Sustainable Urban Transport Index (CEPT, 2013)
1.15	PTAL (Public Transport Accessibility level)	An alternative methodology as against all the indicators measured above to represent sum total of the overall accessibility score for the Public transport (link:)	Number	4	5	ADVANCES IN PUBLIC TRANSPORT ACCESSIBILITY ASSESSMENTS FOR DEVELOPMENT CONTROL
2	PEDESTRIAN INFRASTRUCTURE FACILITIES					
2.1	Signalized intersection delay (%)	Follow methodology as per page no 23-24	%	25	50	MoUD_Service Level Benchmarks_LOS B
2.2	Street Lighting (Lux)	Follow methodology as per page no 23-24	Lux	6	8	MoUD_Service Level Benchmarks_LOS B
2.3	Percentage of City Covered with footpaths (wider than 1.2 metres)	= (Total length of road network / Total length of footpath of a city) * 100	%	50	75	MoUD_Service Level Benchmarks_LOS B
2.4	Availability of signalized intersections	total signalized intersections / total intersections in city (%)				MoUD_Service Level Benchmarks_LOS B
3	NON-MOTORIZED TRANSPORT (NMT) FACILITIES					
3.1	NMT Coverage (% network covered)	= (Total length of road network / Total Length of NMT network) * 100	%	25	50	MoUD_Service Level Benchmarks_LOS B
3.2	NMT parking facilities at Interchanges (%)	= (Total length of the Parking on Cycle Track / Total length of NMT network) * 100	%	50	75	MoUD_Service Level Benchmarks_LOS B
3.3	Cycle Parking facilities at Interchanges (%)	= (Total no. of interchanges / Total no. of interchanges having bicycle parking) * 100	%			MoUD_Service Level Benchmarks_LOS B
4.	LEVEL OF USAGE OF					



INTELLIGENT TRANSPORT SYSTEM (ITS) FACILITIES						
4.1	Availability of Traffic Surveillance System	= (Total no. of bus stations on BRTS, major bus stops, terminals, metro stations and signalized intersections having CCTV / Total no. of bus stations on major bus stops, BRTS, terminals, major bus stops, metro stations and signalized intersections) * 100	%	50	75	MoUD_Service Level Benchmarks_LOS B
4.2	Passenger Information System (PIS)	= (Total no. of bus stops, terminals, metro stations having PIS / Total no. of bus stops, terminals, metro stations) * 100	%	50	75	MoUD_Service Level Benchmarks_LOS B
4.3	Usage of Global Positioning System	= (No. of Public Transport Vehicles and IPT with functional onboard GPS / GPRS and connected to common control center / Total no. of Public Transport Vehicles and IPT) * 100	%	50	75	MoUD_Service Level Benchmarks_LOS B
4.4	Signal Synchronization	= (No. of signals which are synchronized / Total no. of signalized intersections) * 100	%	50	75	MoUD_Service Level Benchmarks_LOS B
4.5	Integrated Ticketing System	= (Total Number of modes and operators in the city (Buses, IPT, Metro etc) which have integrated ticketing / Total Number of modes and operators in the city (Buses, IPT, Metro etc)) * 100	%	50	75	MoUD_Service Level Benchmarks_LOS B
5	TRAVEL SPEED (MOTORIZED)					



AND MASS TRANSIT) ALONG MAJOR CORRIDORS						
5.1	Average Travel speed of Personal vehicles (Kmph)	Follow methodology as per page no 31	Kmph	25	30	MoUD_Service Level Benchmarks_LOS B
5.2	Average Travel speed of Public Transport (Kmph)	Follow methodology as per page no 31	Kmph	15	20	MoUD_Service Level Benchmarks_LOS B
5.3	Road density (km/square kms)	total area covered under roads and shoulders / total habitable land use area of city	km / sq. km	*TBD	*TBD	Composite Sustainable Urban Transport Index (CEPT, 2013)
5.4	% Higher order roads (level 1 and level 2)	total lane kilometers for the arterial and sub-arterial designated roads in city / total lane kilometers in the city	%	*TBD	*TBD	Composite Sustainable Urban Transport Index (CEPT, 2013)
5.5	Road lighting levels (LUX)	average street lighting levels measured at roads in city (on either side for stratified sample covering arterial, sub-arterial, collector and local roads of teh city)	lux	*TBD	*TBD	Composite Sustainable Urban Transport Index (CEPT, 2013)
5.6	Area under roads (%)	Total roads area /total planned landuse area	%	*TBD	*TBD	Composite Sustainable Urban Transport Index (CEPT, 2013)
6. AVAILABILITY OF PARKING SPACES						
6.1	Availability of paid public parking spaces (%)	= (Total available on street paid parking spaces in (Equivalent Car Spaces) ECS allotted for all vehicles / Total available on street parking spaces in (Equivalent Car Spaces) ECS allotted for all vehicles) * 100	%	50	75	MoUD_Service Level Benchmarks_LOS B
6.2	Ratio of Maximum and Minimum Parking Fee in the City	= (Maximum parking fee being charged per 2 hours in the city for public parking /	ratio number	2	4	MoUD_Service Level Benchmarks B



		Minimum parking fee being charged per 2 hours in the city for public parking) * 100				
7.	ROAD SAFETY					
7.1	Fatality rate per lakh population	= ((Total number of fatalities recorded in road accidents within city limits in the given calendar year * 100000) / Population of the urban agglomeration in that year)	ratio	2	4	<i>MoUD_Service Level Benchmarks_LOS B</i>
7.2	Fatality rate for pedestrian and NMT (%)	= (Total number of fatalities recorded of persons who were pedestrians or on non-motorised transport vehicles, in road accidents within city limits in given year / Total number of fatalities recorded in road accidents within city limits in the given calendar year) * 100	%	20	40	<i>MoUD_Service Level Benchmarks_LOS B</i>
7.3	Serious accidents per lakh population	total number of severe crashes (defined as involving plegic/ paraplegic or deep head and spine injuries) / total population	No. / lakh Pop.	*TBD	*TBD	<i>Composite Sustainable Urban Transport Index (CEPT, 2013)</i>
8.	POLLUTION LEVELS					
8.1	Annual Mean Concentration Range of SO2 (µg/m3).	Measure Rating	µg/m3	40	80	<i>MoUD_Service Level Benchmarks_LOS B</i>
8.2	Annual Mean Concentration Range of oxides of Nitrogen (µg/m3).	Measure Rating	µg/m4	40	80	<i>MoUD_Service Level Benchmarks_LOS B</i>
8.3	Annual Mean Concentration Range of SPM (µg/m3).	Measure Rating	µg/m5	180	36	<i>MoUD_Service Level Benchmarks_LOS B</i>
8.4	Annual Mean Concentration Range of RSPM (less than 10 micron) (µg/m3).	Measure Rating	µg/m6	40	80	<i>MoUD_Service Level Benchmarks_LOS B</i>



9. INTEGRATED LANDUSE-TRANSPORT SYSTEM						
9.1	Population Density - Gross (Persons/Developed Area in hectare)	= (Population of current year or the year for which data is available / From remote sensing/satellite image or from Google compute developed area (Hectare))	Ratio	150	175	MoUD_Service Level Benchmarks_LOS B
9.2	Mixed Landuse on Major Transit Corridors/Network (% non-residential area)	Inventory of landuse(% non-residential area) along major transit corridors (500 meters approx) based Master Plan/Development Plan	%	15	30	MoUD_Service Level Benchmarks_LOS B
9.3	Intensity of Development city wide - (Floor Space Index - Master Plan/DP)	Floor space Index (applicable to most part of the city as per Master Plan/DP.	number	1.5	2	MoUD_Service Level Benchmarks_LOS B
9.4	Intensity of development along transit corridor- Ratio of FSI on Transit corridor to city FSI (provision as per Master Plan / Development Plan/ Any other policy)	" = FSI along transit corridors / Floor space Index (applicable to most part	Ratio	2	3	MoUD_Service Level Benchmarks_LOS B
9.5	Clear pattern and Complete network	of the city as per Master Plan/DP"	Text	Somewhat clear Pattern	Some what incomplete	MoUD_Service Level Benchmarks_LOS B
9.6	Proportion of network having exclusive ROW for Transit	Based on existing & proposed network recognize/identify major roads and pattern	%	20	30	MoUD_Service Level Benchmarks_LOS B
10. FINANCIAL SUSTAINABILITY OF PUBLIC TRANSPORT BY BUS						
10.1	Extent of Non-fare Revenue (%)	= (Revenue collections per annum from non-fare related sources / Total revenue per annum from all sources) * 100	%	20	40	MoUD_Service Level Benchmarks_LOS B
10.2	Staff /bus ratio	= (Calculate the total staff of bus operation and maintenance / Calculate the	ratio	5.5	8	MoUD_Service Level Benchmarks_LOS B



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		total number of buses) * 100 = (Calculate cost / bus / Calculate earning /bus) compute LoS as mentioned in indicator 3.	ratio	0.7	1	MoUD_Service Level Benchmarks_LOS B
10.3	Operating Ratio					
11.	INTERMEDIATE PARA TRANSIT					
11.1	Travel Speed of IPT	85th percentile of sampled speed measures in kmph	kmph	*TBD	*TBD	Composite Sustainable Urban transport Index (CEPT, 2013)
11.2	ITS facility (GPS) % in IPT	total IPT vehicles fitted with GPS / total IPT vehicles (%)	%	*TBD	*TBD	Composite Sustainable Urban transport Index (CEPT, 2013)
11.3	Presence of IPT per 1000 population	total IPT vehicles available*1000 / total population	No/1000 pop	*TBD	*TBD	Composite Sustainable Urban Transport Index (CEPT, 2013)
12.	FREIGHT TRANSPORT					
12.1	Goods flow (avg) trips per day	surveyed at the key cordon points (typical day average)	number	*TBD	*TBD	Literature Review
12.2	Inbound Commodity Tonnes per 1000 Population	using truckers survey at cordon points and using freight weight data /e-way bill data	tonnes	*TBD	*TBD	Literature Review
12.3	Inbound vehicles per 1000 population	total freight vehicles entering city on typical day *1000/total population	number	*TBD	*TBD	Literature Review
12.4	Outbound Commodity Tonnes	using truckers survey at cordon points and using freight weight data /e-way bill data	tonnes	*TBD	*TBD	Literature Review
12.5	Outbound vehicles per 1000 population	total freight vehicles exiting city on typical day *1000/total population	number	*TBD	*TBD	Literature Review
12.6	no. of home deliveries per 1000 population	e-commerce delivery trips and other home delivery trips such as groceries,	number	*TBD	*TBD	Literature Review



		newspaper, etc*1000/population of city				
12.7	no of micro-stores (kirana shops) per 1000 population	mixed land use shops /stores that require frequent delivery *1000 / total population	number	*TBD	*TBD	Literature Review
12.8	no. of vendors registered in city	registration / active numbers collected from shops and establishment registration office	number	*TBD	*TBD	Literature Review
12.9	no of carts and other vendors per 1000 population	total observed vendors in sample areas *1000 /total population	number	*TBD	*TBD	Literature Review
12.10	Avg tonnes handled at Mandis and Wholesale hubs	total estimated tonnes of goods handled at wholesale market hubs and mandis	tonnes	*TBD	*TBD	Literature Review
13.	UTILITIES TRIPS					
13.1	water supply tanker trips	total trips made by jal board vehicles on a typical day	number	*TBD	*TBD	Literature Review
13.2	solid waste collection trips	total trips made by ULB vehicles on a typical day	number	*TBD	*TBD	Literature Review
13.3	sewage /soak pit / dump /septic tank cleaners	total trips made by ULB vehicles on a typical day	number	*TBD	*TBD	Literature Review
14.	ROAD INFRASTRUCTURE FACILITY					
14.1	% of arterial road	total lane kilometers designated as Arterial roads / total lane kilometers in city	% share	*TBD	*TBD	Literature Review
14.2	% of Sub-arterial road	total lane kilometers designated as sub-Arterial roads / total lane kilometers in city	% share	*TBD	*TBD	Literature Review
14.3	Signalized junctions as % of total intersections	total signalized junctions / total interscetions in city	% share	*TBD	*TBD	Literature Review
14.4	Total Volume and capacity of the transport infrastructure of city	Volume and capacity estimation per four step transport model	Total vehicle	*TBD	*TBD	Literature Review



			trips and ped trips			
14.5	v/c ratio	Volume/capacity	No.	*TBD	*TBD	Literature Review

*Higher value means poor service

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MoHUA SLB Parameters
 Composite Sustainable Urban Transport Index (CEPT, 2013)
 New Parameter derived from Literature review

Table 4: Final list of parameters and sub parameters

Please note that calculation of thresholds for the new categories of parameters requires an extensive expert consultation based on Delphi technique. This would require time and cannot be completed as a part of this study. It is therefore, suggested that this exercise may be taken up by MoHUA separately. Therefore, for the purpose of this study the new parameters have been ignored and only the SLB parameters have been used for assessment of urban carrying capacity for transport infrastructure.



3.3 Final Evaluation Matrix

Literature review shows that MoHUA's SLB parameters are sufficiently comprehensive and covers most of the parameters covered in other UCC studies. Other UCC studies however give one composite value or index for urban carrying capacity. MoHUA's SLB framework is silent on a single figure combining all categories. This study therefore proposes to use the methodology used by UNESCAP SUTI index, to combine the service levels for each SLB category into a single service level for urban transport in a city. The final evaluation matrix along with their thresholds and their combining methodology is presented below:

S. No.	SLB Indicator Categories	Lower threshold ²	Upper threshold ³	Normalisation on a scale of 1-100*
		a	b	$x=(y-a)/(b-a)*100$
1.	Public Transport Facilities (6 sub-parameters)	1	24	
2.	Pedestrian Infrastructure Facilities (4 sub-parameters)	3	12	
3.	Non-Motorized Transport (NMT) Facilities (3 sub-parameters)	3	12	
4.	Level of Usage of Intelligent Transport System (ITS) facilities (5 sub-parameters)	5	20	
5.	Travel Speed (Motorized and Mass Transit) Along Major Corridors (2 sub-parameters)	2	8	
6.	Availability OF Parking Spaces (2 sub-parameters)	2	8	
7.	Road Safety (2 sub-parameters)	2	8	
8.	Pollution Levels (4 sub-parameters)	1	16	
9.	Integrated Landuse-Transport System (6 sub-parameters) -	1	28	
	>= 1 million population	1	28	
	< 1 million population	1	28	
10.	Financial Sustainability of Public Transport by Bus (3 sub-parameters)	1	12	
	Average			Average of all 10 values above

Note: *Higher value means poor service
y is the value of overall service level in the SLB Indicator category

Table 5: Final Evaluation Matrix

² Lower threshold of service level 1

³ Upper threshold of service level 4

Chapter 4. Faridabad City

4.1 Introduction

Faridabad is one of the important cities of the National Capital Region (NCR), being located to the south of the National Capital Territory of Delhi. In addition to direct and strong connectivity with the NCT of Delhi, Faridabad also enjoys connectivity with other major NCR towns such as Noida/Greater Noida/Ghaziabad on the East and Gurgaon on the West – the seamless flow of traffic among NCR towns including Faridabad coupled with increased urbanization makes the traffic and transportation situation extremely challenging.

Faridabad being a predominantly industrial town, houses a number of small, medium and large-scale industries. More and more investments are flowing into various sectors of industry, commerce and real estate in Faridabad. The major industrial production in the district, mainly represented by Faridabad city itself, is of tractors, steel re-rolling, scientific instruments, power looms, agriculture implements, JCB cranes, etc. As a result, there are significant number of workers employed in the factories who mostly live in Faridabad / Ballabgarh, making it important to provide sustainable mobility solutions. Apart from this, the city is home to many international/ multinational companies which are operating in the Faridabad-Ballabgarh belt. The economic activities in Faridabad have also given boost to the regional economy and employment, stressing on the need for improved transport infrastructure facilities for providing better connectivity and travel experience.

4.2 City Profile

Faridabad city is a million plus city with a population of 1.4 million as per 2011 census. The various characteristics of the city are given in:

S. No.	Parameters	Figures
1	Population	14,38,855 (Census 2011)
	Population	2296791 (2017) Source: Municipal Corporation
2	Area	742.9 km ²
3	Road Length	27.88 km ²
4	PT System Available	Bus, MRTS, Shuttle
5	Bus Fleet	115
6	MRTS Length	16 km
7	No. of MRTS Stations	11

Table 6: Faridabad City Profile

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Faridabad, like all other cities in India, is experiencing transport related issues. The increased dependency on private motor vehicles for personal trips, is leading to increased vehicular congestion and emissions. The modal share of public transport is as low as 11% whereas the dependence on private modes is 51% and NMT is 34%. This indicates higher reliance on private modes for long distance travel.

4.3 Assessment of Urban Transport Carrying Capacity for Faridabad

The data sets for the city of Faridabad was collected through secondary and primary sources, and is presented below. These data sets were evaluated against the thresholds of the SLB framework to assess the current status of Faridabad. The following table shows the present status of service level benchmarks for transport infrastructure in Faridabad:

S. No.	Parameters	DATA	Calculation	LOS from Formula
1	Public Transport Facilities		16	2
1.1	Presence of Organized Public Transport Facilities		0.00%	4
1.1.1	Total Number of Buses in the city	115		
1.1.2	Total Number of Buses under the ownership of STU/SPV or under concession agreement	0		
1.2	Availability of Public Transport		1.19	1
1.2.1	Number of Buses/Train Coaches operating in a city on any day (1 Train Coach = 3 Buses)	2738		
1.2.2	Total Population of the city (Current population)	2,296,791		
1.3	Service Coverage of Public Transport in the city		0.54	3
1.3.1	Total length in road kms of the corridors on which public transport systems ply in the city	75.8		
1.3.2	Area of the urban limits of the city (Sq. Km.)	139.22		
1.4	Average waiting time for Public Transport users	7.2	7.20	3
1.5	Level of Comfort in Public Transport	0.95	1.80	2
1.6	Percentage of fleet as per Urban Bus Specifications		47.83%	3
1.6.1	Total Number of Buses in the city	115		
1.6.2	Total Number of Buses as per Urban Bus Specifications in the city	55		
	Cumulative Score for Public Transport Facilities			

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2	Pedestrian Infrastructure Facilities		11	4
2.1	Signalized intersection delay		0%	4
2.1.1	Total number of signalized intersections having average waiting time more than 45 seconds for pedestrians	0		
2.1.2	Total number of signalized intersections	1		
2.2	Street Lighting	5	5.00	3
2.3	Percentage of city covered		6.02%	4
2.3.1	Total length of road network (multiplied by 2)	822		
2.3.2	Total length of footpath of a city (width >= 1.2m, multiplied by 2 if on both sides)	49.50052535		
	Cumulative Score for Pedestrian Infrastructure Facilities			
3	Non-Motorized Transport (NMT) Facilities		12	4
3.1	Percentage of network covered		0.00%	4
3.1.1	Total length of road network	411		
3.1.2	Total length of NMT network	0		
3.2	Encroachment on NMV roads by vehicle parking		100%	4
3.2.1	Total length of the parking on NMT track	1		
3.2.2	Total length of NMT network	1		
3.3	NMT parking facility at interchanges		0.00%	4
3.3.1	Total number of interchanges (major Bus stops, Terminals and Railway stations)	4		
3.3.2	Total number of interchanges having Bicycle parking (within 250m radius)	0		
	Cumulative Score for Non-Motorized Transport (NMT) Facilities			
4	Level of usage of Intelligent Transport System (ITS) Facilities		17	4
4.1	Availability of Traffic Surveillance		54.84%	2
4.1.1	Total number of Bus stations on BRTS, major Bus Stops, Terminals, Metro Stations and Signalized Intersections having CCTVs	17		

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4.1.2	Total number of Bus stations on BRTS, major Bus Stops, Terminals, Metro Stations and Signalized Intersections	31		
4.2	Passenger Information System (PIS)		48.39%	3
4.2.1	Total number of Bus Stops, Terminals, Metro Stations having PIS	15		
4.2.2	Total number of Bus Stops, Terminals, Metro Stations	31		
4.3	Global Positioning System (GPRS)		0.00%	4
4.3.1	Number of Public Transport Vehicles and IPT with functional onboard GPS/GPRS and connected to common control centre	0		
4.3.2	Total number of Public Transport Vehicles and IPT	10000		
4.4	Signal Synchronization		0.00%	4
4.4.1	Number of signals which are synchronized	0		
4.4.2	Total number of signalized intersections	46		
4.5	Integrated Ticketing System		0.00%	4
4.5.1	Total number of modes and operators in the city (Bus, IPT, Metro etc.) having integrated ticketing system	0		
4.5.2	Total number of modes and operators in the city (Bus, IPT, Metro etc.)	4		
	Cumulative Score for Level of usage of Intelligent Transport System (ITS) Facilities			
5	Travel Speed (Motorized and Mass Transit) along major corridors		6	3
5.1	Travel speed of personal vehicles along key corridor	19.4	19	3
5.2	Travel Speed of Public Transport along key corridors	12	12	3
	Cumulative Score for Travel Speed (Motorized and Mass Transit) along major corridors			
6	Availability of Parking Spaces		5	3
6.1	Availability of paid parking spaces		0.00%	4
6.1.1	Total available on-street paid parking spaces in ECS allotted for all vehicles	0		
6.1.2	Total available on-street parking spaces in ECS allotted for all vehicles	4482		

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6.2	Ratio of maximum and minimum parking fee in the city		5.00	1
6.2.1	Maximum parking fee being charged per 2 hours in the city for public parking	100		
6.2.2	Minimum parking fee being charged per 2 hours in the city for public parking	20		
	Cumulative Score for availability of Parking Spaces			
7	Road Safety		6	3
7.1	Fatality rate per lakh population		11.10	4
7.1.1	Total number of fatalities recorded in road accidents within city limits in the given calendar year	255		
7.1.2	Population of urban agglomeration in that year (2011)	22,96,791		
7.2	Fatality rate for pedestrian and NMT		21.57%	2
7.2.1	Total number of fatalities recorded of persons who were pedestrian or on NMT vehicles, in road accidents within city limits in given year	55		
7.2.2	Total number of fatalities recorded in road accidents within city limits in the given calendar year	255		
	Cumulative Score for road safety			
8	Pollution Levels		5	1
8.1	Annual Mean Concentration Range of Sulphur Dioxide (SO ₂)	10	10.11	1
8.2	Annual Mean Concentration Range of Oxides of Nitrogen	60	60.09	2
8.3	Annual Mean Concentration Range of Suspended Partial Matter (SPM)	162	162.07	1
8.4	Annual Mean Concentration Range of Respirable Suspended Partial Matter (RSPM)	0	0.00	1
	Cumulative Score for pollution levels			
9	Integrated Landuse-Transport System		19	3
9.1	Population Density		113.42	4
9.1.1	Total developed area in Hectare (From remote sensing/satellite image or from google)	20250		

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9.1.2	Population of current year	2,296,791		
9.2	Mixed landuse zoning (Percentage of area under non-residential use)	43.43%	43.43%	1
9.3	Intensity of development-Citywide (FSI)	1.5	1.5	2
9.4	Intensity of development along transit corridor		0.7	4
9.4.1	Citywide Floor Space Index (FSI)	1.5		
9.4.2	Floor Space Index (FSI) along transit corridor	1.1		
9.5	Road network pattern and completeness	2	2	2
9.6	Percentage of area under roads		13.38%	2
9.6.1	Overall developed area of the city (sq.km.)	208.29319		
9.6.2	Total area under road network (sq.km.)	27.87690504		
9.7	Percentage network with exclusive RoW for transit (for >1 million population as per 2001 census)		0.00%	4
9.7.1	Total urban road and rail network (km.)	411		
9.7.2	Total network with exclusive RoW (km.)	0		
	Cumulative Score for Integrated Landuse-Transport System			
10	Financial sustainability of Public Transport (Bus Based)	Data not Available		
10.1	Extent of non-fare revenue	Data not Available		
10.1.1	Revenue collections per annum from non-fare related sources (Rs.)	Data not Available		
10.1.2	Total revenue per annum from all sources (Rs.)	Data not Available		
10.2	Staff per Bus ratio	Data not Available		
10.2.1	Total staff of Bus operation and maintenance	Data not Available		
10.2.2	Total number of buses	Data not Available		
10.3	Operating Ratio	Data not Available		
10.3.1	Cost per Bus (Rs.)	Data not Available		
10.3.2	Earning per Bus (Rs.)	Data not		

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		Available		
	Cumulative Score for financial sustainability of Public Transport (Bus Based)	Data not Available		

Table 7: Service Level Benchmarks for Faridabad and calculation of urban carrying capacity (Source: Faridabad CMP)

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4.4 Faridabad's composite Urban Carrying Capacity for transport infrastructure

The final evaluation matrix calculation as identified in the previous chapter,

#	SLB Indicator Categories	Lower Threshold	Upper Threshold	Value for Faridabad ⁴	Threshold for Service Level 2	Normalisation for Service Level 2 Threshold	Normalisation on a scale of 1-100
		a	b	y		$z=(y-a)/(b-a)*100$	$x=(y-a)/(b-a)*100$
1.	Public Transport Facilities	1	24	16	16	65.22	65.22
2.	Pedestrian Infrastructure Facilities	3	12	11	8	55.56	88.89
3.	Non-Motorized Transport (NMT) Facilities	3	12	11	8	55.56	88.89
4.	Level of Usage of Intelligent Transport System (ITS) facilities	5	20	17	10	33.33	80.00
5.	Travel Speed (Motorized and Mass Transit) Along Major Corridors	2	8	6	4	33.33	66.67
6.	Availability of Parking Spaces	2	8	5	4	33.33	50.00
7.	Road Safety	2	8	6	4	33.33	66.67

⁴ Source: Faridabad CMP

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8.	Pollution Levels	1	16	5	9	53.33	26.67
9.	Integrated Landuse-Transport System >= 1 million population	1	28	19	15	51.85	66.67
10.	Financial Sustainability of Public Transport by Bus	5	7	NA	7	54.55	NA
	Average					46.94	66.63

Note: Higher value of normalised figure means poorer service
y is the value of overall service level in the SLB Indicator category

Table 8: Final Evaluation Matrix for Faridabad

Service level two is considered to be the level at which the infrastructure provision in a city is considered reasonable. As can be seen from table above, to achieve a service level of 2 the composite score of all SLB categories has to be 46.94 on a scale of 100. Higher score would mean poorer service level.

The composite score for Faridabad on the scale of 100 is 66.64. a gap of 20 points to meet service level 2. scale of the composite UCC of Faridabad.

Urban Carrying Capacity for Urban Transport Infrastructure

Following web chart helps understand the situation of Faridabad with respect to each SLBs category. Web diagram below clearly shows that there is a huge gap in in provision of transport infrastructure in Faridabad, in most categories of SLBs. Provision of Public transport is probably the only parameter where Faridabad meets the service level 2 standards.

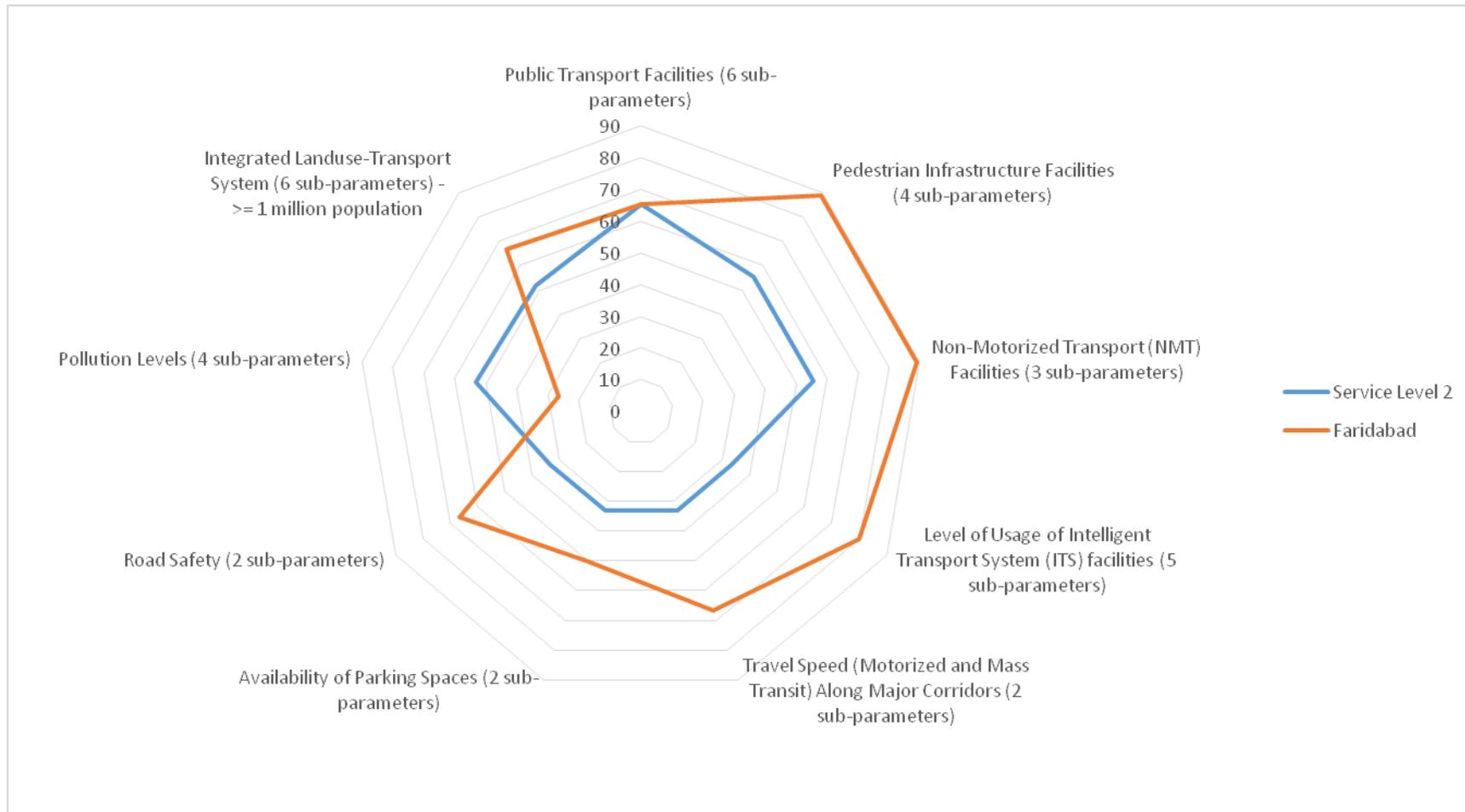


Figure 1: Faridabad existing situation against thresholds (web chart)



4.4.1 Availability

It may be noted from the above table and charts that the fleet size for both PT and IPT vehicles exceed the required threshold for a city. While availability of higher PT fleet size is an added bonus to the city, higher IPT vehicles often causes problems of congestion, safety hazards on road and pollution in the city.

4.4.2 Efficiency

Faridabad does not have any exclusive ROW for its PT modes. While only 48% of PT stations have Passenger Information System, the PT fleets completely lack in GPS facility or integrated ticketing system. This reduces the efficiency of the PT system to a great extent and thus even with a large fleet size, may fail to cater to majority of the commuters of the city. This causes operational inefficiencies and in turn uses up more resources (fleets, fuels, manpower, etc.) to cater to a small portion of commuters.

4.4.3 Accessibility

The low ratio of transit corridor FSI to city FSI depicts the low accessibility nature of the city. This may result in either PT system penetrating deeper into collector roads to cater to few commuters and travelling longer distances to cater to same demand or commuters choosing alternate modes of transport (IPT) with lower seating capacity to access these areas where demand is spread over a wider area. This has also resulted in higher road space requirement than the threshold levels.

Also lack of regularised paid on street parking has resulted in misuse of carriageway and reduction of effective road space available for free flow movement. Due to this, often two wheelers and IPT park hap-hazard on the road degrading the profile of that road and reducing accessibility to various facilities.

4.4.4 Coverage

From the above graph, it can be clearly seen that the city lacks in proper network of PT, pedestrian and NMT facilities. While PT network falls short only by a margin from the threshold, the pedestrian and NMT facilities are absolutely missing. This causes a higher dependence on private modes (two-wheeler, cars, IPT) even for shorter trips thus negatively affecting the health of the city and its residents. This increases the vehicle kms being run in a city which in turn increases the pollution and congestion on the road.

4.4.5 Safety

The graph shows that 55% PT stations have CCTVs. It may be noted that these PT stations mostly comprise of metro stations. When it comes to bus stops, most of them lack a proper surveillance system. Also, it may be noted that none of the signalised intersections have any surveillance system. Presence of a surveillance system in such public places has proved to improve civic sense amongst people and deter any mishaps. Also, they act as a deterrence to motorists not following proper traffic rules (jumping red light; halting after stop line hence taking up space on zebra crossing or reducing the junction flow capacity) at the signalised intersections.

4.5 Recommended Action Plan

As it can be clearly seen from the above Faridabad has the required number of fleet size for PT vehicles, it lacks other supporting infrastructure for an efficient use by its masses. The following action plans are recommended to improve the infrastructural gaps in the urban transport carrying capacity of Faridabad:

1. Prepare and implement a Parking Policy for the city to decongest the city roads and improve the traffic flows.
2. Identify mass transit corridors and develop TOD policy for the same. Also provide exclusive ROW for faster and smoother operations of trunk lines of PT.
3. Identify new feeder routes as well as rationalize existing bus routes and shared IPT routes to complement the trunk lines (Mass transit corridors).
4. Provide proper pedestrian and NMT facilities as per demand, especially catering to high demand around trunk corridors. Trunk corridors should be completely facilitated with wide and barrier free footpaths and cycle tracks. 500m catchment area around PT stations need to be developed as per proper street guidelines encompassing all components for maximising movement of people with provision for dedicated feeder parking areas.
5. Develop Intelligent Traffic Management System for the city through implementation of PIS, GPS, surveillance systems, signal synchronizations, etc. to improve the efficiency of the traffic flow and provide a smoother commuting experience to the end user.

Comprehensive Mobility Plan for Faridabad city has been prepared which will address these issues identified through an extensive collection of primary and secondary data. A detailed analysis is being carried out through the same and above recommendations may be incorporated in the CMP after a thorough understanding of the issues.



Chapter 5. Way Forward

Going forward, the following tasks need to be undertaken for assessment of UCC for the rest 101 non-attainment cities:

- a) Identify gaps in concerned sectors of urban transport infrastructure.
- b) Setting up data collection procedures and centres for assessment of UCC for various cities.
- c) Establishment of nodal agency for execution of UCC assessment for respective cities.
- d) Further validation of benchmark thresholds for Indian cities.
- e) Study for identification of thresholds for new benchmarks/parameters.
- f) The scope of study can be made a part of Comprehensive Mobility Plan Study.
- g) Recommend future action plans for improving carrying capacity of urban transport infrastructure.

Chapter 6. References

1. Centre of Excellence Civil Engineering Department, IIT Guwahati, Integrated Landuse Planning and Water Resources Management, Urban Carrying Capacity, concept & calculation, IIT Guwahati.
2. Wei, Yigang & Huang, Cui & Lam, Patrick & Sha, Yong & Feng, Yong. (2015). Using Urban-Carrying Capacity as a Benchmark for Sustainable Urban Development: An Empirical Study of Beijing. Sustainability. 7. 3244-3268. 10.3390/su7033244.
3. Ministry of Urban Development, Government of India, Service Level Benchmark in Urban Transport for Indian Cities.
4. Ministry of Urban Development, Government of India, Liveability Standards
5. Oh, Kyushik & Jeong, Yeunwoo & Lee, Dong-Kun & Lee, Wangkey. (2019). Determining Sustainable Development Density using the Urban Carrying Capacity Assessment System. Oh, Kyushik and Jeong, Yeunwoo and Lee, Dongkun and Lee, Wangkey (2004) Determining Sustainable Development Density using the Urban Carrying Capacity Assessment System. Working paper. CASA Working Papers (78). Centre for Advanced Spatial Analysis (UCL), London, UK.
6. National Infrastructure Commission UK. Steer Davis Gleeves. (2018). Urban Transport Analysis: Capacity and Cost. Study Report July 2018. ref: 23269801.
7. Sustainability (2015) Yigang Wei, Cui Huang, Patrick T. L. Lam, Young Sha, Yong, Feg, Using Urban Carrying Capacity a Benchmark for Sustainable, Urban Development: An Empirical Study of Beijing.



Comments of Dr O.P. Agarwal on UMTC's study of the carrying capacity

I have gone through the report submitted by UMTC and the orders passed by the Hon'ble NGT in OA No. 773/2018, and OA No. 568/2016.

Based on these, my comments are as follows: Let me give my comments on both as follows:

1. It seems to me that the Hon'ble NGT is looking for an assessment of the carrying capacity from a wider air quality and natural resources perspective and not from just a transport demand perspective. In my humble opinion UMTC seems to have been asked to do a study only from a transport system carrying capacity perspective, by taking into account the relative service level benchmarks. Carrying capacity from an air quality perspective has to begin with the air quality standards prescribed by CPCB – 40 Micrograms/cum for NOx, SOx and RSPM and 180 micrograms/cum for SPM. These are neutral to the source of the emissions and only relate to the total emission. If power plants emit more, then transport systems must emit less. If the carrying capacity assessment was to be even wider, taking into account the entire natural resource base, then we must include water resources, land resources, and others. Hence, in my interpretation, the hon'ble NGT is suggesting carrying capacity assessment that is wider in scope than transport alone. A study of this nature will be complex and will take time. However, given our urbanization trends and projections, it will be a very useful exercise to take up to support policy making. But it will need the support of an academic and/or research organization.
2. If we were to look at transport alone, its carrying capacity is dynamic and depends on the technologies used. If a city predominantly uses a metro rail system its carrying capacity will be higher than a city that predominantly relies on personal motor vehicles. Hence, decisions on accommodating higher transport demand are taken on the basis of the technologies to be deployed as well as how the demand is to be managed (for example which vehicles are allowed to move at what time) rather than just restricting additional demand. Transport demand is a function of the state of the economy and limiting increases in demand would impact economic growth. Carrying capacity assessments, therefore, have to be linked to the technologies used.
3. Unfortunately, UMTC's study is very confusing to me. They seem to have used several service level benchmarks and I am not able to see how all these have been brought together in arriving at the carrying capacity of the existing transport system. Perhaps a presentation by their team, whenever that is possible, would be useful to help understand.



भारतीय प्रौद्योगिकी संस्थान दिल्ली

Indian Institute of Technology Delhi

Geetam Tiwari, Ph.D.
MoUD Chair Professor for Transport planning

Department of Civil Engineering &
Transportation Research & Injury Prevention Programme (TRIPP)
Room No. MS 815, Main Building, Hauz Khas, New Delhi - 110 016(India)

Ph.: 91-11-26591047

Fax 91-11-26858703

geetamt@gmail.com

geetamt@civil.iitd.ac.in

9 April, 2020

Comments on draft report "Guidelines for Assessing Urban Carrying Capacity of Transport Infrastructure" prepared by UMTC."

UMTC has prepared Guidelines for assessing Urban Carrying Capacity of a city. The report is in response to MoHUA request as ordered by NGT to carry out a study for assessment of carrying capacity for NCT of Delhi as well as other major cities particularly 102 'non-attainment' cities.

Further, MoHUA has requested Urban Mass Transit Company (UMTC) to furnish a report on the study of a detailed methodology to be adopted for assessing urban carrying capacity for transport sector for these 102 'non-attainment' cities.

Therefore, I was looking for a methodology to measure impacts on various resources-land, air water etc. of transport sector in urban environment. An understanding of amount of pollutants that can be recycled, impact of different technologies and mobility scenarios on externalities to scarce resources etc.

The current draft report does not address these aspects at all. It has presented SLBs suggested by MOUD earlier. The main objective of the study remains unfulfilled.

There are already papers published on what indicators can be used to assess impact of alternate mobility scenarios under different travel patterns, technologies and landuse patterns. None of these studies have been referred. Pls see the enclosed document for more comments.

The report needs to be written afresh by following the steps listed below:

1. Present a framework, the cyclical nature of the system showing transport impacts on scarce resources.
2. Assess capacity constraints/limits of scarce resources-land, water, air etc.
3. Develop scenarios and link impacts of alternate policies and actions in the short run and the long run.
4. Prepare a dashboard for the authorities to monitor impact on carrying capacity of land , water and air.
5. Some important references are:

Jain, D., & Tiwari, G. (2017). Sustainable mobility indicators for Indian cities: Selection methodology and application. *Ecological Indicators*, 79, 310-322.

Dhar, S., Pathak, M. and Shukla, P.R., 2017. Low carbon city: A guidebook for city planners and practitioners. *Low Carbon Transport in India Project*.

Tiwari, G. "Methodology for developing low carbon mobility plan." *Low Carbon Transport in India Project* (2017).

Epstein, Andrea Hurtado, and Stephanie La Hoz Theuer. "Sustainable development and climate action: thoughts on an integrated approach to SDG and climate policy implementation." (2017): 50.

Revised Comprehensive Mobility Plan Tool Kit, IUT

Wei, Yigang, Cui Huang, Jing Li, and Lingling Xie. "An evaluation model for urban carrying capacity: A case study of China's mega-cities." *Habitat International* 53 (2016): 87-96.

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Tehrani, Nadia A., and Majid F. Makhdoum. "Implementing a spatial model of Urban Carrying Capacity Load Number (UCCLN) to monitor the environmental loads of urban ecosystems. Case study: Tehran metropolis." *Ecological indicators* 32 (2013): 197-211.



Geetam Tiwari

Professor, CED/TRIPP

Observations of Prof. Sanjay Gupta, SPA Delhi

1. It must be recognized that carrying capacity assessment is an essential part of urban planning for giving effect to the concept of sustainable development

2. It is also well known that traffic is a function of land use and transportation is a means to an end & not end by itself. Hence it is imperative that any effort in arriving at carrying capacity of cities with reference to transport sector in an area needs to take into account the parameters of urban development such as population, Jobs, density, built-up area etc. across different land uses.

3. The assessment framework for carrying capacity with reference to transport sector in an urban area essentially would entail the following steps :

i. Analysis: This would incorporate establishing various transport indicators for different components from global literature. These indicators must be selected keeping in view aspects such as easy data availability, quantifiable, consistent, ability to prove policy implications and above all should be small manageable set. This stage would also establish thresholds for each of the indicators. These thresholds normally are adopted from review of global literature on the subject and it is expected in the present study that these are adopted rather than derived which would be subject of another study itself.

ii. Evaluation: This stage would involve developing mathematical relationships or models between urban development parameters and the desired transport capacity in terms of supply to service the derived transport demand from the urban development under consideration. Further in this stage Alternate scenario analysis shall have to be carried out taking into account future development scenarios incorporating Master Plan proposals etc. in a city and comparing it with BAU scenario to assess the transport carrying implications in terms of externalities such as air pollution, safety, level of congestion etc. under various scenarios and the gap with the thresholds proposed to be met

iii. Intervention : In this Stage various policy interventions either in terms of transport supply augmentations in terms of road capacities, mass transit capacity enhancement etc. or demand management policies such as enforcing shared mobility, congestion pricing, flexi work schedule etc. are evolved and tested for different alternative scenarios to identify ideal mix of feasible policy package which shall ensure desired transport capacity in a city and an attempt to reach the threshold values of various indicators. Further taking into account various other factors such as resources available for transport investment, capacity at command to implement schemes and other practical aspects of project implementation the optimal transport capacity is arrived at for a city for feasible set of policy package which also is closest to the targetted thresholds of urban transport indicators,

4. The carrying capacity with reference to transport sector in a city needs to be addressed ideally at four levels, namely :

- City level
- Zonal/ sectoral level
- Ward level

- Site level

4.1 The approach of carrying capacity at *city level* is the one as described above while for *zonal and ward level* a rapid assessment of travel demand based on proposed urban development pattern in the zone/ward should be estimated as per zonal plan or local area plan and consequent impact on transport capacities to be estimated in terms of road, mass transit, para transit, NMT, parking infrastructure augmentation in order to achieve desired LOS within the zone or ward.

4.2 The stage of assessing carrying capacity of transport at a *site level* forms part of traditional Traffic Impact Assessment (TIA) exercise wherein traffic likely be the generated owing to a proposed new development at the project site is estimated based on trip generation rates and its impact on the bounding network of the site is assessed in term of level of service resulting in appropriate realistic mitigation measures of augmented transport capacity of argument transport capacities is limited the traditional urban development activity is restricted accordingly.

5. For assessing carrying capacity across cities of varied types it is imperative to study typologies of cities out of the set of 102 non- attainment cities besides Delhi so that one can arrive at transport carrying capacities of different types of urban area exhibiting different urban development pattern, demographic and socio-economic profile besides varied transport system attributes and transport demand patterns. Such a typology selection can be based on secondary data available from various CMP and CDP reports, Wilbur Smith report on mobility patterns etc.

6. In the present study the SLB study of MoHUA forms the basis of identifying various urban transport parameters as well as service levels while UNESCAP study on SUTI which provides the range of thresholds (maximum and minimum) for various parameters forms the basis for arriving at a single overall service level. However it is not very clear from the approach adopted that this can be interpreted as the carrying capacity of transport sector in a city as it is only an index and not tangible in terms of carrying capacity. At the best it only provides a very broad indication of the level of service of urban transport in a city which may be good for comparing performance of various cities in terms of sustainable urban transport index and how cities need to take various policy measures to enhance their respective index values to address various SDG goals. The existing approach also does not have a cause and effect relationship built in between urban development patterns and transport capacities in cities.

7. Specifically with regards to various indicators considered in the present study it may be noted that aspects such as congestion, air pollution and safety are the impacts of a urban transport scenario and should be used as evaluation parameters for arriving at an appropriate transport capacity. It is proposed that the following nine indicators which signify the transport capacity in an area needs to be considered :

- Public Transport
- Non-Motorized Transport
- Para Transit (Auto/ taxis/app-based cabs/e-rick)
- Pedestrian Infrastructure
- Road Network

- Parking Facilities
- Terminal and multimodal interchange
- ITS (Traffic Management, Parking Management, Public transport management, Terminal Management)
- Freight Transport

The following could be the impact parameters for evaluation .:

- Road Safety
- GHG Emissions
- Average Travel speed (in peak hour)
- Average LOS
- % share of PT share
- % of Walk share
- Average Trip Length
- VKT (Vehicle Travelled Kilometer)