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MARIELISA PADILLA | NIKITA SHETTY | SOPHIE MOK | IRENA RAVLIC | VLADYSLAV LATYPOV

MOBILITY CITY LAB COIMBATORE

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Mobility City Lab Coimbatore

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List of abbreviations

AADT – Annual Average Daily Traffic
APS – Automated Parking System
ATM – Automated Teller Machine
AVLS - Automatic Vehicle Location System
BMZ – Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung
BOV – Battery Operated Vehicle
BRTS – Bus Rapid Transit System
C-DAC – Centre for Developing of Advanced Computing
CBD – Central Bus District
CBE JN – Coimbatore Junction
CCMC – Coimbatore City Municipal Corporation
CCR – Coimbatore Commuter Rail
CCTV – Closed Circuit Television
CDM – Clean Development Mechanism
CII – Confederation of Indian Industry
CMP – Comprehensive Mobility Plan
CNG – Compressed Natural Gas
CSCL – Coimbatore Smart City Limited
CSF – Critical Success Factor
CSML – Cochin Smart Mission Limited
CSR – Corporate Social Responsibility
DPR – Detailed Project Report
DRUCC – Divisional Railway Users Consultative Committee
ECS – Equivalent Car Spaces
EOI – Expression of Interest
ESCI – Emerging and Sustainable Cities Initiative of Inter-American Development Bank
ESF – Environmental and Social Framework
ETA – Estimated Time of Arrival
ETV - Flat-panel displays
ETVM – Electronic Ticket Vending Machines
EUR – Euro
EV – Electric Vehicle
GDDP – Gross District Domestic Product
GHG – Greenhouse Gas
GOI – Government of India
HOD – Head of Department
ICFS – Infrastructure Leasing Financing Service
ICT – Information and Communications Technology
IMaCS – ICRA Management Consulting Services
INR – Indian Rupee
ITDP – Institute for Transportation & Development Policy

IPT – Intermediate Public Transport
ISO – International Organization for Standardization
ISS – Intelligent Signalling System
ITS – Intelligent Transportation System
LCV – Light Commercial Vehicle
LPA – Local Planning Authority
LRTS – Light Rail Transit System
MCC – Micro Composting Centre
MIS – Management Information System
MLCP – Multi-level Car Parks
MNRE – Ministry of New and Renewable Energy
MOUD – Ministry of Urban Development
MRTS – Mass Rapid Transit System
MS – Bus shelter
MTP Road – Mettupalayam Road
NGO – Non-Government Organization
NGT – National Green Tribunal
NH – National Highway
NHAI – National Highway Authority of India
NMT – Non-motorised Transport
NPC – National Payment Corporation
OECD – Organization for Economic Co-operation and Development
PEA – Project Execution Agencie
PHPDT – Peak Hour Direction Traffic
PIS – Passenger Information Systems
POI – Point of Interest
PPP – Public Private Partnership
PV - Photovoltaics
RAAC – Residents Awareness Association of Coimbatore
RFI – Request for Information
RFID – Radio Frequency Identification
RFP – Request for Proposal
RTA – Real-Time Application
RTI – Real-Time Information
RTO – Regional Transport Office
SETC – State Express Transport Corporation
SME – Small and Medium Enterprises
SOR – Specification of Road items
SPV – Special Purpose Vehicle
STP – Sewage Treatment Plant
TC – Transport Commissioner
TEDA – Tamil Nadu Energy Development Agency
TEEMP – Transportation Emissions Evaluation Model Project

TN – Tamil Nadu

TNAU – Tamil Nadu Agricultural University

TNEB – Tamil Nadu Electricity Board

TNIDB – Tamil Nadu Infrastructure Development Board

TNSTC – Tamil Nadu Transport Corporation Ltd.

TNUIFSL – Tamil Nadu Urban Infrastructure Financial Services Limited

TWAD – Tamil Nadu Water and Drainage

UNFCCC – United Nations Framework Convention on Climate Change

UTP – Urban Transport Planning

Watsan – Water and Sanitation

Actors

For over 35 years, the Fraunhofer Institute for Industrial Engineering IAO in Stuttgart has been a highly regarded provider of services in the fields of company and work structures and organization, technology management, and information and communication technology. The IAO has leading expertise in numerous fields, including industrial engineering, logistics, product development, innovation and industrial R&D-management, business model and manufacturing planning – to mention just a few of them which are most relevant to the scope of this project. Moreover, Fraunhofer IAO coordinates the Innovation Network "Morgenstadt / City of the Future" which is a platform of high-level first movers from cities and industry. It aims to accelerate the global transition to sustainable cities and fully supports the New Urban Agenda as set out during the UN-Habitat III in Quito. Our mission is to shape sustainable cities by designing and implementing innovative urban systems solutions that solve sustainability challenges in the social, environmental and economic development of cities. Thanks to its close cooperation with the Institute for Human Factors and Technology Management IAT at the University of Stuttgart, Fraunhofer IAO is able to combine university-level basic research, application-oriented science, and business practice.

The KfW Entwicklungsbank is the commissioner of this project and supported technically the City Lab team throughout the assessment. The KfW banking group is one of the largest development banks worldwide. On behalf of the German government, it financially supports projects in more than 100 developing and emerging countries. The focus is on topics such as poverty reduction, economic development, education, health, and environmental protection. The aim is to create sustainable and viable structures to ensure long-term improvement (KfW, 2018).

The project „Städtische Infrastrukturentwicklung Tamil Nadu" of the Tamil Nadu Infrastructure Financial Services LTD. (TNUIFSL) and the Tamil Nadu Urban Development Fund (TNUDF), are implemented in partnership with the KfW Entwicklungsbank on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ). The project aims to improve the living

conditions of the population and protect the environment through innovative approaches to municipal financing in order to close the financial gap and in particular to guarantee water supply and wastewater disposal (Kühlken, 2016). This is aligned with the Indian Smart City Mission, especially in the field of urban development and the promotion of climate-friendly urban mobility, for example through the expansion of eco-friendly local public transport and intelligent traffic control systems (BMZ, 2018).

Authors

M.Sc. Marielisa Padilla
Project Manager/City Lab Leader

Fraunhofer IAO
Urban Governance Innovation
Marielisa.padilla@iao.fraunhofer.de

M.Sc. Nikita Shetty
Researcher

University of Stuttgart
Urban Governance Innovation
Nikita.Shetty@iao.fraunhofer.de

M.Sc. Sophie Mok
Researcher

Fraunhofer IAO
Urban Governance Innovation
Sophie.mok@iao.fraunhofer.de

Irena Ravlic
Research Assistant

University of Stuttgart
Urban Governance Innovation
irena.ravlic@iao.fraunhofer.de

Vladyslav Latypov
Research Assistant

University of Stuttgart IAT
Urban Governance Innovation
Vladyslav.Latypov@iao.fraunhofer.de

Contributors

M.Sc. Alexander Schmidt
Mobility Expert
BABLE UG
Alexander.Schmidt@iao.fraunhofer.de

Dr. Jillella Satya Sai Kumar
Smart Cities and Transport Expert
Indian Institute of Science
kumarssj@yahoo.co.in

Aditya Fuke
Electronics Expert
Fraunhofer Office India
Aditya.Fuke@fraunhofer.in

Sinduya Jeevaratnam
Research Assistant
University of Stuttgart IAT
Urban Governance Innovation
Sinduya.Jeevaratnam@iao.fraunhofer.de

City Lab teams

Fraunhofer IAO

M.Sc. Marielisa Padilla
CIty Lab Leader

M.Sc. Nikita Shetty
Researcher

M.Sc. Sophie Mok
Researcher

BA Vladyslav Latypov
Research Assistant

Hari Vallabi
Local Research Assistant

Fraunhofer India

Mr. Aditya Fuke
Manager - Research Expert

CCMC & CSCL

J. Sravan Kumar, I.A.S.
Commissioner & Special Officer, CCMC (from 03.2019)

Dr. K. Vijayakarthikeyan, I.A.S.
Commissioner, CCMC (till 02.2019)

Mr. Sarvanakumar Naidu
Executive Engineer, CCMC

Mr. Subash Chandira
Team Leader, CSCL

Mr. Thirumurthi
Urban Infrastructure Expert, CSCL

Mr. N. Babu
Transportation Expert, CSCL/PMC

BABLE
(On-site assessment)

M.Sc. Alexander Schmidt
Mobility Expert

Indian Institute of Science
(On-site assessment & pre-feasibility studies)

Prof. Dr. T.G. Sitharam
Department of Civil Engineering

Dr. Jillella Satya Sai Kumar
Centre for Infrastructure, Sustainable Transportation and Urban Planning

Preliminary remarks - Morgenstadt City Labs

The Innovation Network "Morgenstadt / City of the Future" is a platform of high-level first movers from cities and industry run by the German Fraunhofer-Society. It aims to accelerate the global transition to sustainable cities and fully supports the New Urban Agenda as set out during the UN-Habitat III in Quito.

Within this innovation network "Morgenstadt / City of the Future", the Fraunhofer Society together with the University of Stuttgart and its partners from industry and municipalities has developed the Morgenstadt City Lab Approach – a holistic analytical framework that helps design individual sustainability strategies for cities that build on digital innovations, clean technologies and a broad stakeholder dialogue moderated through Fraunhofer experts. The Morgenstadt Model is a globally unique instrument, which has been developed and tested with the six globally leading cities in sustainable urban development: Copenhagen, Singapore, Freiburg, New York City, Berlin, and Tokyo.

From 2017 to 2018, the Fraunhofer Innovation Network "Morgenstadt / City of the Future" has been successfully applied to cities as Prague, Lisbon, Chemnitz, Leipzig, Sabadell, Joinville, and Berlin TXL, boosting the sustainable development of these cities in an integrated way. The result of each Morgenstadt City Lab is an individual roadmap towards a sustainable city, integrating several specific measures in the areas of research as renewable energies, energy efficiency, sustainable mobility, water infrastructures, waste management, sustainable buildings, urban resilience, environmental and urban planning, economic development, urban governance and digital innovation. Apart from creating sustainable and well-functioning cities, it also spurs local economic development and job creation by guiding investments and designing policies and strategies for long-term development.

1. Introduction

1.1 India – a fast growing and dynamic economy

India is an emerging country with a rapidly growing economy and industry. It is a member of the G20 states and is also one of the five major emerging national economies together with Brazil, Russia, China and South Africa (BRICS states) (GIZ, 2018).

Although the economy is developing so rapidly, India still faces major challenges such as poverty, lack of education, unemployment, and other socio-economic problems. About 70% of India's population lives in rural areas and only 30% in cities. There is a prediction by the Ministry of Urban Development that 40 percent of India's population will live in cities by 2021 (Coimbatore City Municipal Corporation, 2017), so rural-urban migration will increase pressure on urban infrastructures and water supply within the city (Weskamp, 2018).

However cities are already overcrowded and in some cases have population densities of over 6000 people per km² while in provincial areas there are less than 100 people per km² (Betz, 2007). For comparison, the average population density in India lies around 450 people per km² (Statista, 2018), while in the European Union it is only at around 120 people per km² (Statista, 2017).

The Indian population is quite young on average with 54% being younger than 30 years and only 6% older than 64 years (Bräunig, 2018), which results in a large economic growth and migration to the city as well as alarge number of workers and this labour potential will continue to increase.

Regarding mobility, currently, the number of registered cars is 24 per 1000 inhabitants (Bräunig, 2018). The local mobility market shows a high share of around 80% of two-wheelers, which clearly exceeds the share of 14% of passenger cars. India is also the largest manufacturer and user of three-wheelers with a market share of nearly 3% of total domestic vehicle sales (Sachs, 2017).

With 13 of the 20 most polluted cities in the world being Indian cities, the government has launched several programs to promote the use of electric vehicles. The National Electric Mobility Mission Plan 2020, launched in 2013, aims to reduce environmental damage caused by low-quality, gas-powered vehicles, promoting domestic production of electric vehicles and national energy security in general. The goal is to sell 6-7 million electric vehicles by 2020. The domestic vehicle sales show that the two-wheeled vehicle market offers considerable innovation potential for electrification, due to a dominant sales volume of the Indian vehicle market every year. The overall market for electric vehicles in India is still rather small, and the electric three-wheeler market mostly consists of e-rickshaws (Sachs, 2017).

1.2 Coimbatore city – a major trade & commercial centre of Tamil Nadu

With 1.6 million inhabitants and an area of 257, 04 km², Coimbatore is the second largest city of the southern state Tamil Nadu after Chennai and the 16th

largest agglomeration in India. This corresponds to a density of approximately 6225 inhabitants per km². It is situated on the banks of the Noyyal River and surrounded by the Western Ghats. The city is administered by the Coimbatore Municipal Corporation and also constitutes the administrative capital of Coimbatore district (Nagl, 2011). The district has a total population of around 3.5 million inhabitants on an area of 4.723 km² (Coimbatore District Profile, 2016).

Coimbatore is the largest and most important industrial centre in Tamil Nadu after the capital Chennai due to its textile industry, technical equipment, the IT sector, the various universities and educational opportunities (Pradeep, 2015). It is also referred to as "Pump City" for supplying nearly half of India´s requirements of motors and pumps. Also, Coimbatore has been ranked 4th among Indian cities in investment climate by a survey done by the Confederation of Indian Industry (CII).

In general "Coimbatore performs better than national and state average in most development indices, including literacy, sex ratio, Human Development Index, Child Development Index, life expectancy at birth, infant and maternal mortality, rates of violent crimes and crimes against women" (Weskamp, 2018). The per capita income amounted to 77.975 INR (about 913,72 EUR) (finanzen.net GmbH, 2018) with a Gross District Domestic Product (GDDP) per capita of 2.601.933 INR (about 30.489,63 EUR) (finanzen.net GmbH, 2018) at constant prices in 2011-2012 (Coimbatore District Profil, 2016).

Due to the increase of population as well as traffic, there is a high negative contribution to climate change, which has negative environmental and social wealth impacts. Figure 1 shows the emission by this sector. As more vehicles enter the city, emissions are also increasing. Due to these existing pressures, it is considered urgent to draw up a plan to find sustainable solutions to current problems.

GHG emissions by sector		
	2010-2011	2015-2016
residential	31%	15,3%
commercial, governmental and institutional	8,17%	13%
industrial	14%	28,7%
transport	34%	39,7%
waste	8%	8,0%

Figure 1. GHG emission by sector of Coimbatore (Weskamp, 2018)

1.3 Smart city initiatives

Coimbatore is known for its future-oriented policies and efforts towards becoming a smart city. In 2015 the so-called Smart City Concept Plan for Coimbatore was launched. Its main objectives are co-creating the city of the future and improving its citizens' quality of life. The plan has four main working areas: to improve the structure, economy, and mobility of the city, to develop the "watsan" (water and sanitation), energy and environment management, to secure inclusion, housing and security and to introduce smart solutions and IT-led delivery.

Furthermore, the Citizen´s Charter was signed in 2016 as a commitment by the Municipal Corporation of Coimbatore to implement smart city projects such as the introduction of e-governance (proposed in 2003) and the automation of access to many functions and services involving engineering, public health, town planning, accounts, payroll, human resource matters and the ability to contact the Corporation on civic and societal matters.
The charter provides information on the areas in which citizens can get involved and cooperate with the city in order to ensure a more efficient and generally better life in the community. These areas include public health, town planning, roads and street lights (Coimbatore Municipal Corporation).

1.4 City Lab goal

Coimbatore seeks further support in developing solutions in this context. The Morgenstadt Initiative in a strategic Cooperation with the Kreditanstalt für Wiederaufbau (KfW banking group) co-designed a project for supporting the city of Coimbatore in the development of a Roadmap for sustainable urban mobility. The goal of this City Lab is to help this city to become a model in India for innovative mobility concepts and create a precedent on how intelligent growth and sustainable urban development can be initiated in one of the world´s fastest-growing economy. The project was brought towards realization in a joint effort between the Coimbatore Municipal Corporation, Coimbatore Smart City Limited, research, industry, and national strategic actors. The results of the Mobility City Lab presented here constitute an integrated set of innovative mobility projects, tailored to Coimbatore´s unique needs and are meant to support the city in addressing its specific challenges in the area of mobility. The proposed projects are combined with the already ongoing and planned activities in Coimbatore and aim to strengthen its position within Tamil Nadu further and make it a lighthouse city in India and beyond.

2. Methodology

2.1 City Lab process

The process in the setting of City Lab is divided into four different steps.

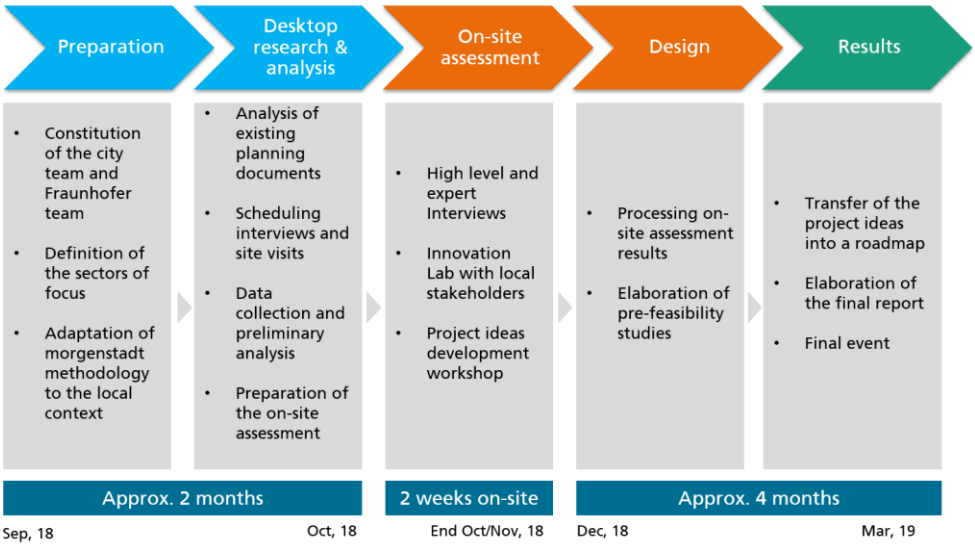


Figure 2. Structure of the Mobility City Lab process in Coimbatore

The first phase comprised the overall preparation and with it, the constitution of the local team in Coimbatore as well as the assessment team from the Fraunhofer side.

The second phase consisted of the analysis of strategic documents relevant to mobility and the initial data collection. The actor landscape in the field of mobility was scanned and analysed, which helped to identify interview partners for the on-site assessment. The selection was done, ensuring that strategic stakeholders from all kinds of action fields of mobility were represented, like pedestrian and cycling transport, public transport and logistics as well as political and planning institutions.

The data collected in the before mentioned phases and on-site results, especially the outputs of the interviews, was then compiled. The project ideas generated, the design of the strategic roadmap, as well as the finalization of the city lab report, comprise the co-creation phase of the city lab.

In an effort to bring the ideas closer to its realization, five packaged solutions were selected among the 10 developed, to be further described and analysed in the form of pre-feasibility studies. These are presented in a separated report.

2.2 Adapting the City Lab Framework to the Indian context

The framework of the Mobility City Lab in Coimbatore is based on the Morgenstadt City Lab Framework and can be divided into two levels of analysis:

- **Assessment of indicators**: measuring the current status quo of urban systems and showing the sustainable performance of the city with a focus on the mobility sector (quantitative assessment)
- **Assessment of action fields**: measuring the degree of intervention in key areas that promote sustainability and the current activities of the city (quantitative (yes/no) assessment).

The sum of all assessment levels allows the research team to get an understanding of the current performance and focus of Coimbatore in the mobility and urban transportation area (and closely linked key areas), assisting in the development of coherent strategies and an integrated roadmap. At the same time, the process respects the unique factors of the city that are conditioned by external pressures, socio-cultural dynamics, geographic and historical pre-determinations, etc. Moreover, a standardized data assessment throughout the whole evaluation process helps to identify critical challenges and opportunities, which are crucial for further project ideas and roadmap development. The assessment process is outlined in the following graph:

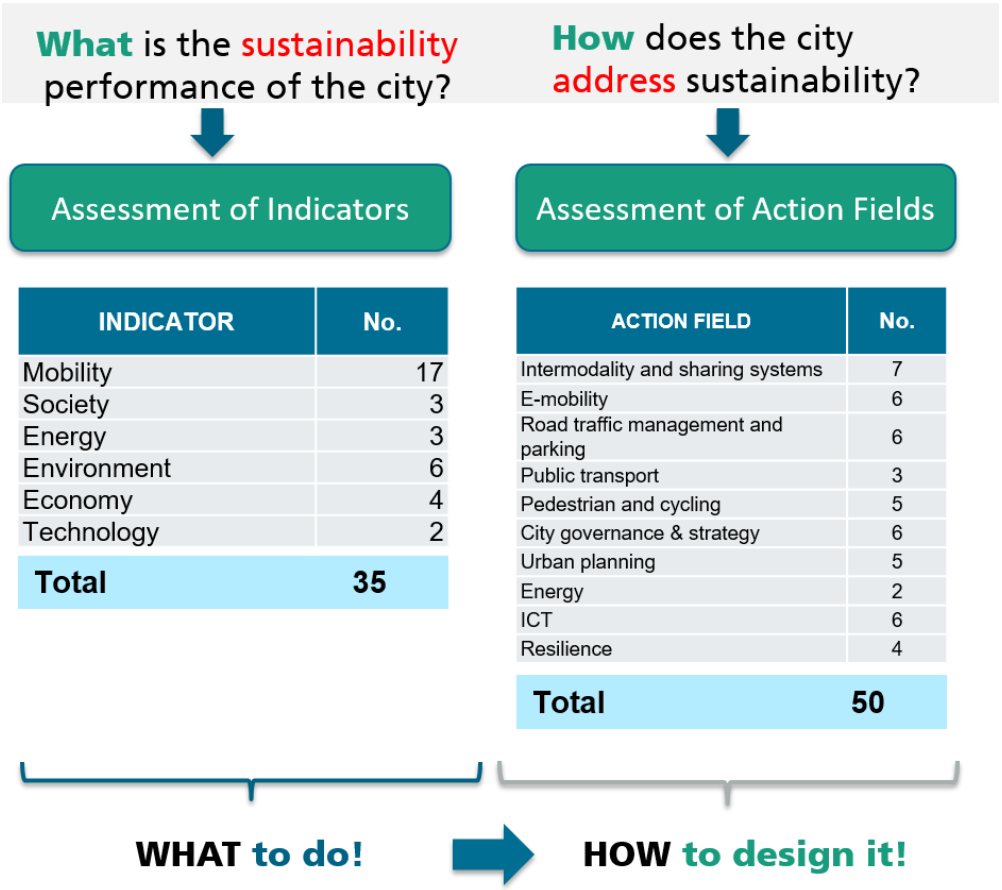


Figure 3. City Lab assessment framework for Coimbatore

As cities around the world are on different stages of development, the respective indicators and action fields need to be carefully chosen and adapted to the individual case of study. Given that most of the indicators and action fields refer to highly developed cities with rather advanced infrastructures and technologies, the preparation phase was used to adapt the existing framework to the local context of India and research medium values of the country itself.

Furthermore, as the focus of the City Lab in Coimbatore was set on mobility, the scope of the analysis was narrowed down to include only indicators and action fields which are relevant or closely linked to this sector. Out of the initial list of 115 Morgenstadt indicators, 35 were selected for this purpose. These consisted of original Morgenstadt indicators, „Indicators of the Emerging and Sustainable Cities Initiative" (ESCI) and indicators which have been developed in the course of the SCC2 "UNaLab" project. To assess the respective indicators, related benchmarks have been updated to be more comparable with other cities within the region. These included region-specific data of the Fraunhofer „Morgenstadt: City Insights" model, International Organization for Standardization (ISO) standards, World Bank and Organization for Economic Co-operation and Development (OECD) independent studies. The City Lab indicators were tailored to cover the most important aspects of such city categories as mobility, society, economy, energy, technology, and environment.

In total, 10 action fields were elaborated consisting of in total 50 „yes/no"-type of questions to identify priority areas and key activities in the city. The adaptation of the existing framework referred mainly to selecting action fields and questions which fit the Indian context. After that, each question was linked to an evaluation factor which has been designed in such a way that each action field can receive up to a maximum of 10 points if completely developed or implemented. In total, such a grading system has been developed to important fields such as intermodality, e-mobility, traffic management, public transport, pedestrian/cycling modes, city governance, urban planning, ICT, resilience and energy.

3. Mobility profile Coimbatore

Strategic plans provided by the Coimbatore Municipal Corporation and other strategic partners such as the "Smart City Concept Plan for Coimbatore" and the "Comprehensive Mobility Plan for Coimbatore Local Planning Area," both released in 2015, were studied and formed the basis of the sustainability profile of Coimbatore regarding Mobility presented in this chapter.

3.1 Analysis of the mobility in Coimbatore

The city has a good transport connection by road, rail, and air. According to the Smart City Concept Plan conducted in 2015, the main means of transport used

in Coimbatore were buses (42%), followed by two-wheelers (21%), cars (17%), walking (14%), auto rickshaws (5%) and bicycles (1%) (Madhavan, 2015).

The total road length in the district amounts to 12,934 km. Coimbatore Corporation's roads cover 2106.11km, of which more than 70% are paved. In addition, there are 58.06 km of highways (district, state and national) crossing through the city. The road density is 7,06 km/sq.km and the average driving speed during peak hour is about 20 km/h on an average motorised trip length of 10 km. There are six arterial roads namely NH 47 (Avinashi Road) which is one of the most important arterial roads that run in a west-east direction. It starts at Uppilipalayam flyover and ends at Nillambur by-pass junction where it joins again NH 47. The road traverses most of central and east Coimbatore, connecting the metropolis of Bangalore and Chennai. Other arterial roads are NH 47 (Palakkad Road from east to west), NH 67 (Trichy Road from central to southeast), NH 67 (Mettupalayam Road from north to south), NH 209 (Sathy Road from south to northeast) and NH 209 (Pollachi Road from north to south) (Coimbatore City Municipal Corporation, 2017). In figure 5 the major/arterial roads are marked in yellow colour. These carry most of the traffic and form the critical points in the Local Planning Area (LPA) (ICRA Management Consulting Service Limited, 2015).

Coimbatore's major junctions are Laksmi Mills Junction, Sowripalayam Junction, Valankurichi Junction, Hopes College Junction, Uppilipalayam Junction, Singanallur Junction and Gandhipuram Junction (Gokul, 2015).

Figure 5. Overview of arterial roads in Coimbatore (TTK Maps, 2015)

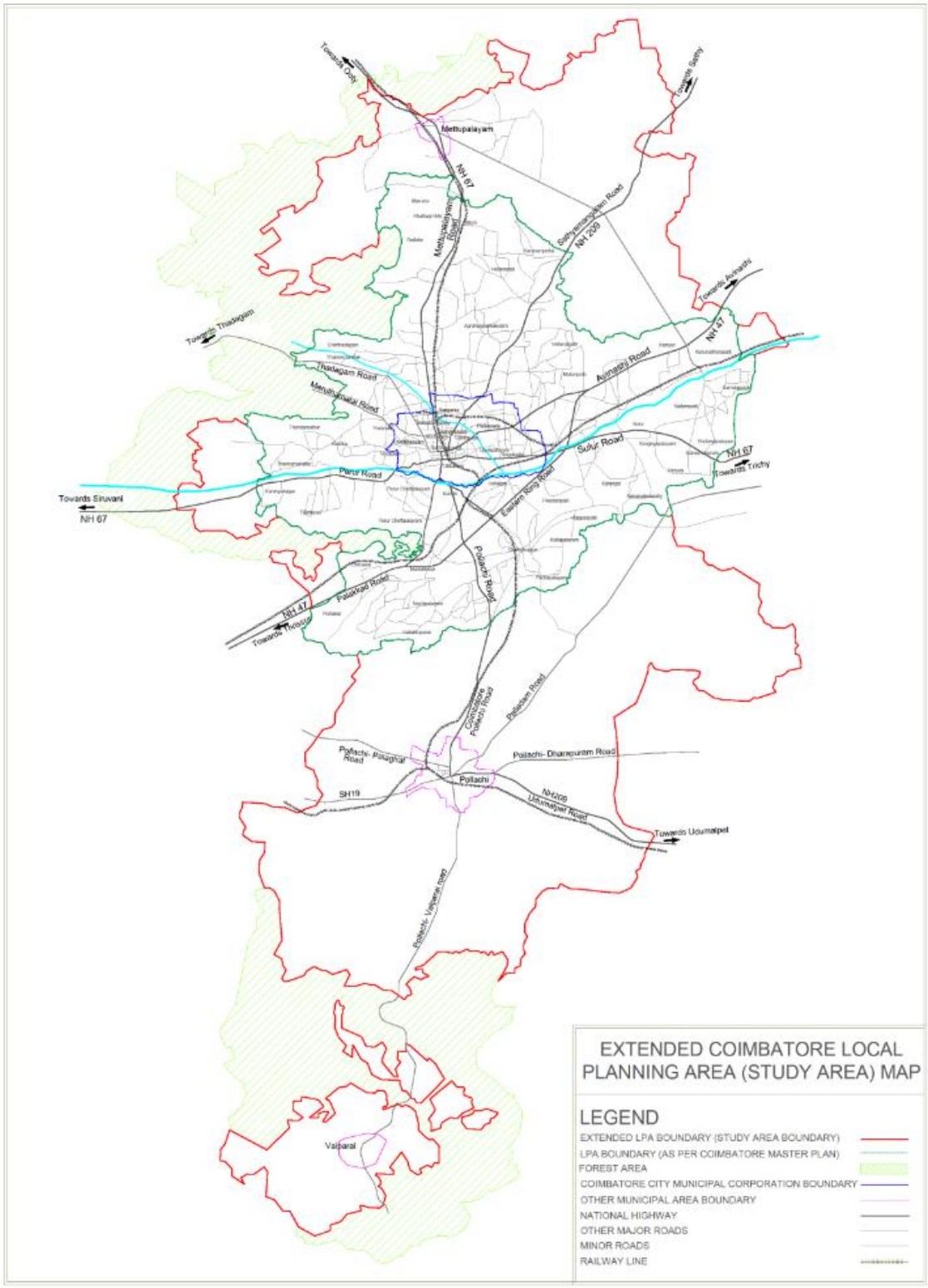


Figure 6. Extended Coimbatore Local Planning Area (Pradeep, 2015)

3.1.1. Private motor vehicles

According to the Comprehensive Mobility Plan (CMP), there is a large number of registered private vehicles. The growth in registered vehicles exceeds the population growth which indicates an excessive dependence on private vehicles, partly as a result of insufficient public transport or its non-use, leading to higher motorisation and thus to a reduction in the use of non-motorised vehicles or walking. The private vehicle ownership rate for taxis is 91% and 81% for cars, meaning that only a few vehicles drive on hired basis (Pradeep, 2015).

In order to determine the traffic volume characteristics in Coimbatore, four different areas were selected (Mid-Block, Inner Cordon, Outer Cordon, and Screen Line) to cover most of the city´s traffic. This allowed almost all traffic and its density to be recorded, especially on the major roads, in order to identify problems and provide appropriate solutions and strategies (Pradeep, 2015).

Traffic volumes in mid-block: The highest traffic movement in the mid-block is seen on Pollachi Road and the lowest at Kottur Main Road. The average midblock traffic volume within the LPA is about 15,000 Passenger Car Units[1] (PCU) and outside the LPA around 18,000 PCU. These are units used for expressing road capacity, involving all motor vehicles for transporting people like cars, cycles, motorcycles, buses, and trucks. About 40% of the traffic participants are two-wheelers, followed by around 29% cars, 4,29% three-wheelers and 4 - 10% of public transport buses. The peak hour is between 8.00 and 11:30, while the evening peak is between 19:00 and 20:30.

[1] "A measure of the impact that a mode of transport has on traffic variables compared to a single standard passenger car." https://nptel.ac.in/courses/105101008/521_TrVolume/point8/point.html

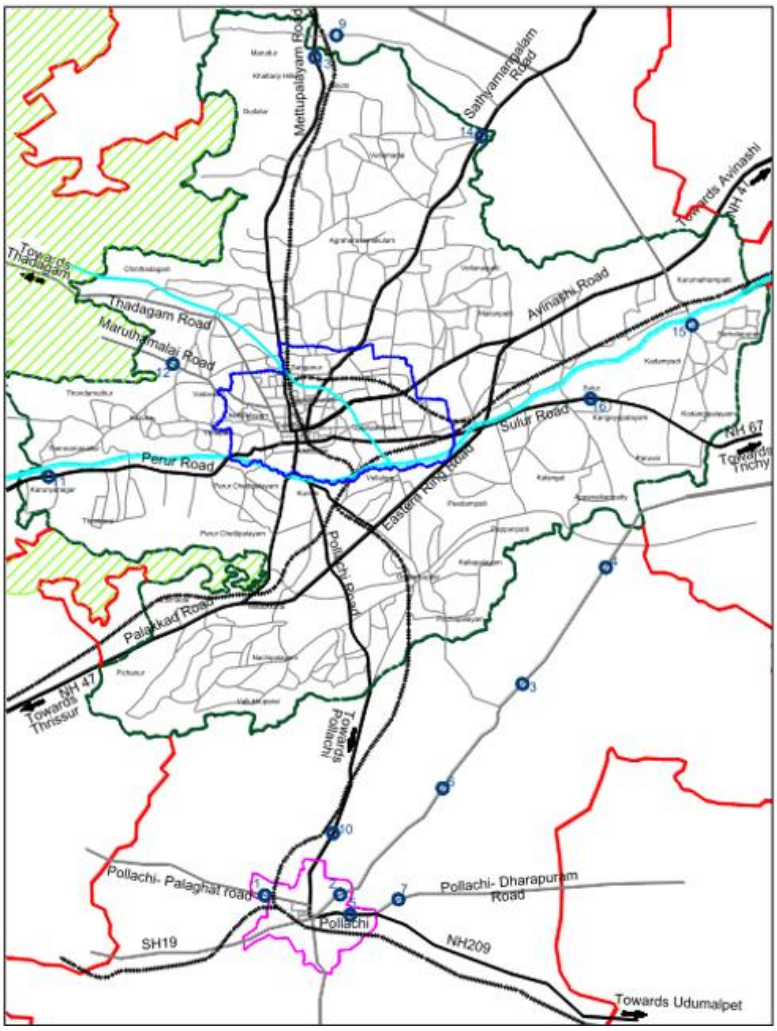


Figure 7. Locations of Traffic Volume Counts - Mid-Block Locations (Pradeep, 2015)

Traffic volumes in the inner cordon and screen line: The highest traffic volume in the Inner Cordon is to be found on Mettupalayam Road, with an average PCU volume of around 37,000. The passenger vehicles account for 93% of the peak hour traffic (between 8 and 9 am) while 7% is goods traffic. Two-wheelers constitute more than 55% of the total traffic.

The average PCU volume in the screen line amounts to about 28,000 PCU, with a two-wheeler share of 52% to 54%.

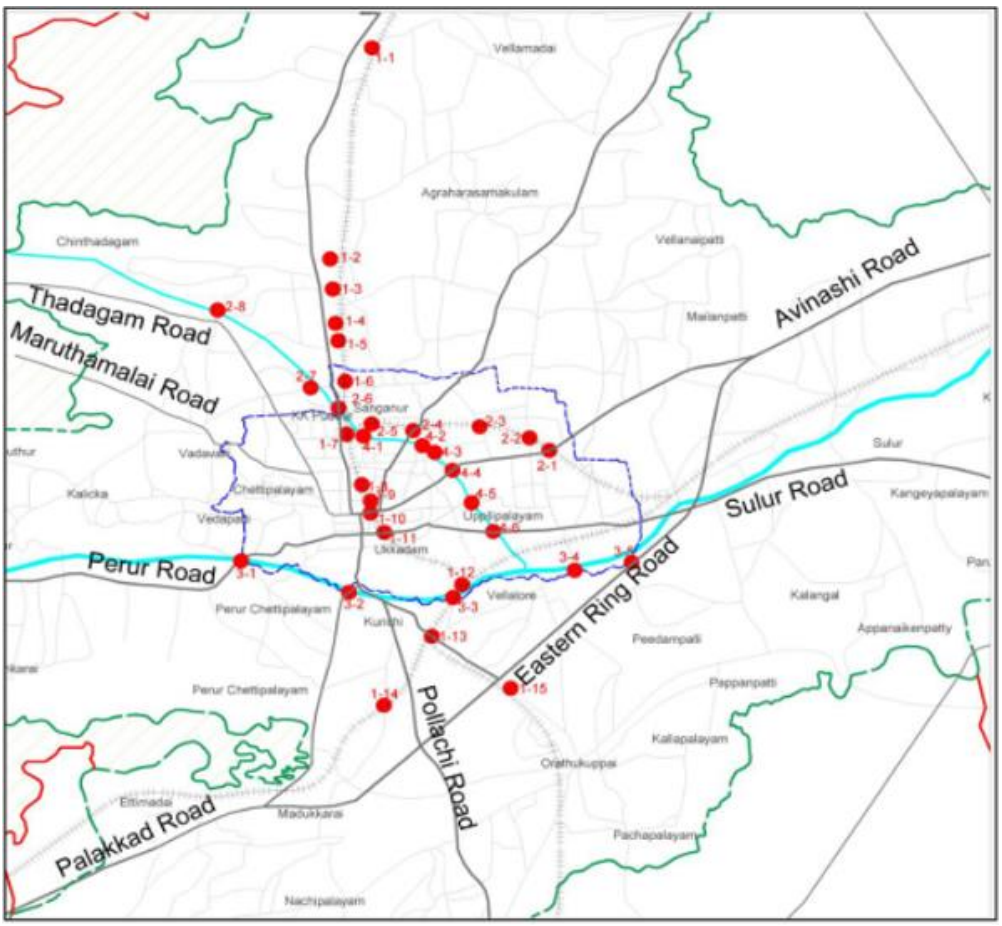


Figure 8. Locations of Traffic Volume Counts - Screen Line Locations (Pradeep, 2015)

Traffic volumes in the outer cordon: The PCU level of the outer cordon lies around 20,000 with the highest traffic volume on Palladam Road followed by Avinashi Road and Mettupalayam Road. The two-wheelers constitute 37% of the traffic and goods vehicles comprise 23%, while the share of public transport is only at 7%. Morning peak hours are observed between 7:00 and 12:15 and evening peak hours are from 17:00 to 20:00 (ICRA Management Consulting Service Limited, 2015).

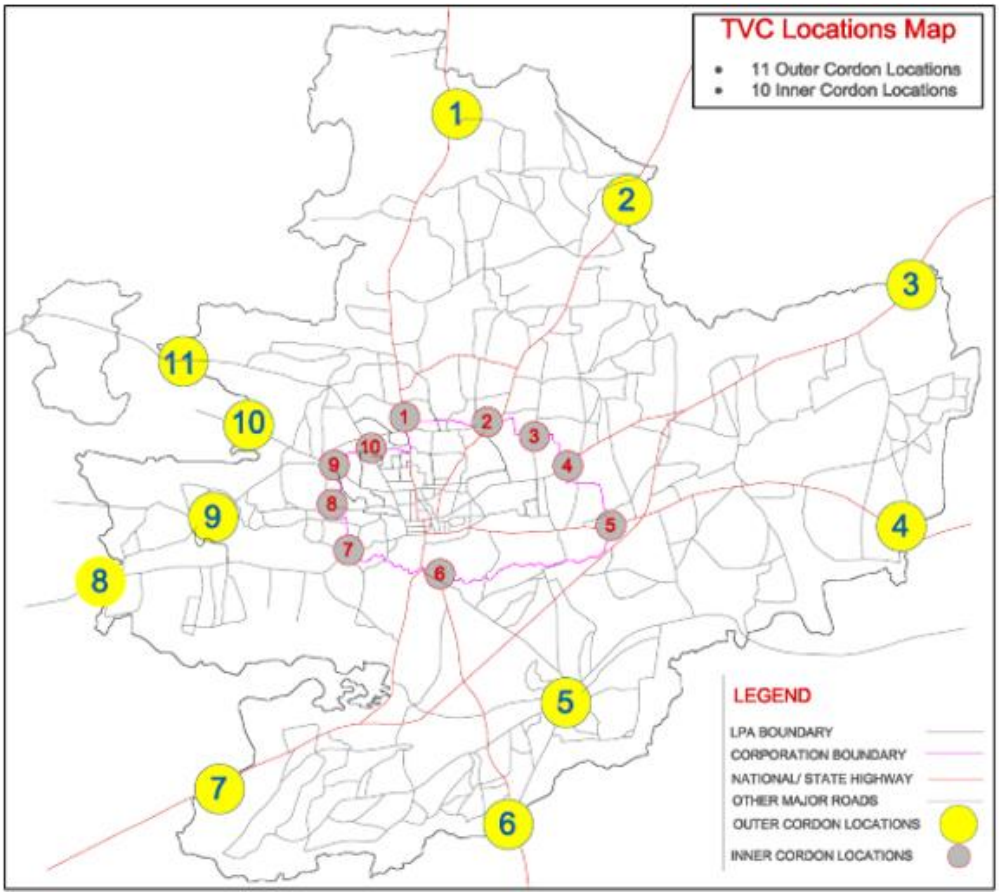


Figure 9. Locations of Traffic Volume Counts - Inner and Outer Cordon Locations (Pradeep, 2015)

3.1.2 (Intermediate) Public transport

The use of public transport is stagnating at around 42% due to lack of investment in improving the capacity and quality of public transport, overlapping routes (insufficient optimization) and a sharp increase in personal vehicle ownership. However, about 87% of households reported an income of less than Rs.15,000 (175,45EUR) (finanzen.net GmbH, 26.09.2018) per month and thus formed a large base of commuters for whom a functioning, efficient and affordable public transport system would be beneficial (ICRA Management Consulting Services Limited, 2015).

The public transport system in Coimbatore consists of buses and railways. In total there are around 1075 buses including outer and city buses. Out of those, around 722 are run by the Tamil Nadu State Transport Corporation (TNSTC). Other 475 are run by private operators, 83 being city buses and 392 intercity buses. There are nearly 40 private companies operating in Coimbatore which are licensed to run specific routes (Interview with Mobility Department Coimbatore, 25th of October 2018). According to a study from 2015, overall the extensive bus system supports over 40% of the motorized passenger trips in the city (NIUA 2015).

There are 5 bus terminals in the city and 7 more in the Local Planning Area (LPA). Five bus termini operate under CCMC, namely Ukkadam bus stand, Singanallur bus stand and the Central bus terminus/ Mofussil bus terminus at Gandhipuram along with a bus stand near Sai Baba Colony which caters buses bound to and from Mettupalayam, Nilagiri, Ooty, Sathyamangalam, Mysore and Bengaluru. The fifth one run by "The State Express Transport Corporation" (SETC) which is also under the control of (CCMC). This terminal has his exclusive bus stand at Grandhipuram. It operates long-distance buses from the Gandhipuram terminal. (ICRA Management Consulting Service Limited, 2015).

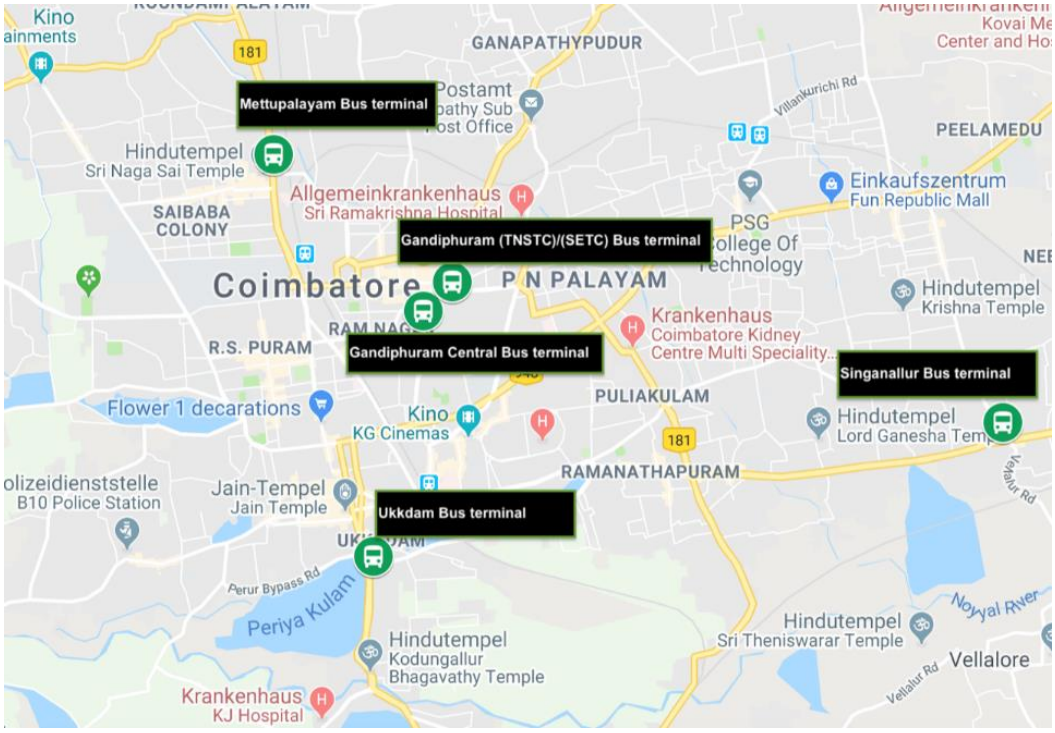


Figure 10. Overview of the five terminals of Coimbatore (Google Maps 2019) online added through the author

Central bus terminus/ Gandiphuram mofussil terminus takes care of 30-40% of the district bus traffic, and covered destinations are more in the North like Avinashi, Andhiyur, Anaikkatti, Tiruppur, Sathyamangalam, Erode, Salem, Mettupalaya, Dharapuram, Bhavani and Palladam. (ICRA Management Consulting Service Limited, 2015).

Gandiphuram SETC terminus takes 32,5% of mofussil traffic. Connecting state capitals areas like Tamil Nadu (Chennai), Kerala (Palakkad, Chochin, Trivandrum, Guruvayoor, Pattanamithtta, Kozhikode, Ernakulam), Karnatake (Bengaluru and Mysore) and Andhra Pradesh (Tirupathi). (ICRA Management Consulting Service Limited, 2015).

Singanallur bus terminal is in the East but covering into the South like Palladam to Kangeyam which is splitting in Karur, Kulithalai, Trichy, Thanjavur,

Kumbakonam, Nagapattinam, Karaikkal, Pudukottai, Dharapuram, Ottenchatram, Madurai, Tirunelveli, Tuticorn, Tiruchendur, Nagercoil, and Raeswaram and covering 21,30% of traffic. (ICRA Management Consulting Service Limited, 2015).

Ukkadam bus stand connects southern parts and Kerala covering routes along Pollachi, Udumalpet, Palani, Dindigul, Palakkad, Aanamalai, Valparai, Trivandrm, Ernakulam to Kozhikode and takes care of 25,14% of the traffic. (ICRA Management Consulting Service Limited, 2015).

Sai Baba colony, also called Mettupalayam bus stand, covers north-western parts from Coimbatore namely Mettupalayam, Kothagiri, Nilagiri, Ooty, Gudalur, Mangalore and Mysore and thus 11,92% of the traffic (ICRA Management Consulting Service Limited, 2015).

Table 1. Overview of bus traffic (ICRA Management Consulting Service Limited, 2015)

	Number of bus bays	Existing bus configuration	Number of buses plying per day	Number of trips per day	Peak number of trips/hour	route coverage (%)
Central bus terminus/ Gandiphuram mofussil terminus	48	parallel parking	721	1665	69	32,51
Gandiphuram SETC	12	sawtooth parking	171		24	9,13
Singanallur bus stand	15	sawtooth parking	399		34	21,3
Ukkadam bus stand	15	sawtooth parking	831		52	25,14
Mettupalayam bus stand						11,92

Coimbatore has 3 major railway junctions, which are Coimbatore Junction, Mettupalayam and Pollachi, and several smaller stations around these, to help reduce the passenger traffic at the big junctions (ICRA Management Consulting Services Limited, 2015).

The intermediate public transport (IPT) is mostly served by auto rickshaws (8541) with an average trip length of 5km, then taxis (434) with an average trip length services on a daily basis because they provide the last mile connectivity for passengers traveling long distances by buses (Pradeep, 2015).

According to CMP and compared to Germany (for example Stuttgart with about 30 buses per 100.000 inhabitants) (Stuttgarter Straßenbahnen AG, 2018), Coimbatore has enough buses (38 buses per 100.000 inhabitants) to handle the passenger flow, but the bus stations are not sufficiently equipped for the traffic flow or transfer journeys and thus lead to traffic jams in the Central Business District area. The mobility plan states that people have a distance of less than 5km to a bus or rail station and only about 10% have a longer distance. To get to the bus terminals, people walk or use rickshaws, while only a few prefer to use cars or two-wheelers (about 2%). Town Bus Stand, Ukkadam, and Central

Bus Stand have the highest passenger flow (in and out) while Karamadai, Mettupalayam and Somanur have a lower passenger flow. Considering intermodal stations, Coimbatore train junction is the most used with the most passengers (ICRA Management Consulting Services Limited, 2015). Regarding the trip frequency, most passengers travel daily (49%), followed by passengers traveling weekly (21%) and the monthly and occasional passengers (16% and 14%). 29% of the daily passengers travel to work, for 23% the trip purpose is for education (to go to school or university, etc.), 16% have a business purpose, 10% of the trips are for social reasons and 21% for other purposes (Pradeep, 2015).

3.1.3 Non-motorized transport

Although there are almost as many pedestrians (14%) as car drivers (17%), there are only a few pavements (Madhavan, 2015). On more than 80% of the major arterial roads, where space would be available, sidewalks or non-motorised tracks have not been provided. Existing footpaths are often not used because they are blocked by hawkers and parked cars or are poorly maintained. For these reasons and due to insufficient compliance and enforcement of traffic rules, there is a high accident rate involving pedestrians or vehicles, especially at the big roads like Avinashi Road, Trichy Road, Mettupalayam Road and Pollachi Road (ICRA Management Consulting Service Limited, 2015). Moreover, there are no explicitly assigned cycle tracks or parking areas.

3.1.4 Goods traffic

Due to the location of the Ukkadam Bus Terminal in the city centre and only one bypass (Eastern bypass from Neelambur to Madukkarai on NH 47), the goods traffic from outside is added to the city traffic. Almost 23% of traffic on Avinashi Road is caused by external-external traffic; on an average day, about 12,000 trucks enter and exit the city core area (ICRA Management Consulting Service Limited, 2015).

3.1.5 Parking situation

According to the CMP, the parking situation is mainly unplanned, random and unregulated. Cars are often blocking footpaths and roads. The most significant demand is daily from 8:00 to 20:00, especially along major arterial roads like Avinashi Road, Mettupalayam Road or large bus or railway stations, where most parking spaces are required. It is also observed that in commercial areas more than 30% of the vehicles are parked for less than one hour (ICRA, Management Consulting Service Limited, 2015).

3.1.6 Airport

Coimbatore International Airport (CJB) is located about 10km away from the city at Peelamedu. It links Coimbatore with all major cities of the country and a few

international destinations in the Middle East and South East Asian countries (Pradeep, 2015).

3.2 Existing mobility plans and goals

The urban sprawl, population growth, and the rapid economic growth brought new challenges to the city such as the increasing number of vehicle owners. Most of the difficulties in Coimbatore traffic arise from the mix of regional traffic on city roads as well as the absence of bypass/ring roads (Gokul, 2015). Further, there is no well-performed organization of the buses. Tamil Nadu Transport Corporation Ltd. (TNSTC) covers the city and its suburbs, additional a large number of intra-city private buses also operate within the city and the same suburbs area (Coimbatore City Municipal Corporation, 2017).

Additionally there is a lack of traffic hierarchy (insufficient right of way, control devices, intersections or carriageway width) (ICRA Management Consulting Service Limited, 2015), a lack of traffic corridors and most of the internal city roads are only 1-2 lanes (Gokul, 2015); also there are no well-designated roads or areas for pedestrians, bicycles or other vehicles only. Further obstacles emerge from an inefficient public transport system and no adequate/efficient transport infrastructure (Nagl, 2011). Lack of parking lots and organized on-street parking facilities have resulted in haphazard and un-organized parking on most stretches of commercial roads in the city (Gokul, 2015).

The road infrastructure has not expanded in tandem with the increase in the number of vehicles in the city. Important roads of the city, primarily the NH 209, SH15 and NH 47, present high traffic congestion. The road and transportation infrastructure has to not only meet the existing demand, but also cater to the demand that will be generated by the increasing population (Gokul, 2015).

With the aim of finding ways to efficiently approach the challenges that come with a growing population and urbanization in general, the Tamil Nadu Urban Infrastructure Financial Services Limited (TNUIFSL) commissioned ICRA Management Consulting Services Limited (IMaCS) to develop a Comprehensive Mobility Plan (CMP) for Coimbatore LPA, which was released in 2015.

The CMP was prepared in conformance with directives of the Ministry of Urban Development Government of India (MoUD) and sought to identify short, medium and long-term measures for safe, efficient and sustainable mobility in the examined area.

The studies include an assessment of motorised and non-motorised traffic, a review of mobility patterns in the LPA and an assessment of the relevance of existing strategies. Thus, an Urban Transport Planning (UTP) model was developed with short, medium and long-term strategies to ensure the integration of the various mass transit models and public transport with Intermediate Public Transport (IPT). The requirements for the infrastructure and the associated investments were taken into account.

The results of the CMP are based on extensive surveys and stakeholder consultations conducted in December 2013 and June 2014 under the leadership of District Collectorate Coimbatore and TNUIFSL.

3.2.1 Non-motorized transport

Here the aim is to increase the modal share of pedestrians and cyclists from the current 14% to at least 20%. For this purpose, a continuous, unimpeded and separate cycle track of 2.0 – 2.5m width on at least 80% of the road network, especially on major corridors and along lakes and rivers, should be made available (Pradeep, 2015). The "Sustainable Cities through Transport" plan makes proposals for footpaths and pedestrian zones with total footpath upgrade of 49 km and total pedestrianized streets of 16 km (ITDP, 2013). Further, the Smart City Mission plan proposes a 30km eco-mobility corridor for pedestrians and cyclists which links vantage points including lakes, Ukkadam Bus Stand, busy market streets, educational institutions, hospitals, and others. Also, NMT-only eco-bridges are planned on 8 road crossings on the NMT corridor (NIUA, 2015). Referring to pedestrian traffic, 75% of the road network is to be equipped with pavements and facilities for seamless pedestrian traffic. The footpaths should have a width between 1.80m and 2.50m (on both sides of the road) and be accessible to everyone, for example with ramps for handicapped people. There should be traffic lights at a distance of 25m and near every bus station as well as clearly recognizable zebra crossings. Finally, day-time non-motorized streets in the market area between Selva Chintamani lake and Perur lake are proposed (Pradeep, 2015).

3.2.2 Public transport and intermodal facilities

A further goal in the CMP is to increase and stabilize the use of public transport from the current level of 42% to 55% by 2020, 60% by 2025 and 70% by 2033 (Pradeep, 2015). To achieve this, it is proposed to provide bus stops with bus shelters at every 1,0 -1.2km and to build underpasses at junctions for easier access to the stops. Currently, all buses originate and terminate at Gandhipuram bus stand which is located in the city core area causing major congestion. Therefore 2 relocations and 7 new locations for bus terminals have been identified:

- Relocation of Gandhipuram bus stand, Mofussil bus stand, Gandhipuram SETC bus stand, Town bus stand, Ukkadam bus stand, and Thiruvalluvar Bus Stand to the area of Vellalore;
- Relocation of Polacchi bus terminal on Pollachi Road (NH-209) near Sangampalayam.

Proposed new locations for bus terminals:

- Thudiyalur bus terminal on Mettupalayam Road;
- Bus terminal on Avinashi road between Neelambur and Chinniyapalayam

- Periyanaicken Palayam Town bus terminal;
- Perur bus terminal near Perur Chettipalayam;
- Vadavalli bus terminal;
- Madukkarai bus terminal;
- Kurumbapalayam bus terminal on Sathy Road.

Also, there are some bus stands which need improvement to tackle the traffic in central areas such as Siganallur main bus stand, Mettupalayam City Bus Terminal and Ganapathy Bus Terminal (Pradeep, 2015).

Critical steps for the relocation to Vellalore will be the integration of mofussil, city & interstate buses and omni Buses, the development of integrated bus terminus for handling future traffic and next-generation buses at Vellalore and the integration with other modes of transport.

3.2.3 Mass rapid transit system (MRTS)

An MRTS offers a more efficient and faster transport option for large groups of people in the same travel corridor at low cost to individual passengers. There are different types of MRT Systems, but as proposed, the most suitable and recently available system options are a Bus Rapid Transit System (BRTS), a Light Rail Transit System (LRTS) and/or Metro Rail. Its implementation is being proposed and analysed for the four corridors described below. The implementation of these projects is also being pushed as CDM measures (Clean Development Mechanism- a project established through the Kyoto Protocol of 2005 with the aim to reduce Green House Gas emissions). In this context, specific MRTS options have been already proposed for each of the corridors.

1. Kaniyur-Ukkadam
   The total length of the corridor is 26km. The proposed MRTS would be a mix of at-grade (19.18km) and elevated (6.82km) sections along Avinashi Road. The average trip length would be 14km and peak hour peak direction traffic (PHPDT) in 2020 would be 7633 vehicles with 244485 passenger-km. The route can be extended by 9.5 km to Madukkarai, depending on demand. For this corridor, the Clean Development Mechanism (CDM) proposes a BRT System.
2. Bilichi-Ukkadam
   The length of the traffic corridor along Mettupalayam Road is 24km and can also be extended by 9.5km to Madukkarai in the future. The average distance travelled on this corridor should be 15 km. Projected PHPDT in 2025 is 7658 vehicles using a BRT System.
3. Karanampettai-Thannerpanthal
   This corridor covers a distance of 42km with elevated sections for LRT Systems along Trichy Road and Thadagam Road. The average trip length

is 16 km, with a forecast demand of 15323 vehicles with 539196 passenger-km in 2025.

4. Ganeshapuram-Karunyanagar
   The track in this area is 44km long with elevated sections along Sathymangalam Road and Perur Road. The projected demand in 2033 should be at 15225 vehicles with 469632 passenger-km. The CDM proposes an LRT System for this corridor.

The actual technical options for each mass transit corridor are further studied in order to select the appropriate system (Pradeep, 2015).

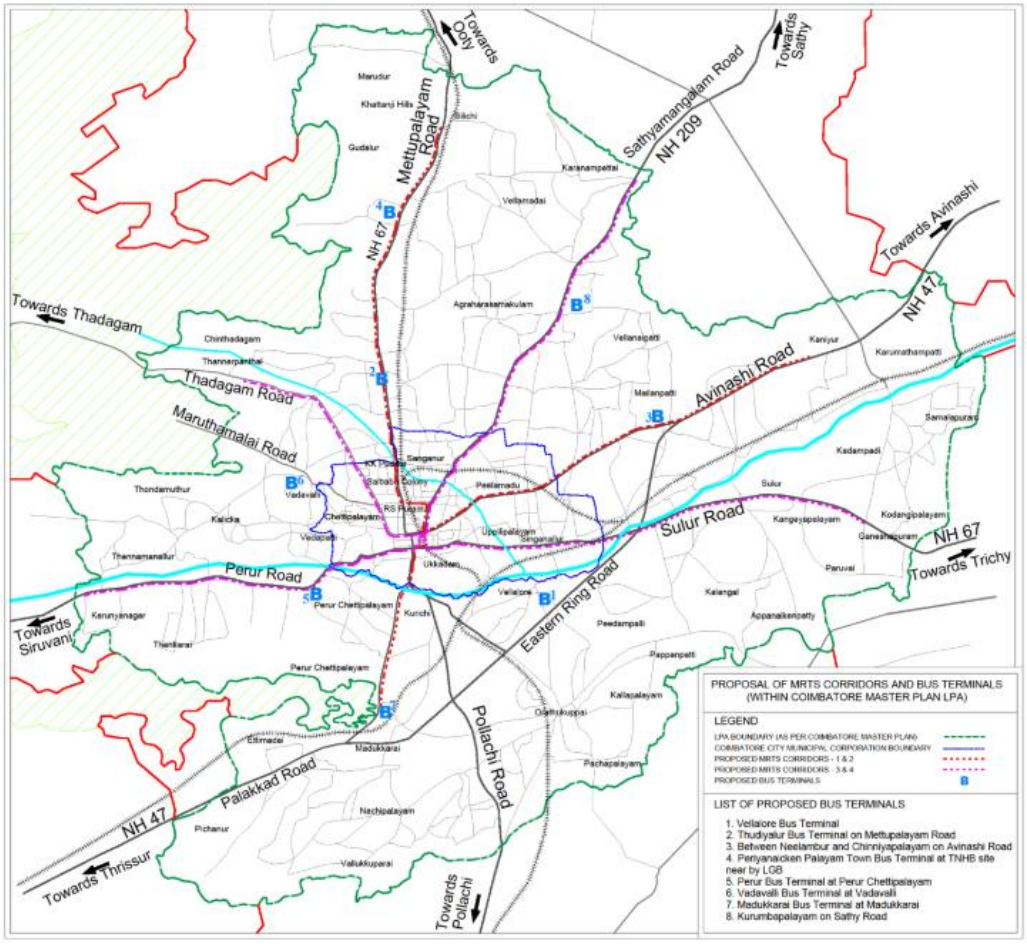


Figure 11. Proposed MRTS Corridors and Bus Terminals (Pradeep, 2015)

3.2.4 Roads for motor vehicles

In order to ensure a seamless traffic flow, a clear road network system must be established, with multi-lane roads (4 lane roads and 6 lane roads), flyovers and underpasses also for crossing railways, bans on certain turning movements or the introduction of one-way streets, better street lighting and traffic control systems which could also improve the road hierarchy. Also, the existing main road network should be supplemented with new constructed linking roads to

allow a redistribution of traffic. Besides, the road surfaces are to be renewed or improved in order to avoid lifting the roadway by braking vehicles or fast turning. Based on the large pedestrian and vehicular movement it is proposed to reduce speed and calm the traffic for increasing the safety for pedestrians through measures such as speed breakers or humps, speed tables or by building bridges at Kulathupalayam Channel, PWD Channel – Pillaiyarpalayam Main Road, Tichy Road and Sowripalayam Road, Rajaji Street and Vilankurichi Elementary School Backside (Pradeep, 2015).

3.2.5 Parking facilities

It is proposed to create a parking system including, i.e. park and ride or parking facilities near public transport stations, to give commuters and other traveling people the opportunity of leaving their vehicle and parking near a station and switch to public transportation or carpool.

The problem of parking on streets could be regulated through paid on-street parking with a total length of 32,4km ensuring free. Besides, off-street at-grade parking facilities, which are required at 6 locations, and 7 multilevel parking shall be established of which three already have been approved for implementation. The Coimbatore City Municipal Corporation Area offers a location for an off-street at-grade parking lot at Gandhipuram through shifting the existing Omni Bus Stand to Codissia where a parking lot is also proposed (Pradeep, 2015).

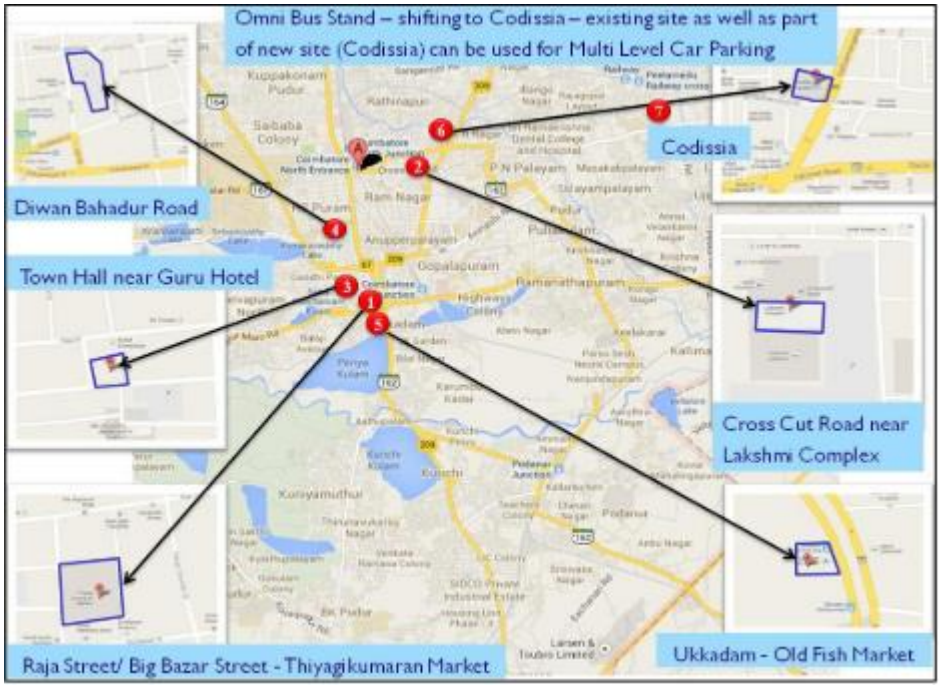


Figure 13. Proposed multi-level parking locations in the CMP (Pradeep, 2015)

3.2.6 Freight transport

Ring and by-pass roads are to be built to relocate freight traffic outside the city. There will be fully equipped truck terminals (with restaurants, workshops, petrol

stations, etc.) for a better organization of the large influx of goods and regional traffic. These can serve as growth and economic engine for the region and at the same time reduce truck traffic within the city. Also, a 200ha logistics park is to be set up near Ukkadam, covering the infrastructure for rail and road freight and offering warehousing, private freight terminals, distribution, and consolidation. Another proposal is entry restrictions for heavy vehicles during peak hours (Pradeep, 2015).

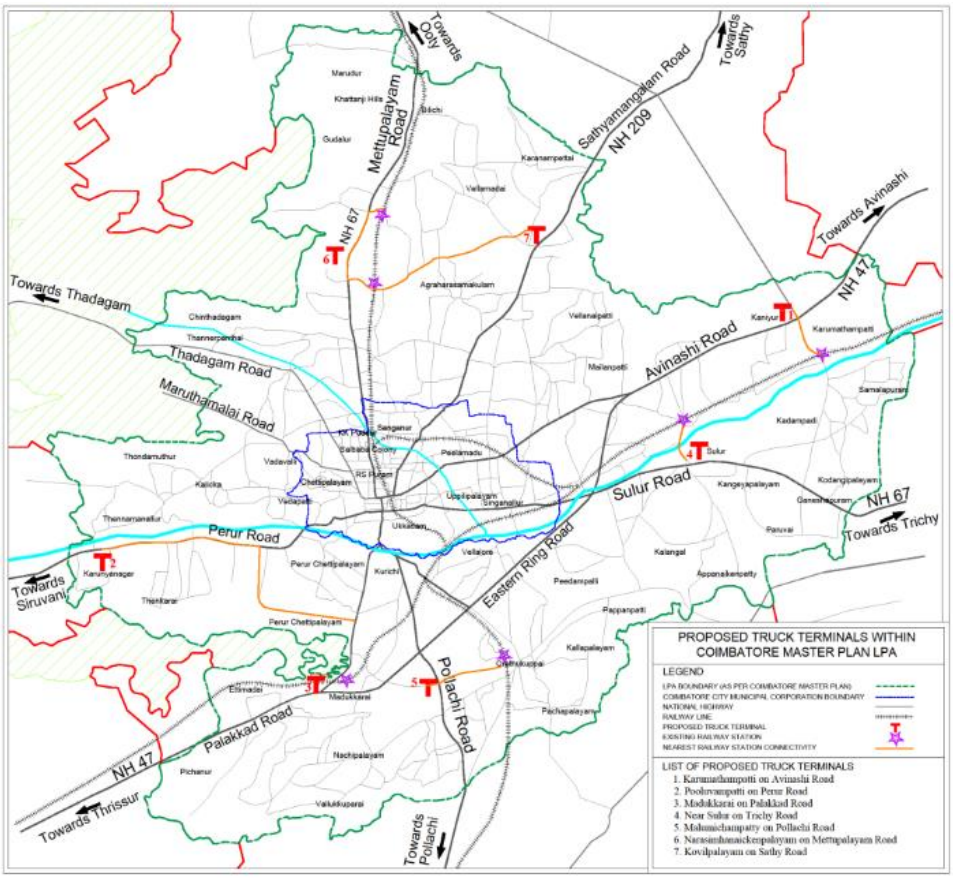


Figure 14. Proposed Truck Terminals (Pradeep, 2015)

3.2.7 Intelligent transportation system (ITS) application

Using ITS networks can be more efficiently managed, and passengers can be better informed about decisions regarding their journeys.

Proposed ITS facilities are installations of security camera network systems (CCTV) on major corridors, at bus stops/depots and in buses, the implementation of an Intelligent Signalling System (ISS) or priority signalling, introduction of an automatic vehicle location system or GPS, as well as a Central Control Station with SMS service, incidence management, a real-time information system, a web portal and a help desk management system.

Other preferable ITS Components are for example a door obstruction sensor, handheld electronic ticket vending machines (ETVM) or passenger information

systems (PIS) with LED boards placed in buses and at stations along with an in-bus voice announcement system (Pradeep, 2015).

3.2.8 Paratransit and feeder services

To supplement the existing public transport services, the introduction of paratransit and feeder services are recommended. On the proposed BRT corridors, minibus operations should be banned or only act as a feeder to arterial roads.

3.3 Other related plans

3.3.1 Smart Cities Mission

The Government of India sponsors a program under the Ministry of Urban Development (MOUD) which is called Smart Cities Mission. It is a national five-year program with the goal of providing Indian cities with more citizen-friendly and to provide a sustainable growth environment. This mission is divided into two stages, with stage 1 being the already completed shortlisting of 100 cities by states and stage 2 being a countrywide competition with a challenge round for selection. In stage 2 a city-wide concept plan and a smart city proposal have to be presented. The information for the concept plan is based on studies from the CMP (Madhavan, 2015).

3.3.2 Solar City Master Plan

In 2015 the Ministry of New and Renewable Energy (MNRE) approved the Solar City Master Plan (SCMP) in collaboration with the CCMC and the Tamil Nadu Energy Development Agency (TEDA). This plan promises the addition of renewable energy as well as savings through energy efficiency. Therefore Coimbatore plans, e.g. to expedite its solar rooftops and to provide energy efficient street lighting (NIUA, 2015).

3.3.3 Water management

Coimbatore is known for the drought-prone area which leads to flooding in low-lying areas and ecosystems are declining. So the risk of both seasonal drought and flooding are rising. Already they have problems with an adequate water supply system. Currently, the inhabitants in Coimbatore receive just 5 to 10 days water mostly from the Noyyal lake and at Perur Selva Chintamani lake, but the water they receive have negative effect of children and people because of infectious wastes dumped there (Weskamp 2018).

In 2012, Coimbatore launched a Slum-Free City Action Plan which plans to include an integrated solution for the inadequate water management as well as project ideas to cater the contaminant lakes/water bodies (Liehr, 2018) and to re-connect the channels and reduce dumping of domestic and industrial sewage in lakes and additionally reduce emission. Initial steps have been taken to clear the open water bodies out of Juliflora sp. weed and collected plastic waste in

the important lakes (Perur Periya Kulam lake, Perur Selva Chintamani lake, Vellalore lake, and Noyyal river) (Krishnaveni, 2017). Furthermore a team of experts (Fraunhofer institution for Interfacial Engineering and Biotechnology IG, Institut für öklogische Forschung, Institute for Social-Ecological Research and other German companies namely DREES&SOMMER, trAIDe GmbH and DEUS 21) are currently working together and focusing on topics like improving Semi-centralized sewage collection and treatment, the industrial water supply and wastewater treatment and the improvement of water quality data and monitoring (Mohr, 2018).

4. Indicators analysis

The analysis of the indicators shows a status quo inventory of Coimbatore and addresses the following question: „What is the sustainability performance of the city? ". Additionally, it assesses what kind of data is being measured and available at the city level. A total of 35 indicators were taken into account for the analysis addressing different aspects concerning mobility and related sectors, such as the environment, economy, society, energy, and technology. Due to the limited availability of data, not all indicators were evaluated. Accordingly, the report only presents arguments based on existing data.

The indicator analysis mainly uses „Indicators of the Emerging and Sustainable Cities Initiative" (ESCI) of the Inter-American Development Bank, as well as indicators developed by the Fraunhofer "Morgenstadt City Initiative" (MCI). According to their standards, the benchmarks are divided into three categories: green (no problem), yellow, and red (critical issue). Additionally, an average value for India was added to show the city's performance with regards to the country. The following figure shows an overview of the evaluated mobility indicators and benchmarks.

Table 2. Coimbatore indicator assessment.

Indicator name	Indicator scope	Value Coimbatore	Average value for India	Comment / Source
Mobility-related Indicators				
Modal split in % of total traffic	share of traffic by pedestrian [%]	**20**	16-57	based on trips per day. Source: (ITDP 2015)
	share of traffic by bicycle [%]	**3**	1-20	based on trips per day. Source: (ITDP 2015)
	share of traffic by public transport [%]	**43**	40-60	based on trips per day. Source: (ITDP 2015)
	share of traffic by personal vehicles (cars, motorcycles,etc) [%]	**34**	20	based on trips per day. Source: (ITDP 2015)
Special roads for public transport in km/100.000	Kilometers of roads dedicated exclusively to public transit per 100.000 population	**0**		Source: Interviews
Safety	number of annual fatalities per 1000 inhabitants	**0.12**	0.11	207 fatalities in total of 2017. Source: (The Times of India 2018a)
Society-related Indicators				
Urban density	Number of people inhabiting a given urbanized area [number of inhabitants per km2]	**7400**		As of 2014 - population: 1,650,080, urban extent: 224.34 m^2. Source: (Atlas of Urban Expansion 2016)
Population Dynamics	Annual increase in population [%]	**+4.1**	+2.76	Since 2000. Source: (Ministry of Urban Development 2016a)
Average household income	Monthly average household income [in € per month]	**812.66**	464.65 EUR (2015)	Income per capita: INR 65781. Source: (Ministry of Urban Development 2016b)

What stands out of the indicator assessment, is that Coimbatore is growing at a very fast rate, which in consequence will have an impact on the urban density. The average monthly income in Coimbatore is about 40 % higher than the average Indian household. Accordingly, also the possession and use of a private vehicle are comparatively high. Efforts should be put into promoting the use of public and non-motorized transport further.

As a key finding, the assessment also shows that data availability and organization will be a crucial issue to be improved so as to facilitate evidence-based planning, monitoring and performance measurement in the future. Most data was unknown or not available at the municipal departments and had to be collected from different report and literature sources.

Indicators that could not be found and respected include:

- Mobility-related indicators: level of motorization, parking fees, km of bicycle paths, use of public transport (rides/year/capita), the modal split of the freight system, the share of e-vehicles;
- Environmental indicators: average CO_2 emissions per capita, air pollution (yearly average PM10, NO_x, CO_2), noise pollution, sealing degree of surfaces;
- Economic indicators: GDP, Unemployment rate, income equality;
- Electricity-related indicators: share of renewable energy in the grid, local energy production, prices;
- Technology-related indicators: internet connectivity, the share of smartphone owners.

Future activities in these areas should consider opportunities to record such or related information and feed it into an organized central storage system where all departments have access to. Future data sources could, for example, include the planned command and control center, CCTV cameras, GPS trackers, regular inventories, etc. (see action field analysis). The city could also consider working together with local universities and institutes and institutionalize data collection and exchange with state and national level agencies to overcome the lack of available information.

5. Action fields analysis

The following analysis indicates how the city addresses sustainability and which activities it is focussing on. It gives an overview of relevant fields of actions and related sub-aspects.

5.1 Intermodality and sharing systems

This action field addresses aspects such as the creation and utilization of combined and integrated transport solutions and passengers' opportunities to easily choose and change between different modes of transport so as to be

mobile in the most efficient way. As of upcoming and quite widespread transport models, car and bike sharing options were also assessed. Mixed-mode commuting and sharing options can be used to support the strengths and offset the weaknesses of the already existing transport infrastructure by combining various modes of transport.

The municipality of Coimbatore has already done some work in this area: 3 bus stops with the possibility to change lines or transport mode have already been implemented (ICRA Management Consulting Service Limited 2015, p.76). Additionally, the city has declared the willingness to support further and expand such services, e.g., with the relocation of 7 intercity bus terminals and the construction of park & ride facilities on the outskirts of the city (ICRA Management Consulting Service Limited 2015, p.286). Still, if compared to some other locations in India and Europe, more can be done in this action field to unlock its full potential. Thus, the municipality should use different opportunities to intervene and introduce solutions that allow for better and more convenient connection of different transport modes, providing better user experience, and promoting the use of environmentally-friendly alternatives.

In terms of sharing models, several private car sharing initiatives like Ola and Zoomcar already exist (Zoomcar India Private Ltd 2017; Pooja Kiran 2018). Currently, the city itself does not see an added value in increasing its own transport portfolio with a municipal "sharing" alternative. In general, the invasion of shared mobility in India is still low if compared to more mature markets of China and Europe. However, a significant shift is ongoing in densely populated cities, due to the lower costs of the use of e-cabs compared to driving a private car (Gupta et al. 2018). As of now, there is no bicycle sharing system in place. In the last years, different private companies were interested in setting up such schemes. However, all of them backed off due to different reasons such as vandalism and cost ineffectiveness (Babu 2018; The Times of India 2018b). Here a local initiative or partnership could help to integrate this offer in the overall transportation planning and promote affordable access to bicycles short-distance trips. As a non-motorized alternative, this could significantly contribute to reducing congestion, noise, and pollution in the city center. However, attention has to be paid to improve road safety and create a cycling-friendly environment and infrastructure, to ensure the use and uptake of such solutions. In Coimbatore, local universities and technology parks have also expressed interest to implement e-mobility and bike sharing schemes to begin the transition towards more sustainable modes of transport.

Table 3. Action field intermodality and sharing systems

Im	**Action field intermodality and sharing systems**	
Im1	Does the city implement mobility hubs to combine several modes of transportation (bus, bicycles, sharing vehicles, charging stations, etc.)?	YES
Im2	Has the city implemented park&ride slots around public transport nodes?	NO
Im3	Has the city implemented sharing stations (car or bike) around public transport nodes?	NO
Im4	Does the city provide one ticket for all mobility alternatives (public transport, car-sharing, parking, etc.)?	NO
Im5	Does the city provide parking spaces for shared vehicles?	NO
Im6	Does the city implement car sharing in the city?	NO
Im7	Does the city implement bike sharing in the city?	NO

5.2 E-mobility

This action field focuses on the promotion and integration of E-mobility through adequate incentive structures (e.g., support for purchasing electric vehicles, free parking, tax reductions, etc.) and the implementation of charging infrastructure in public space. As of now, the city of Coimbatore has not been actively engaging in this field. However, as the Indian electric car market is slowly but constantly growing and governmental programmes such as FAME (Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles) and the National Electric Mobility Mission Plan are supporting public and private uptake of E-mobility, this might be interesting and important to explore further in the near future (McKinsey & Company 2017), p.17). As a first step, the city is introducing 20 E-busses, which can be a major asset to promote E-mobility, reduce traffic emissions and raise public awareness for environmentally friendly transport. Furthermore, local companies such as OLA are already working on and offering solutions such as E-rickshaws and E-vehicles and can be good partners to work with. As a big challenge, local charging infrastructure will have to be developed for which careful planning and a good strategy is needed, as up to now only very few electric vehicles exist.

Table 4. Action field e-mobility

Em	**Action field e-mobility**	
Em1	Does the city administration have electric vehicles in their municipal fleet?	NO
Em2	Are there specific "free parking slots" in the public space reserved for electric vehicles?	NO
Em3	Does the city incentivize the purchase of EVs (e.g., by reduction on the carbon tax?)	NO
Em4	Is there a plan to implement charging infrastructure in the public space of the city?	NO
Em5	Are electric vehicles allowed to use special lanes (e.g., bus lanes)?	NO
Em6	Is there a booking system in place for the charging stations?	NO

5.3 Road traffic management and parking

This action field aims at tackling challenges related to traffic flows, congestion and the regulation of parking. Thereby emphasis is put on relieving the city center, as well as highly congested roads or heavily polluted districts. Actions involve aspects such as environmental and low-emission zones, the systematic reduction of parking lots in the inner city as well as payment systems for parking in specific areas. Furthermore, the use of intelligent traffic management and control systems is assessed. With 2106.11 km of roads and 80% of motorized movement in Coimbatore (ICRA Management Consulting Service Limited 2015), these could provide new and innovative services relating to different modes of transport and traffic management, to improve the available data and information base and enable a safer and more coordinated use of the transport and road network.

Currently, the city has set up traffic control stations at strategic and highly frequented intersections which are directly monitored by Coimbatore Traffic Police officers, with limited use of technologies. However, a central command-and-control center is in planning, which will provide the city with the necessary tools and data to improve traffic regulation and planning. Furthermore, the Traffic Police will soon launch an app, „Police-E-Eye" that will enable citizens to take pictures and directly send traffic violations to their database (THe Hindu 2019). The planned app also aims at regulating and improving the current parking situation in the city: As of now parking spaces are not well defined, and there is no charging system in place. However, the city has planned but not yet implemented paid on-street parking along various roads in the core city area, as well as 6 off-street parking complexes (ICRA Management Consulting Service Limited 2015, p.290). These measures will enable Coimbatore to monitor parking patterns and adjust the amount of parking lots and fees accordingly, to encouraging private vehicle owners to avoid the city centre and park in less impacted areas. As space is rather limited and the amount of private vehicle owners is expected to significantly increase, flexible and multi-level parking facilities in well-connected and strategic parts of the city could be established, and smart parking management systems which spot and manage the availability of parking lots could be considered in the future. Also, defined low emission zones and green blocks can help to preserve pedestrian and cycling friendly urban spaces.

Table 5. Action field road traffic management and parking

Rm	Action field road traffic management and parking	
Rm1	Has the city created low-emission zones?	NO
Rm2	Is the city undertaking a systematic process of decreasing the number of car parks in the city?	NO
Rm3	Has the city implemented pricing mechanisms to control commuting patterns (congestion charging, tolls, etc.)?	NO
Rm4	Has the city implemented a parking payment system on public roads?	YES
Rm5	Does the city have traffic management systems and intelligent traffic control systems?	YES
Rm6	Is the city actively pursuing the development and expansion of car-free areas (e.g., in the city center)?	NO

5.4 Public transport

As one of the main drivers to encourage sustainable mobility behaviour, this action field assesses activities around the attractively and quality of public transportation services in comparison to private car use. Coimbatore is not a unique example, where despite high percentage (42%) of public bus usage and low costs of public transport, the number of privately owned cars is constantly rising. It has been mentioned that amenities and comfort will have to significantly rise in order to make it more attractive and eliminate the image of being a "poor people transport option." To address this challenge, Coimbatore developed the already mentioned "Bus service improvement plan" and plans an additional MRTS system. To support these measures, the development of more universal and streamlined payment systems (see intermodality), new navigation and information systems for passengers (such as bus network plans and route calculators) could improve the quality of public transport services. As means to further enhance public transport attractivity, priority bus lines which are connected and complement the proposed MRTS/BRT systems could be considered (ICRA Management Consulting Service Limited 2015, p.243). Additionally, the already existing rail system could be used to introduce commuter trains with frequent stops to decongest the city center and add an alternative for suburban connection.

Table 6. Action field public transport

Pt	Action field public transport	
Pt1	Is high quality of public transport given (high frequency, high density, punctuality, moderate cost)?	NO
Pt2	In general, is commuting by public transport cheaper than commuting by car (excluding parking)?	YES
Pt3	Do buses/trams have their own priority lines?	NO

5.5 Pedestrian and cycling

This action field focuses more specifically on the promotion of non-motorized transport, namely cycling and pedestrian movement. It thereby considers the prioritization of pedestrian and cyclist friendly infrastructure (sidewalks and bicycle lanes) in urban planning, as well as attractively and safety aspects. Despite high motorization rate, a significant share of trips made in the city is non-motorized (14 %). Cycling and pedestrian accessibility are key elements in the existing mobility plan, and the city has already put lots of effort and emphasis on this topic. It has improved through road configuration and cross sections by providing footpaths along major urban sprawl corridors. Still, several challenges remain. Most importantly, it has been mentioned that safety is not sufficiently guaranteed. Even though several concrete sidewalks have been constructed, their (illegal) use by two-wheelers and trade encroaching are limiting their usability. As a response to the problem, the town planning department has conducted eviction drives on a weekly basis to remove illegally parked or erected obstacles which are planned to be followed by imposing fine (THe Hindu 2018). Also concerning cycling, which only accounts for roughly 1% of daily ridership, the city has indicated in the CMP facility improvement plan the need to ensure the safety of bicycle commuters, e.g. by construction of segregated bicycle tracks (2 m width for one-way and 3 m width for two-way movement) along major roads (ICRA Management Consulting Service Limited 2015, p.278). To conclude, further identification and limitation of key danger areas are needed to complement and support activities in the area of non-motorized transport. Furthermore, attractive and healthy surroundings (such as green spaces which can regulate air quality, provide cover and offset the warming effect of paved surfaces) should be created. The development of green areas is also a part of the Urban Transport Development Strategy proposed by ITDP (ITDP 2013).

Table 7. Action field pedestrian and cycling

Pc	**Action field pedestrian and cycling**	
Pc1	Does a mobility-plan include cycling and pedestrian accessibility as key elements?	YES
Pc2	Does the city expand pedestrian-activities in the public space (e.g., pedestrian zones etc.)?	YES
Pc3	Does the city expand cycling-activities in the public space (e.g., cycling lines etc.)?	YES
Pc4	Does the city redevelop (mobility plan) former street and parking spaces to provide more public green?	YES
Pc5	Is the city actively identifying and reconciling key danger areas for cyclists and pedestrians (e.g., providing a reporting system)?	NO

5.6 City governance & strategy

This action field addresses governance subjects which are relevant in order to steer and manage mobility-related activities effectively. These involve the existence of an integrated mobility strategy with defined short- and long-term

goals which integrates all transport modes to achieve a sustainable mobility transition, the coordination, and cooperation within the city, or the availability of funds for sustainable mobility projects.

The municipality of Coimbatore has developed the previously mentioned Comprehensive Mobility Plan for Coimbatore LPA and thus taken the first important step towards achieving better governance mobility management. The plan includes defined development goals, planned actions, and implementation programmes, as well as relevant data for these. On this basis, more accurate actions and objectives can be defined. In terms of communication and coordination of mobility actions, the city still lacks a single body or organization that is in charge (e.g., a transport department). Especially in large cities with a rich stakeholder portfolio and a hierarchical structure, such a vehicle could significantly improve and facilitate sustainable mobility planning by integrating and coordinating all ongoing activities and plans, identification of synergies, as well as gathering and streamlining relevant data and information (e.g., see indicator analysis). In the light of sustainability being a highly complex issue, it could be worth considering a sustainability advisory board to counsel and support this body.

Table 8. Action field in city governance & strategy

Cs	**Action field in city governance & strategy**	
Cs1	Has the city developed an integrated mobility strategy?	NO
Cs2	Does the city have a single body/organization responsible for the communication and coordination of transport managers (e.g. parking, PT, Bike/car sharing..)?	NO
Cs3	Is there a sustainability advisory board in place within the city?	NO
Cs4	Does the advisory board cover civil society, research, business and city administration?	NO
Cs5	Does the city allocate funds or has a separate budget for greening the mobility sector?	NO
Cs6	Are there concrete long-term sustainable mobility goals that have been agreed upon by the council?	NO

5.7 Urban planning

The action field focuses on the links between mobility issues and long-term sustainable city planning and district design. Here Coimbatore is actively pursuing the goal of prioritizing non-motorized and public transport (e.g. in the green corridors), as well as in promoting mix-use concepts (e.g. in the envisioned logistics terminals, park and ride stations and around stations of high importance). The biggest challenge that has been identified in this regard is that, due to the bureaucratic and hierarchical nature of the Indian system, the city has rather limited planning sovereignty. Furthermore, the city is lacking meaningful data and monitoring assessments which would enable more evidence-based planning. Here a more standardized approach with regular and consistent data

collection should be developed with the goal to gain deeper insights into current and future scenarios and to plan mobility actions in a more precise manner based on public and private needs. Lastly, public policies will have to support and complement spatial planning measures, e.g. considering low emission policies in the green zones, issuing regulated and adequate zoning regulations and building permits, or incentivizing high-occupancy in private cars and public transport use to be able to regain urban space.

Table 9. Action field in urban planning

Up	**Action field in urban planning**	
Up1	Does city planning follow principles that support sustainable mobility (e.g. the compact city, the walkable city, the green city etc.)?	YES
Up2	Are there regular data assessments with respect to the city structure?	NO
Up3	Does the long-term planning correspond to and link with regional or federal planning?	NO
Up4	Are transport companies allowed to engage in district development?	NO
Up5	Do districts around stations have a high density and a high use mix?	NO

5.8 Energy

This action field focuses mainly on the availability of renewable energy and its link with the local grid. There are operating wind farms in the Coimbatore area, which have to be further enhanced and complemented by other sources in order to achieve the city's renewable energy goals (according to the data from the website: http://www.leapgreenenergy.com/). Even though E-mobility activities are just slowly taking off in the city, their future introduction has to be aligned with increased efforts in clean energy supply and storage options. This will be crucial to ensure power supply and unlock the full potential in terms of GHG emission and pollution reduction. The city has partially implemented solutions that link renewable energy production and energy demand through intelligent systems. This could be further developed and upscaled to integrate electricity storage solutions and different modes of electrified transport.

Table 10. Action field in energy

En	**Action field in energy**	
En1	Have test-projects with smart grid components been carried out in your city?	NO
En2	Are solutions in place that link renewable energy production & energy demand with intelligent systems?	YES

5.9 ICT

In this action field, the links between sustainable and efficient mobility and available information and communication technologies are explored. This involves the collection and use of real-time data for traffic management and

monitoring purposes and additional services such as uniform ticketing and payment systems which could generate data on how people move in the city.

In the city of Coimbatore certain types of real-time data (mainly from public transport) are available, but until now not directly used for monitoring. However, the municipality has piloted data application during the festive season which is characterized by a higher traffic pressure on main corridors. Furthermore, environmental sensoring has been installed in about 30 different locations along with an online information portal that gathers and displays the information and could be further rolled out and integrated into future planning. Also, the Comprehensive Mobility Plan proposes further development and implementation of an IoT-based Intelligent Transport System in the near future (ICRA Management Consulting Service Limited 2015, p.204). Proposed measures include the mentioned command-and-control center, an Intelligent Signalling System, CCTV cameras at bus stands to conduct demand studies and increase safety, and GPS tracking of busses to feed public transport planning and public information systems. Electronic ticketing has so far not been considered, as there are sufficient manpower and structures for data collection, storing and processing are just starting up.

Table 11. Action field ICT

It	**Action field ICT**	
It1	Does your city offer an electric ticketing system (smart transport card that can be used across different public transport operators)?	NO
It2	Can the "transport card" be used as a means of payment in the majority of local transport vehicles?	NO
It3	Are real-time data from the public transport system used to monitor the traffic in the city?	NO
It4	Is the overall transport system being improved on the basis of real-time data measurement?	NO
It5	Does the city utilize real-time data to optimize traffic management (e.g. user data to understand mobility behavior and artifact-based data)?	YES
It6	Does the traffic management respond to real-time data (e.g., change traffic light circuits)?	YES

5.10 Resilience

The action field on resilience investigates the ability of a city to deal with external shocks and hazards. In terms of mobility, mostly the links between infrastructure and climate and urbanization-related risk are being assessed. In the recent decade, it has been recognized that sealed surfaces such as roads, bridges, parking lots, etc. have a significant impact on the urban climate and water cycle by contributing to heat islands and increased surface runoff. According to reports from the Tamil Nadu Fire and Rescue Services control room, some parts of Coimbatore also have witnesses flooding during heavy rainfall (ICRA Management Consulting Service Limited 2015, p.327). Thus, the city has partially worked on measures to reduce stormwater runoff from the roads. Moreover, the

city-based NGO Siruthuli in cooperation with CCMC has constructed rainwater structures such as roadside digging borewells across the city depending on the ground formation of the location (THe Hindu 2018). The city is also highlighting accident spots as part of its risk mapping. This practice should be further institutionalized and could be enhanced by applying resilience scorecards and building criteria which demand the use of permeable pavings, buffer zones, shading street trees or rainwater retention systems in future mobility infrastructure projects. Furthermore, care should be taken that emergency and evacuation plans are included in infrastructure planning.

Table 12. Action field Resilience

Rs	**Action field Resilience**	
Rs1	Does the city apply resilience scorecards for infrastructures?	NO
Rs2	Do emergency plans for critical infrastructures exist and are they regularly updated?	NO
Rs3	Has risk mapping taken place in the city and is it regularly updated?	YES
Rs4	Is the city actively taking measures to improve stormwater runoff from road infrastructure (e.g. using permeable pavements, green strips, buffer zones)?	YES

6. Project ideas for the transformation of the mobility in Coimbatore

During the two weeks of on-site assessment, a total of 32 project ideas were developed together with the interviewees and during the internal co-creating sessions with the local team in Coimbatore. To facilitate the selection process, the projects were then grouped in so-called "packaged solutions" according to their specific sector. For instance, the projects related to improving the bus system, such as the upgrade of bus stops, the design of new bus routes and the creation of mobility hubs, were packaged as "improving bus services." Like this other 10 packages were put together:

- Improving bus services;
- Promoting shared mobility;
- Improving railway services;
- Improving road infrastructure;
- Intelligent parking management;
- Improving logistics;
- Intelligent Transport Management;
- Smart Solid Waste Management;
- Technical solutions;
- Smart governance.

On the 28th of November an innovation workshop was organized for presenting, verifying, discussing and further developing the existing ideas Given the limited time available on the innovation workshop, 7 out of the 10 packaged solutions were selected by city representatives and the City Lab team, to be discussed in detail on the 28th of November.

6.1 Innovation workshop

More than 40 representatives from the municipality, private companies as BOSCH India, Clancor Technologies, the Lorry Owners Association, Jayem Automotives bus operators, universities, and KfW representatives participated in the session. As an introduction, the City Lab methodology was presented followed by the presentation of the preliminary results and the 32 developed ideas. The participants were divided into groups according to their expertise and/or area of interest for a detailed discussion on a specific project package. The discussion was used to validate and further develop the projects regarding the needed components, the strategic stakeholders, next steps, possible financing options, and others. For this, templates were designed and distributed and explained to the moderators in advance. The groups had one hour for the discussion and to fill in the templates (see project descriptions below). The moderation of the small groups was done by one expert of the assessment team, accompanied by one representative of the Municipality.

After redistribution of the participants, the second round of one hour followed for the discussion of the next 4 project packages. Finally, the results of the discussion and the filled templates were presented in the plenum in the form of a market place with a short 3 minutes pitch.

6.2 Project ideas for Coimbatore

The 32 project ideas developed throughout the City Lab are presented below. Projects discussed on the 28th November are presented with more detail.

Improving bus services

Increase the usage of public and private bus services by improving service, comfort and reach.

Upgradation of bus stops: Real time information and additional services at the bus stop for a better user experience.

New circular bus routes: Increasing the reach of bus routes and adding express routes.

Multimodal mobility hubs at bus stations: Providing alternative transit options at bus stops to enable door-to-door transit.

Real-time bus arrival information app: Development of a Mobility App that integrates data for all urban modes of transport and enables easy transit

Upgrading the bus fleet: Increasing the size of fleet and improving the existing buses.

Solution 1: Upgradation of bus stops

Upgrading bus stops along the busiest roads

Description and Objectives

In an effort to promote the use of public transport, the existing infrastructure shall be improved. Bus stops need to be transformed into attractive meeting points, where users have access to real time information on the time of arrival of the buses and ideally additional services such as Wi-Fi shall be provided. For choosing the routes, the next upgrade of the fleet (e.g. new electric buses) was taken into account.

Objectives:

- Improve bus stops as an attractive meeting point for commuters
- Modernize the bus stop infrastructure to improve commuters experiences
- Increase the user's experiences with real-time bus arrival displays
- Few bus stops proposed with a solar-based renewable energy source.

Elements (full list on next slide):

- Screens with RTI
- Wi-Fi

Suggested bus stops:

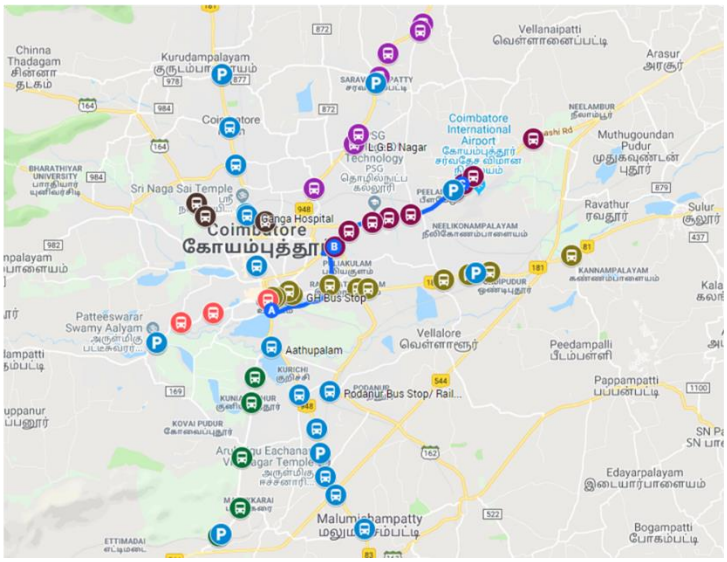
- Initially 50 bus stops along the bus routes number 2,11,4,7 have been identified together with TNSTC. All the 50 locations are with bi-directional traffic flows having bus stops on either side of the road, which makes 100 bus stops.

Solution 1: Upgradation of bus stops

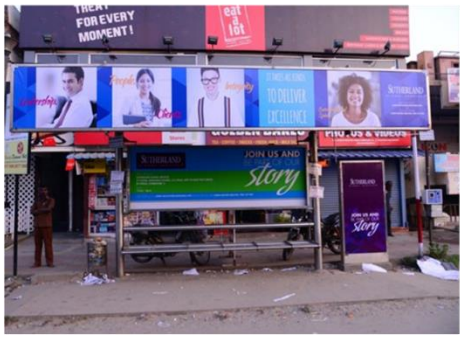
Components	Stakeholders
• Sophisticated shelter construction with a full or partial roof, supported by a two, three or four sided construction • Inbuilt seats • Lighting • Dust bins • Visible name of the stop on top of shelter • Bus services timetables display • LTE/3G antennas (for info services) • Wi-Fi receiver • Solar panels • ATM for water • Regular housekeeping • Docks for cycle • Advertising screen • Maps of bus routes • Improve accessibility for specially able	• CCMC/CSCL • TNSTC • Private Bus Operators • RTO • RTA • Tamil Nadu State Government • RAAC, Coimbatore • Technology Vendors (BusChalo, Bosch, ClanCor, Bharat Solar) • Transport Commissioner (TC) • Traffic Police • Highways Department • Private sector shared ride services providers and operators, app vendors • LPA • CREDAI (Real estate developers association)

Next steps	Possible funding options	Preconditions
• Rationalization of bus stop locations considering MRT and other initiatives. • Detailed bus stop designs, and drawings • Prioritization on amenities for current and future needs. • Preparation of bid documents • Coordination of approvals from TNSTC, RTO, Highways for new bus stops	• Smart City Funds • Advertisement revenues • Donor agency funding (e.g. KFW) • Energy savings with solar options	• Availability of space • CCMC prioritization of facilities • Safety and security for amenities • The land is available with CCMC

Solution 1: Upgradation of bus stops - 50 bus stops suggested



Solution 1: Upgradation of bus stops



CURRENT STATE

FUTURE STATE

Source: http://www.oohworld.com/advertisements/bus-shelters-coimbatore-3/; https://www.station-i.de/produkte/fuenffache-station/

Solution 2: New circular bus routes

Some routes need to be redesigned to decongest the city center, decentralize the system and allow for better connectivity. Added express lines provide high-speed connectivity.

Description and Objectives

The current system in Coimbatore is designed in a way that all bus lines go through the city centre. As a consequence the city centre is very congested, specially the area around Gandhipuram bus terminal. The creation of new routes and a re-design of the routing system can considerably contribute to improving the service offered and decongesting the city centre. For such a rerouting project, road widening, rehabilitation and also some new roads are needed. The suggested routes are aligned with other projects suggested as new park & rides, truck terminals, and also with ongoing projects of roads widening in the city. To implement this, it might be required to build flyovers. Additionally, for private mini bus operators, it would be suggested to extend the served routes from current 4 km to 7-8 km so that they can drop the passengers at bus stations instead of bus stops. The private bus operators could also be given higher network in areas not covered by the TNSTC.

Objectives:

- Connect and provide access to residents between radial routes
- Reduce congestion in the city center.
- Attract bus commuting experiences
- Allow direct travel to destinations without coming to the city center.

Suggested new routes:

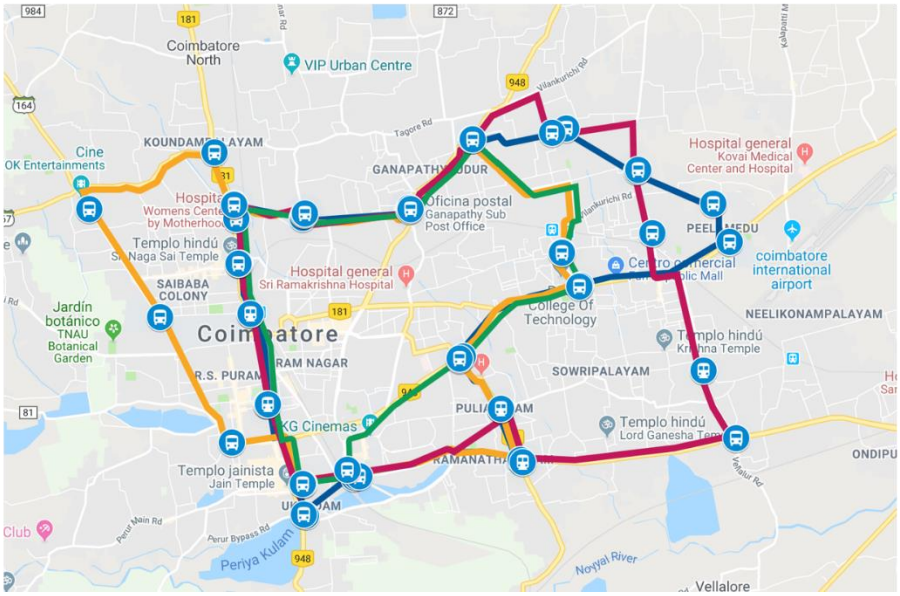
- Express line from the airport upto Shukrawarpeth on the proposed flyover on Avinashi road
- Connecting services between park & ride stations

Solution 2: New circular bus routes

Components	Stakeholders
• Planning of the four ring routes • Assessment of demand for each route • New bus stops on the routes proposed • Assignment of electric bus fleet • Bus-only lane alignment • Off-board fare station • Platform-level boarding • Charging hubs (if electric powered) • Monitor real time scheduling of buses • Express electric bus-services	• TNSTC • Private Bus Operators • RTO • RTA • Transport Commissioner (TC) • Traffic Police • RAAC, Coimbatore residents • CCMC/CSCL • Highways Department • Electric bus fleet suppliers

Next steps	Possible funding options	Preconditions
• A detailed proposal, including traffic modelling • Demand assessment • Plan the route schedules and electric bus fleet requirements • TNSTC to propose the ring routes suggested to RTA and RTO approvals • Traffic commissioner needs to be updated • CSCL to ensure new bus route road improvements and bus stop requirements • Procurement of electric bus fleet • TNSTC to resume operations post	• Smart City Funds • Central government assistance • Donor agency funding (e.g. KFW)	• Rehabilitation/improvement of specific roads • Improvement of road conditions • Operate out of park and rides, in some cases only during rush hour in the peak direction • High amount of passengers during peak hours • Upgradation of interlinked roads • New routes need to offer better connectivity to the industrial hubs and be the points of interest • Multi-agency approvals for new routes • Route demand assessment • Assignment of the electric bus fleet

Solution 2: New circular bus routes suggested



Solution 2: New circular bus routes

Source: https://www.swr.de/swraktuell/baden-wuerttemberg/stuttgart/Stuttgart-Expressbus-X1-startet,meldung-17404.html; https://www.stuttgarter-zeitung.de/inhalt.neue-stuttgarter-expressbuslinie-am-morgen-viele-freie-sitze-in-den-schnellbussen.0d950f81-9383-4aca-b986-1e132b7f34b1.html

Express lines driving on a dedicated lane

Solution 3: Multimodal mobility hubs at bus terminals

Creation of Mobility Hubs in strategic points for transforming bus stations into interactive and attractive meeting points with various services.

Description and Objectives

There is a need in Coimbatore to transform the bus stations into more livable meeting points, with additional services and offer intermodal options to facilitate door-to-door commuting. For this there is a need to connect the different modes of transport for a better user experience and promoting use of alternative modes of transport. To have main points to access services such as: car sharing, bike sharing, car and bike repairing stations, lockers, etc.

Objectives:

- Increase use of public bus transport by facilitating door-to-door transit.
- Offer various transit options at strategic bus terminal locations to improve user experience and comfort
- Upgradation of bus terminals into multimodal and multi-purpose terminal hubs to generate additional commercial revenues.

Suggested locations and focus:

- Thudiyalur (North), Saravanampatti (North-east), Gandhipuram (Centre), Singanallur, New bus terminal at MTP Road, Ukkadam (will be done with the green corridor project).
- Foreseen the future growth of the city, further locations, specially on the south and east of the city were suggested.

Solution 3: Multimodal mobility hubs at bus terminals

Components	Stakeholders
• Well-designed bus bays & platforms • Multi-purpose terminal buildings • Ticketing machines • EV Car & two wheeler sharing service (with charging) • Car pooling/Uber/Ola assigned car spaces • Passenger conveniences/amenities • Bicycle sharing station • Information systems regarding connections • Park and ride facilities • Additional car and bicycle services • First Aid Facilities/Fire Station • Well-maintained restrooms • Landscaped areas • ATMs, food counters and shopping areas	• Bus operators • Shared ride services providers and operators • TNSTC • Private bus operators • CCMC/CSCL • Traffic police • Highways Department • Private Sector • RAAC

Next steps	Possible funding options	Preconditions
• Preparation for DPR each bus terminal with designs for mobility hubs • Stakeholder interactions within each terminal zone to understand their mobility priorities. • Assessment of commercial asset demand within each terminal zone. • E-bikes and e-charging requirements to be assessed	• Smart City Funds • Donor agency funding (e.g. KFW) • PPP based models	• High passenger flow and demand for different types of public transport in a bus terminal • A detailed study with design, the scope of operations, identifying multi-purpose, and multi-modal requirements will generate more sustained asset-based revenues. • A study on the last mile connects mobility options and commercial space demand around the terminal area to be evaluated.

Solution 3: Multimodal mobility hubs at bus terminals

Solution 4: Real-time bus arrival information app

The real-time mobile app based bus arrival project will enable intelligent information flows between commuters and bus operations.

Description and Objectives

This project is highly demonstrative and futuristic as the majority of city bus commuters are equipped with smartphones. More importantly, all city bus commuters can access the real-time information of all bus routes in operation on their mobiles, ETV displays at bus terminals and selected bus stops. Further, the scope inclusion of citywide bus operations, including private and public bus services, will help optimize the app development effort and make it easy for implementation.

Objectives:

- Improve bus commuting experiences with real-time bus arrivals
- Increase the predictability of bus commutes
- Improve the user´s experience
- Improve operational efficiencies

Solution 4: Real-time bus arrival information app

Components

- Due diligence
- GPS systems installed on each bus in service
- Digitization of bus routes
- Development of AVLS Software
- Development of the mobile app
- ETA/Screens to display bus arrival on real-time (2 Liner or 4 Liner channels)
- Bus Time-Table Poles at Bus Stops
- Electronic Ticketing machines (QR screen readers)
- Censors for Fleet management (Optional)

Stakeholders

- CCMC/CSCL
- TNSTC
- Private Bus Operators
- RTO
- RTA
- DC Traffic
- Bus Services Aggregators
- Tamil Nadu State Government
- RAAC, Coimbatore
- App vendors (Clancor technologies, Bosch, Bus Chalo)

Next steps

- The decision on the scope of work to include in the project.
- The decision on PPP model with the outsourced application or Donor funding with customized app development and execution.
- Preparations of RFP/Bid documents as required.

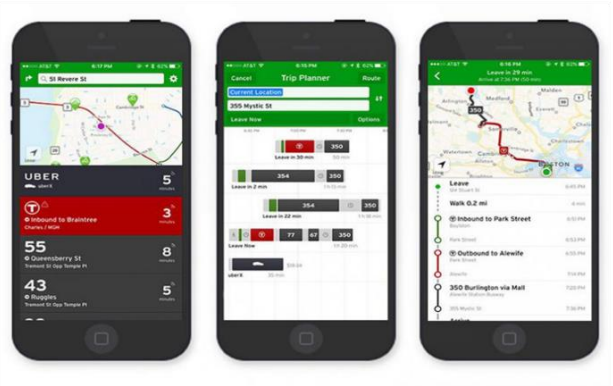
Possible funding options

- Smart City Funds
- Donor agency funding (e.g. KFW)
- Third-party Bus Aggregators
- Advertisement revenues
- PPP based models

Preconditions

- An approval required from TNSTC state unit to develop real-time information app, including private and public operations and exclusive to Coimbatore city bus services.

Solution 4: Real-time bus arrival information app



Source: https://media.bizj.us/view/img/10973819/img6466*750xx2448-3264-0-0.jpg

Solution 5: Upgrading the bus fleet

Upgrading the bus fleet by modernizing the vehicles as well as introducing more buses with an increasing number of fossil free propulsion systems (e.g. battery electric and hydrogen buses).

Description and Objectives

To increase the usage of buses in the modal split of Coimbatore, many stakeholders expressed the need for more frequent and higher quality services and therefore an upgrade of the vehicle fleet. In the CMP it is estimated that more than 1,000 buses are needed to offer a high frequency and quality service. This includes installing GPS monitoring devices which facilitates regularisation of the bus travel timing and avoids multiple buses at peak hours creating passenger discomfort. The buses shall increasingly use emission free technologies. Electric buses are already planned by TNSTC. It is highly important to have special training for the bus drivers on how to use the buses. The vehicles should have in-bus storage space for goods.
Additionally, while upgrading the fleet, installing high resolution air quality sensors in the buses would enable creating a city wide air quality map. The sensors allow measuring PM1, PM2.5, PM10, O3, CO, CO2, NO2, LDSA which can be used to increase awareness and create preventive and reactive measures to manage air quality. Accessibility needs to be improved, for example for wheelchairs.

Objectives:

- Increase the use of buses in the modal split
- Increase the quality of the bus service for adding new customer groups

Suggested locations and focus:

- Starting from the city center routes 2,11,4,7, which will be run by the electric buses and continuously widening towards the outskirts

Solution 5: Upgrading the bus fleet

Components

- Battery electric buses
- Hybrid buses
- New ICE buses
- Driver training program
- Screens in buses to show next stops and route
- Air quality sensors in busses
- GPS systems
- Increased storage space for commuters to store their shopping bags with less seats as suggested by Traffic Commissioner and WS participants
- Crowd management system to be put in place

Stakeholders

- Transport Department
- Bus Manufacturers

Next steps

- Use the 20 electric buses to collect lessons learned
- Define an intended service level to determine the number and type of buses needed
- Define a design for the buses

Possible funding options

- Loans blended with municipal funds and possible regional/national subsidies
- Repaid with service fees

Preconditions

- Alongside the introduction of a ring road infrastructure
- Bus schedules need to be better coordinated but also enforced

Solution 5: Upgrading the bus fleet

CURRENT STATE

FUTURE STATE

6.2.2 Solution Package "Promoting shared mobility"

Promoting shared mobility

Introducing shared mobility for public and with large institutions in pioneering the transition to environmental friendly transport options

Public vehicle sharing scheme: Introducing car sharing for promoting intermodality and offering alternatives.

Shared Electric Fleets: Electrifying the existing shared fleets of institutions and providing supporting infrastructure.

Bike Sharing Scheme: Providing station bound bicycle sharing services for institutional users.

City wide AC charging infrastructure: Providing electric charging infrastructure and upgrading electric grid to facilitate use of private and shared electric vehicles.

Solution 1: Public vehicle sharing scheme

Introducing public e-car and e-two wheeler sharing in the city to promote intermodality

Description and Objectives

Intermodality needs to be introduced and promoted in the city of Coimbatore and different alternative modes of transport need to be offered to the citizens. If well combined with public transport and bike sharing systems, car sharing services can contribute to stop the increase in the amount of private cars circulating in the city and be an alternative to potential new car buyers. Sharing stations can be installed in the proposed park & ride stations and mobility hubs and further locations along the main arterial roads. The upgrade of the bus stops, road rehabilitation and the on road parking implementation needs to be used as an opportunity to implement the public car sharing.

Objectives:

- Create an alternative for the potential future car owners
- Give alternatives to the user of public transport
- Promote the use of public transport by increasing intermodality
- Promote the transition to e-mobility
- Attract further international investment

Possible locations of the stations:

- Terminals/mobility hubs as last mile services
- Airport
- Along main arterial roads: Avinashi road, Pollachi road, etc.
- Petrol stations e.g. (near Flower Market, Ettimadai).

Solution 1: Public vehicle sharing scheme

Components

- Bus terminal as an important precondition, public multimodal transport needs to be better-sharing only additions
- Priority for sharing: daily/hour rent from airport, train & bus stations/hubs- Ukkadam, Singanallur, Gandhipuram & MTP roads
  Work: cars for business day trips
  EV cars/bicycles/two-wheelers
- Charging points and designated parking lots
- Keyless entry and ignition systems for customer access to vehicles (for example “smart card”)
- GPS systems for tracking vehicles
- Website and mobile portal

Stakeholders

- Jayem Automotives
- Ampere Vehicles Pvt. Ltd
- Public agencies/corporation to subsidise electric vehicles
- Red taxi
- Daimler India
- Clancor
- Lorry association

Next steps

- Regional electrification/sharing-strategy needs to be developed
- Define priority use cases under which people are willing to split their trips

Possible funding options

- Private entity buying and operations supported by subsidies

Preconditions

- Demand for a reliable car service in the shortest time and at a good price
- Developed charging and parking infrastructure
- Complemented with mobility hubs
- Along with manufacturers, there is a need to subsidise purchase of EVs to make a considerable business case
- Mindset change

Solution 1: Public vehicle sharing scheme

Possible locations in Coimbatore

Source: https://www.automobile-propre.com/wp-content/uploads/2011/10/autolib.jpg
http://redtaxi.co.in/
Stadtwerke Stuttgart:
https://blog.car2go.com/de/2016/05/30/was-man-zum-elektroauto-wissen-sollte/

Solution 2: Shared electric fleets

Introducing e-shared fleet in institutions for promoting the transition in the city

Description and Objectives

It is a national goal to promote electric mobility in the whole country. Coimbatore has renowned universities, which would be willing to implement an e-mobility project and start the transition to more environmental modes of transport. Institutions can be excellent locations for starting these projects. The University of Agriculture in Coimbatore, hosts to approximately 2300 students (1400 girls, 900 boys) has 16 colleagues and 50 research centers across Tamil Nadu. The University fleet is of about 50 cars. The TNAU has around 30 buses to transport the student to the different research centers. The fleet could slowly be electrified to reduce operational costs and emissions and utilize the solar energy produced in the campus. The PSG Universities have shared fleets for staff at each of the locations, including 25 at the PSG Tech. The University is willing to electrify the shared fleet and reduce emissions

Objectives:

- Reduce pollution in the city
- Enhance the very good image of the University within India and abroad
- Enhance the mobility transition within the city

Possible locations of the stations:

- Universities. e.g. Agricultural University, PSG Universities (different campuses)
- Coimbatore Corporation

Solution 2: Shared electric fleets

Components	Stakeholders
• EV cars fleet • Charging points at the campus • Keyless access using RFID • GPS systems for tracking vehicles • Online booking system	• PSG University • Tamil Nadu Agricultural University • Municipal Corporation • Jayem Automotives • Daimler • Schools, universities, electric ones in railway stations • Fleet operators: employers-public agencies/universities/hospitals

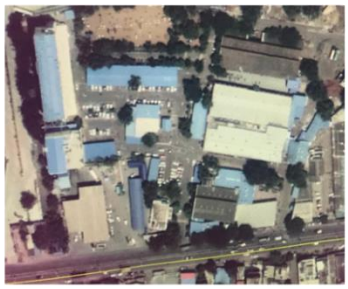
Next steps	Possible funding options	Preconditions
• Define a financing support scheme to purchase of e-vehicles for economic people and fleet owners	• Direct funding from the institution • Loans from development banks	• Institutional drive to become more sustainable • Developed charging and parking infrastructure • Availability of vehicles • Economic feasibility • Early adapt needed • Early education

Solution 2: Shared electric fleets

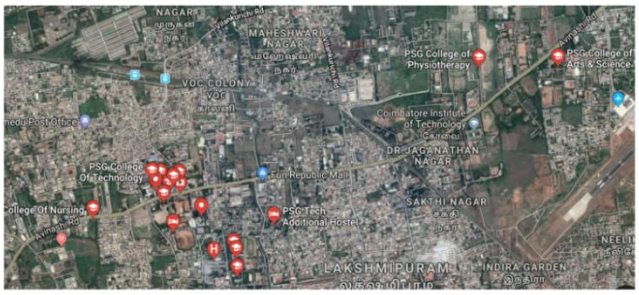
Possible locations:

Bharathiar University

Tamil Nadu Agricultural University



Shanthi Social Service Centre



PSG Colleges along Avinashi road

Solution 2: Shared electric fleets - Reference project

Corporate Electric Car Sharing for Manchester Metropolitan University

Source: https://www2.mmu.ac.uk/news-and-events/news/story/6019/

Sharing scheme to **reduce number of own cars** of universities and to increase use of EVs. System managed by third party enterprise through an **online booking system**.

Online booking system and RFID cards used to access vehicles → no need to transfer keys

Improves personal efficiency // promotes sustainable behaviour //

Corridor board, universities, system provider

2 Nissan Leaf (30 kWh) purchased and two additional charging points installed (7kW)

10 - 15 years	50k – 250k €
<0.5 years	<0.5 years

Solution 3: Bike sharing scheme

To kick-start the use of bicycles in Coimbatore, sharing schemes can be started from university campuses and strategic connecting locations in the city.

Description and Objectives

Increasing non motorised, sustainable transport in Coimbatore is vital towards improving the air quality in the city. To promote the uptake of bicycles, sharing bikes in a combined system will be introduced. The early adopters have been identified to be university students on the corresponding campuses (e.g PSG and agricultural universities). A free floating system shall be installed there. In addition, station bound sharing shall be offered at locations linking to the university campuses, such as railway stations and major commercial and industrial zones.

Objectives:

- Introduce bicycles into the modal split
- Create an early adopter user group for bicycle usage

Possible locations:

- PSG University campus
- Tamil Nadu agricultural university
- All suggested park & rides
- Peelamedu railway station - close to industrial zones
- Singanallur Railway station - close to industrial zones
- Podanur junction
- Along main arterial roads, train stations

Solution 3: Bike sharing scheme

Components	Stakeholders
• Free floating geo-fenced system in the university campuses • Access/authentication system • Safe docking stations • Bikes • For electric bikes, charging station ideally solar powered • Bike booking system • Payment system • GPS system to locate bikes • Maintenance of bike	• Universities • Shared bike providers • Maintenance of bikes

Next steps	Possible funding options	Preconditions
• Co-develop an access scheme with the students • Identify 5 pilot-campuses and 25 connecting strategic locations outside stations • Talk to schools & universities for pilots • Talk to companies for purchasing bicycles • CMC to request/ask for pilots from companies	• Corporate CSR (Corporate Social Responsibility) budget of big enterprises and SMEs • Bicycles available for free for users	• Good infrastructure (safe, convenient) for riding bikes • Blue parking zones need to foresee a space for parking of bike sharing system

Solution 3: Bike sharing scheme

CURRENT STATE

Source: https://www.thehindu.com/todays-paper/tp-national/tp-tamilnadu/ofo-withdraws-from-coimbatore/article24148629.ece
Felix Zahn/dpa

FUTURE STATE

Solution 4: City-wide AC-Charging infrastructure

Following the fuel switch strategy of the city a starting point of 2,500 electric multi purpose charging stations to electrify the private vehicle fleets is suggested.

Description and Objectives

In order to extend electrification of vehicles also to privately owned motorbikes and cars, a city-wide basic multi-purpose infrastructure is proposed. First stage implementation size: one charging station every 5 km on main roads and 2-4 charging stations on POIs (e.g. Park & Ride, bus terminals, train stations, large shops, cinemas, public administration offices). One charging station should contain 2-4 charging points. Final implementation size: 0.5 charging points per electric vehicle in the city. They are placed in front of shops and stores in the city centre at trip-end locations. As in most cities around the globe, most of the people and goods transportation in Coimbatore is provided by privately owned vehicles. Before introducing penalising measures, such as low emission zones, alternatives have to be provided to the citizens. As there are very few electric vehicles already driving through the city, the infrastructure should be available also for other usage, such as charging of mobiles/smartphones, city cleaning and security services. The proposed measure includes a general upgrade of the power network to prepare the grid for large scale rollout of electric vehicles.

Objectives:

- Promote the use of private electric vehicles
- Prepare the electric grid for large scale electric vehicle rollout
- Provide value added services to citizens

Solution 4: City-wide AC-Charging infrastructure

Components

- Charging stations
- Access to charging stations
- Payment system
- Parking spots for vehicles while charging

Stakeholders

- Jayem Automotives
- PSG Tech University
- Ampere
- Road Authority

Next steps

- Analyse the number of electric vehicles being implemented in different use cases
- Define a financing support scheme to purchase of e-vehicles for economic people and fleet owners

Possible funding options

- Loans by development banks
- Grants by national/ public governments

Preconditions

- Parking spaces need to be prioritised for the vehicles
- Aligned with electric vehicle roll-out plan
- Along with writing a regional electric/ shared mobility strategy

Solution 4: City-wide AC-Charging infrastructure

CURRENT STATE

FUTURE STATE

Source:
https://inhabitat.com/wp-content/blogs.dir/1/files/2013/11/EV-Charging.jpg
https://www.nap.edu/openbook/21725/xhtml/images/p83.jpg
Electricscooters.com

6.2.3 Solution Package "Improving railway services"

Improving Railway services

Increase the usage of trains for inner city commute and facilitating suburban commuter mobility

Rail link: Reducing congestion in the city centre by creating a rail-bypass in the south

Revival of abandoned stations: Upgrading the abandoned railway stations to improve accessibility

Introducing commuter rail services: Installing complementary suburban rail line with stops to ease out inner city commute

Mobility hubs at train stations: Providing alternative transit options at train stations to enable last mile connectivity

Solution 1: Rail link

Link North of Podhanur to travel directly to the East without the need to go via the Coimbatore Junction

Description and Objectives

The proposed rail link could reduce travel time from Irugur to CBE JN by 45 min according to estimations by the Chamber of Commerce. It creates an alternative and faster and 5km shorter route to link the two stations, both providing a faster and more reliable service on this route as well as opening up capacity on e.g. the Coimbatore Junction for the proposed commuter rail service. It also closes the railway infrastructure into a ring that enables better services incl. the Commuter Rail. According to several stakeholders, the land is still owned by the railway company and therefore available for reconstruction. Parts of the old railway are also supposedly still available and upgraded in a simple way. Commuters and travelers from the south of Coimbatore would have an alternative for a more direct route.

Objectives:

- Reduce travel time
- Decongest the city center
- Create a ring-routes for public transport
- Improve the railway services

Solution 1: Rail link

Components

- Preferred commuter stations
- Sub-urban commuter priorities
- Earlier abandoned railway stations
- Gauge differences (if any)
- Infrastructure gaps (routes/stations)
- Station last mile connectivity
- Possibility for dedicated corridor

Stakeholders

- Commuters & students
- Sub-urban residents
- South Central Railway (Salem)
- Divisional Railway Users Consultative Committee (DRUCC)
- City Corporation
- Ministry of Railways, GOI (central)
- Tamil Nadu State Government
- Chamber of Commerce/Industries

Next steps

- Stakeholder meet
- Corporation and SCR leadership
- Stakeholder collaboration
- Pre-feasibility study

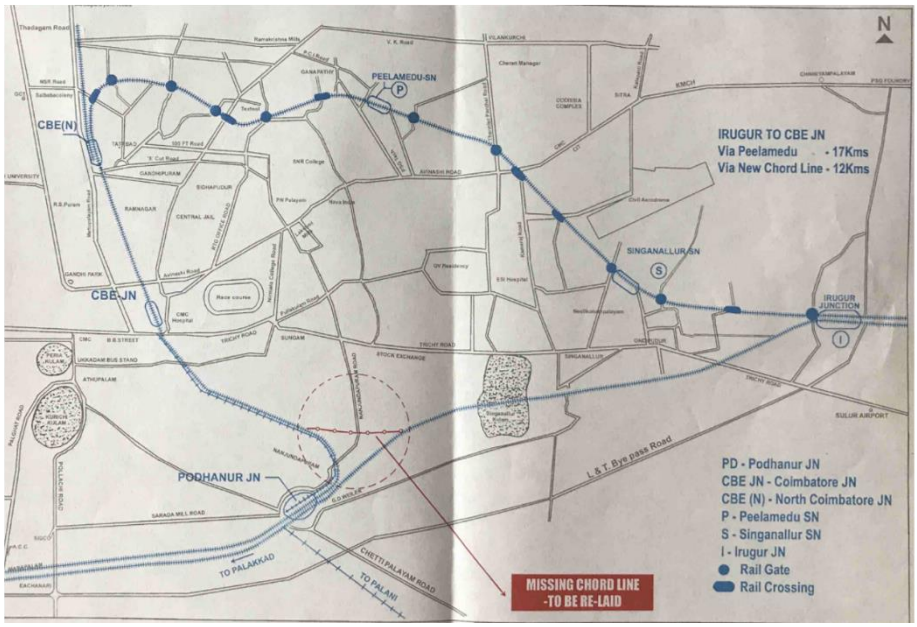
Possible funding options

- Development banks (Japan, Germany, World Bank)- Loans
- ICFS (Infrastructure Leasing Financing Service)
- TUFIDCO / TUFISL (Public agencies)

Preconditions

- SCR support and approvals
- City Corporation proposal
- Stakeholder Lobby group
- Central & State Funding

Solution 1: Rail link



Solution 2: Revival of abandoned stations

Revival of few abandoned stations along the network for better accessibility and reducing downtown traffic.

Description and Objectives

Coimbatore attracts commuter traffic from suburban towns Pollachi, Tirupur, Mettupalayam, to Coimbatore Junction. At present many commuters need to pass through Coimbatore junction station currently due to non-availability of stops and stations enroute and doing detours. So this adds to their pain for last mile connectivity and commuters have to come to central station and again go back to their destination points. However there are good number of station locations available and functioning, in the past were later abandoned due to earlier given emphasis for road based traffic than rail driven traffic movements. Therefore a revival of the existing abandoned stations can provide much improved accessibility across the city and commuter traffic can be distributed with much ease and reduce commuting time with less detours.

Objectives:

- To avoid concentrated traffic at Coimbatore Junction and make last mile connectivity more accessible
- To reduce commuting time and reducing the detour
- To provide dedicated new station points distributed across cities by reviving the abandoned stations
- To optimize utilisation of existing infrastructure and resources through improvements and revival

Possible new stops with revival: Singanallur (old), Vellalore on circular route, Revival of Chettipalayam, **Urumandampalayam* Thudiyalur***, Veerapandi, Pudupalayam, Nallatipalayam, Kolipalayam and Thamaraikulam, Urumandampalayam, CBE North (upgrade), Periyanayakenpalayam and Karamadai adding more stops offering many benefits (*City Corporation funding at 35 lakhs each)

Impacts: New employment opportunities, economic growth, reduction of travel time, increase of accessibility also for less affluent people, Increased safety and speed, reduce accidents, increase real estate values and developments around the new stations, providing affordable transport options

Solution 2: Revival of abandoned stations

Components	Stakeholders
• Preferred commuter stations • Sub-urban commuter priorities • Earlier abandoned railway stations • Gauge differences (if any) • Infrastructure gaps (routes/stations) • Station last mile connectivity	• Commuters & students • Sub-urban residents • South Central Railway (Salem) • Divisional Railway Users Consultative Committee (DRUCC) • City Corporation • Ministry of Railways, GOI (centra) • Tamil Nadu State Government • Chamber of Commerce/Industries

Next steps	Possible funding options	Preconditions
• Stakeholders to meet and form a lobby group • Corporation and SCR leadership • Stakeholder collaboration • Pre-feasibility study	• Loans and national subsidies • Income from private sector at hubs • Development banks (Japan, Germany, World Bank)- Loans • ICFS (Infrastructure Leasing Financing Service) • CSR funds (for station maintenance and small works) • TUFIDCO / TUFISL (Public agencies)	• SCR support and approvals • City Corporation proposal • Stakeholder Lobby group • Central & State Funding

Solution 3: Introducing commuter rail services

Introducing electrically operated commuter trains and additional railway stations to connect all main areas of Coimbatore

Description and Objectives

At present the railway stations on the two main tracks are at a distance of every 8km. This leads to several commuters needing to use additional means of transport to reach their final stations and adding to their commuting time. Hence, the suggestion is to develop a suburban rail line along the main railway line with frequent stops to relieve congestion in the city centre. A unique electrically operated commuter rail system to connect inner city and nearby suburban towns would improve connectivity by adding more capacity, more stops, revival of stations, upgrading rail links and leveraging existing infrastructure. This commuter train could connect with sub-urban towns Pollachi, Tirupur, Mettupalayam, Coimbatore North, Coimbatore Junction, Podanur, and Singanallur.

Objectives:

- To provide an efficient, affordable and optimised alternative mode – Commuter Rail
- To reduce overall commuting time overall for passengers from sub-urban locations and make Coimbatore city more accessible
- To provide dedicated operations which shall attract more commuters and ease peak time traffic
- To optimise utilisation of existing infrastructure and resources through improvements and revival of existing infrastructure (optional: use few stations also for logistics)

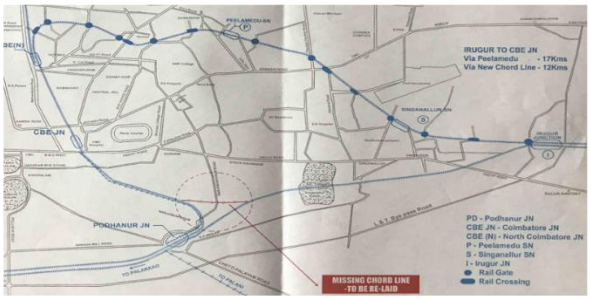
Possible new lines: connecting the two railway lines north of Podanur Junction to enable trains from Pollachi to move to Irugur bypassing Coimbatore Junction. A new circular line (old link revival) Irugur to Coimbatore jn.

Solution 3: Introducing commuter rail services

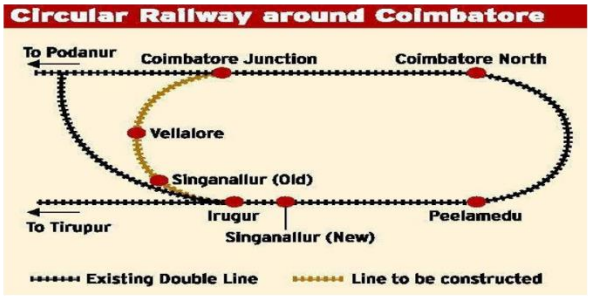
Components	Stakeholders
• Existing city rail connectivity • Preferred commuter stations • Sub-urban commuter priorities • Earlier abandoned railway stations • Gauge differences (if any) • Infrastructure gaps (routes/stations) • Station last mile connectivity • Possibility for dedicated corridor	• Commuters & students • Sub-urban residents • South Central Railway (Salem) • Divisional Railway Users Consultative Committee (DRUCC) • City Corporation • Ministry of Railways, GOI (centra) • Tamil Nadu State Government • Chamber of Commerce/Industries

Next steps	Possible funding options	Preconditions
• Stakeholder meet • Corporation and SCR leadership • Stakeholder collaboration • Pre-feasibility study • Define agency to carry out the project	• Loans and national subsidies • Income from private sector at hubs • Development banks (Japan, Germany, World Bank)- Loans • ICFS (Infrastructure Leasing Financing Service) • CSR funds (for station maintenance and small works) • TUFIDCO / TUFISL (Public agencies)	• Local agency/ organisation with right mandate to build infrastructure and operation • Support from national government • Limited land acquisition required • Feasibility study (passenger demand, status of system, commuters preferences) • SCR support and approvals

Solution 3: Introducing commuter rail services



CURRENT STATE



FUTURE STATE

Solution 4: Mobility Hubs at train stations

Creation of Mobility Hubs around existing and future train stations to allow for quick and efficient interchanges between several modes.

Description and Objectives

There is a need in Coimbatore to transform the train stations into more livable meeting points, with additional services and offer intermodal options to facilitate door-to-door commuting. For this there is a need to connect the different modes of transport for a better user experience and promoting use of alternative modes of transport. To have main points to access services such as: car sharing, bike sharing, car and bike repairing stations, lockers, etc. it is proposed to start at points with high passenger flows. The primary location therefore is of course the Coimbatore Junction. The project is in a similar way done at large bus stops.

Objectives:

- Increase use of public transport by facilitating door-to-door transit
- Offer various transit options at strategic locations to improve user experience and comfort

Suggested locations and focus:

- Every 1 km on existing railway lines. Primary Hub: Coimbatore Junction.

Solution 4: Mobility Hubs at train stations

Components

- Bike sharing, bus stops, car sharing, taxi stand
- ATM
- Bath-/washroom
- Upgrade of the existing sleeping facilities
- Restaurants/ fast food
- Real time information system
- Space for commercial shops

Stakeholders

- Railway Authority
- National government (for approval)
- Local stakeholders (form lobby groups)
- Passenger association (Awareness creation, station consultancy committees) commuters, students, Sub Urban commuters
- NGOs
- Transport ministry
- Local bodies (including corporation)
- Southern Railways
- Chambers of Commerce

Next steps

- Create a design for new multimodal train stations
- Start with the Coimbatore junction as a lighthouse project and then use the Coimbatore North station
- Local government to approach central government for approval
- Local stakeholders to form lobby group
- Stakeholder engagement

Possible funding options

- Loans and national subsidies
- Income from private sector at hubs
- Development banks (Japan, Germany, World Bank)- Loans
- ICFS (Infrastructure Leasing Financing Service)
- CSR funds (for station maintenance and small works)
- TUFIDCO / TUFISL (Public agencies)

6.2.4 Solution Package "Improving road infrastructure"

Improving road infrastructure

Expanding the road infrastructure and creating dedicated infrastructure for promoting public transport and sustainable transport options

Ring Roads by road rehabilitation or opening up roads: Constructing connecting roads between major arterial roads to enable implementation of new bus routes and improve connectivity.

Creation of Safe Bike Lanes: Creating a network of dedicated lanes for bicycle riders along major arterial and connecting roads.

"Green blocks" with pedestrian streets: prioritizing pedestrian and bike movements in selected blocks by limiting motorized transport and developing pedestrian and bike friendly infrastructure.

Solution 1: Ring Roads by road rehabilitation or opening up roads

To implement the suggested ring routes, some roads need to be rehabilitated and some have to be open.

Description and Objectives

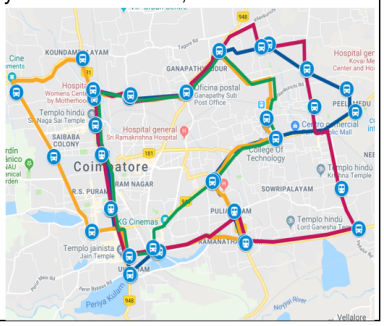
The implementation of a new designed bus routing system following a ring system, requires some changes in the roads in terms of infrastructure. Likewise the successful implementation of park and rides as well as new logistic terminals require the existence of road infrastructure to allows for good connectivity. Thus road planning and widening of roads, should be done in coordination with the here suggested mobility projects for improving the bus services offered and the parking management systems. Schemed roads across the city should be well analysed. Within those, the ones in North-East should be prioritised.

Objectives:

- Allow the implementation of new bus ring routes
- Promote public transport
- Improve connectivity
- Decongest arterial roads
- Decongest the city centre and the Gandhipuram terminal

Suggested Locations:

- Based on the proposed ring routes of buses and
- Recommendations from RAAC
- Commercial areas should have good connectivity
- New park and rides should be well connected



Solution 2: Creation of safe bike lanes

Creation of safe bike lanes along arterial roads to promote the use of bikes as a transport mode

Description and Objectives

A network of wide bike lanes adhering to national standards, which are clearly separated from the motorised traffic routes and enable use of bikes for commuting through the city during day and night times. Well marked separators that give great visibility day and night could be used to ensure a smooth and safe ride. Aim is to promote use of bikes as a preliminary mode of transport by creating dedicated bike lanes along the main arterial routes and connecting them to the eco-corridor. The bike lanes need to be aligned with road widening projects and road rehabilitation projects currently under implementation (Pollachi and Trinchi road). The implementation can be done in areas having 80 or more feet roads. The city has approximately 80 of these roads are the moment. Among these, a further analysis and periodisation can be done. Besides, areas with regular development are also suitable. Further Ideal locations can be identified along the Eco-corridor. The proposals need to be aligned with the NMT network currently under development.

Objectives:

- Promote the use of bicycles as a mode of transport
- Improve safety while biking in the city.

Suggested routes:

- along Avinashi road
- along Trichi road
- along Mettupalayam road
- along pollachi road
- along Podanur main road & Kaniapa Komar Street
- Raja street, RG street, Thomas Street, Oppanakara street sugested during WS)

Solution 2: Creation of safe bike lanes

Components

- Construction of biking network as per national norms
- Robust, reflective and eco-friendly dividers which improve the cycling experience by giving good visibility day and night.
- Connecting and access roads to the dedicated bike lanes

Stakeholders

- Coimbatore Corporation
- Transport Department
- Highways Authority
- Bike network in Copenhagen could be used as an example.
  - (E.g. Road dividers from Zicla)

Next steps

- Check schemed roads across the city
- Within those prioritise North, east and southern roads
- Eventually check what land acquisition is needed

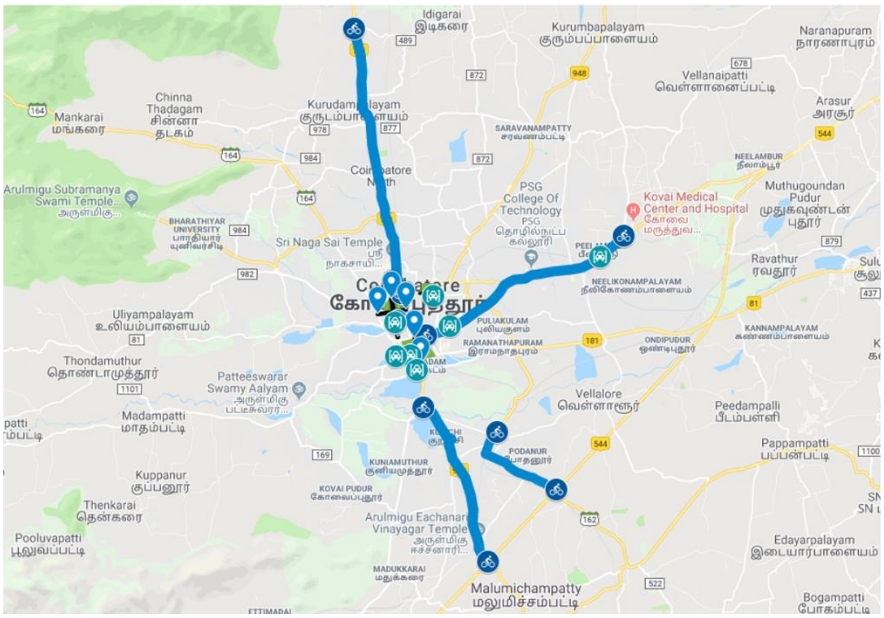
Possible funding options

- Corporation
- PPP modes
- Highways
- State government

Preconditions

- Wide roads where there is possibility to have dedicated lanes which are 2.5 - 3 km
- Important to consider the entry and exit to shops

Solution 2: Creation of safe bike lanes



Solution 2: Creation of safe bike lanes

Reference project – Zicla cycling lanes/cycle tracks/bike lanes (Spain)

Solution 3: "Green blocks" with pedestrian streets

Creation of "green blocks" or "super blocks" in the city to promote cycling and walking, decongest the urban center, and make city more livable

Description and Objectives

Project aim to provide a better street infrastructure with more space for pedestrian movements and NMT as priority over other transport modes. In total, the project will cover 8 streets (around 9,7 km of paved ways) selected within the scope of 3 green blocks. The renewed streets should include wider foot paths, integrated service infrastructure, landscaping with native shrubs and trees, street amenities like benches, cycle tracks, Wi-Fi access, bar coded zebra crossings, smart waste bins, solar powered LED lamp posts etc.

Objectives:

- Promote cycling and walking
- Enhance citizen interaction and engagement
- Promote economic development
- Reduce pollution
- Improve street furniture and greenery
- Improve water sensitive design and reduce surface runoff

Suggested locations:

- Zones around the in November newly approver modal roads (DB Road, TV Swamy Road, Race Course Road) are therefore ideal for this selection.

Solution 3: "Green blocks" with pedestrian streets

Components

- Solar lights, waste bins, air quality sensors installed with LED
- Landscaping around roads, rainwater retention everywhere
- Battery operated vehicles
- Speed regulation-inner roads
- Parking for commercial areas
- Nodes-not bus-pass-nonstop
- Radius of grid-walkable range
- Alternate traffic flow regulation (RS Puram)
- ON road parking (multi level parking)
- Different blocks model (parallel to Trichy road via: A.pallam-NJ puram-vellalur)
- Three round rings (Kunimathur-Pollachi road),(Perur Selvapuram –Thadagam road)

Stakeholders

- CCMC/ Commissioner/ CSCL
- Engineering Department
- Local business groups and traders associations
- Traffic police TC
- RTO
- Highways Authority & Department
- Industry groups, technology and service providers
- RAAC, Coimbatore
- Parking aggregators
- Chamber of Commerce
- If infrastructure works needed: PWD, TANGEDCO, BSNL, etc.
- CREDAI (earlier experiences)
- TNSTC

Next steps

- Convince traders association and talk to informal vendors
- Creation of a cross-departmental team for project implementation
- The need of pedestrianization combined with public transport needs to be evaluated
- Identification of alternative routes for people and goods traffic. Roads need to be assessed regarding their connectivity
- The process of urban densification should be in place

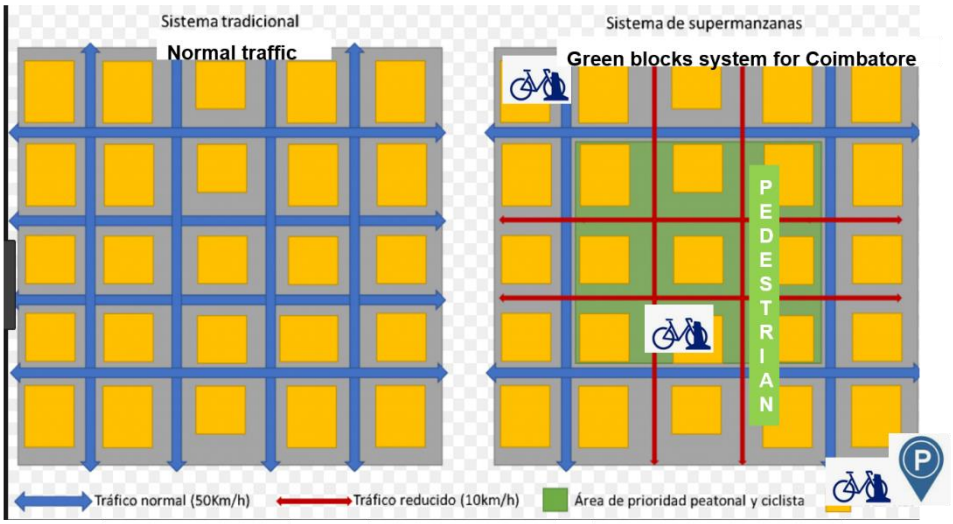
Possible funding options

- Capital investments could be covered using KFW development loans.
- Local businesses can be involved in co-financing
- Infrastructure development investments could be done through Urban Development Funds of CCMC.
- Collaboration with shopkeepers associations

Preconditions

- Wide roads where there is possibility to have dedicated lanes which are 2.5-3 km
- Traffic deviation
- Important to consider the entry and exit to shops
- Shading for pedestrian areas should be ensured
- Parking around the block needs to be available
- Proper drainage system
- Speed and entry regulations have to be adapted and effectively enforced
- Parking regulations should be effectively enforced

Solution 3: “Green blocks” with pedestrian streets

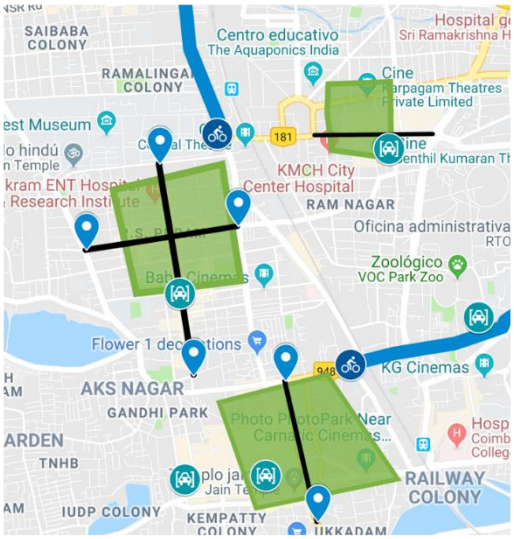


Source: https://blogs.iadb.org/movilidad/2017/08/10/supermanzanas-una-distribucion-eficiente-del-transporte-las-ciudades/

MG Road Pune, Walkin Plaza

Milaneo Shopping Mall Stuttgart, E-Rickshaw

FUTURE STATE



Suggested possible areas for identifying blocks in Coimbatore

Source: https://www.google.de/maps/place/Municipality+Office
https://www.businessinsider.de/barcelona-superblocks-protest-2017-1?r=US&IR=T
https://www.theonlinecitizen.com/2016/08/31/how-barcelona-superblocks-return-city-streets-to-the-people/https://www.videoblocks.com/video/residential-houses-and-streets-in-barcelona-spain-aerial-top-view-4k-video-srfri2uuxjt164kp4
https://timesofindia.indiatimes.com/city/pune/pcb-mulls-walking-plaza-on-mg-road/articleshow/56981989.cms

6.2.5 Solution Package "Intelligent parking management"

Intelligent parking management

Improving parking infrastructure to incentivise use of public and shared services for moving into city centre and reducing congestion related to parking

Park & Ride stations: Creating parking lots with multi-modal services at strategic locations at the city periphery.

Multi-level car parks: Constructing multi level car parks to efficiently manage parking space.

Intelligent parking management system: Implementing a smart system to locate, book and manage parking spaces through apps.

Solution 1: Park & Ride stations

Development of "Park & Rides" in 7 locations: Eachanari (Pollachi Rd), Madukkarai (Palakkad Rd), Perur (Siruvani Rd), Thudiyalur (Mettupalayam Rd), Saravanampatti (Sathy Rd), Arvind Eye Hosp (Avinashi Rd), Ondipudur (Trichy Rd) (all TBC)

Description and Objectives

The creation of well equipped, multimodal and attractive park & ride stations, complemented with express bus lines can promote the use of public transport and considerably contribute to decongest the urban centre. The suggested park & ride stations are aligned with the corridors identified for MRT in the Mobility Plan are intend to complement this project by providing adequate parking with additional service to enhance the transition from private cars to public transport. Therefore the implementation would have to be in lined with the results of the MRT study to be finished by June 2019. Initial possible locations have been identified together with TNSTC.

Objectives:

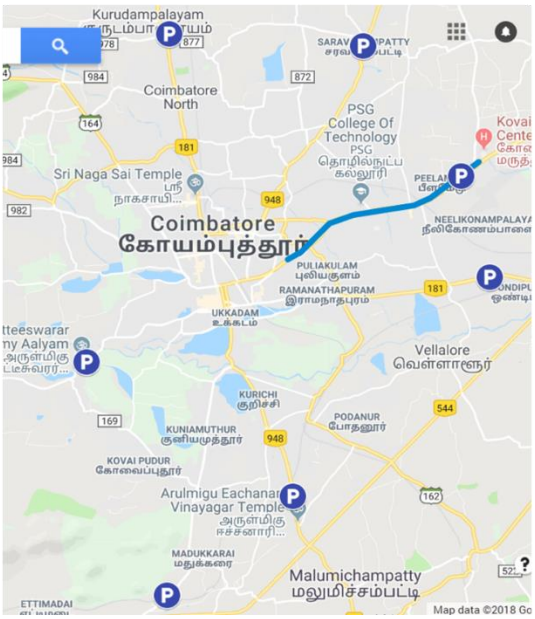
- Promote the use of public transport
- Complement MRT project
- Reduce the pressure on the road infrastructure
- Reduce the amount of cars circulating in the city center
- Provide an alternative for new possible "car" buyers

Solution 1: Park & Ride stations

Components	Stakeholders
• Proposed (P) / Raised at meeting (M) • Secure parking for bicycles (private bicycles) (P) • Bike sharing service (P) • Intelligent parking (sensors and application) (P) • Cameras for security (P) • Car sharing (P)/ Car pooling • Repair / maintenance of bicycles (P) • Accessibility (M) • Commercial attractions in the surroundings (M) • Infrastructure for users (BWC, cabinets) (M) • Mobility Card • Maintenance shops/air filling shops at the parking stations	• Bus companies • Car Sharing Company • BOSCH (P) • Public sector (financing, strategic planning, shared management) • Bicycle Companies • Academies • Daimler • Car assembly plants • Advertising agencies • International agencies • Hero • Ola

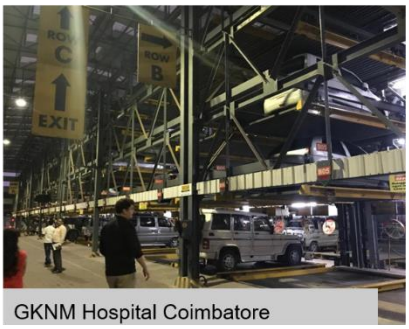
Next steps	Possible funding options	Preconditions
• Set service laws • Municipal legislation • Define model (PPP, public or private) • Socio-economic viability • Design scenarios • Demand analysis • Run pilot projects • Encouraging existing startups projects • Announce for public • Perception of user value • Parking need in the areas and expected increase needs to be estimated well before planning size	• Funding by public banks • Public Private Partnerships • Use of public spaces for selling advertisements and use the proceeds to support deployments • Parking companies for management and logistics • Tax Incentives / Compensations / Incentives for users • Urban instruments • International organisations	• Locations need to be close to high speed transport options (MRTS) • Shuttle Bus service, bicycle sharing and other options needs to be provided from parking spaces • Regulations to push Ola/Red Taxi/Uber and other taxi providers to use the parking spaces instead of streets for waiting for customers • Enforcement of the suggested low emission zone

Solution 1: Park & Ride stations



- P&R - Pollachi Main Road
- P&R - Palakkad Main Road
- P&R - Siruvani Main Road
- P&R - Thudiyalur Bus Stop
- P&R - Sathy Rd
- P&R - Aravind Eye Hospital
- P&R - Trichy Road
- Flyover to be built in 2019

Solution 1: Park & Ride stations



GKNM Hospital Coimbatore

FUTURE STATE

Solution 2: Multi-level car parks

Multiuse of existing and planed car parks special section for motorbikes.

Description and Objectives

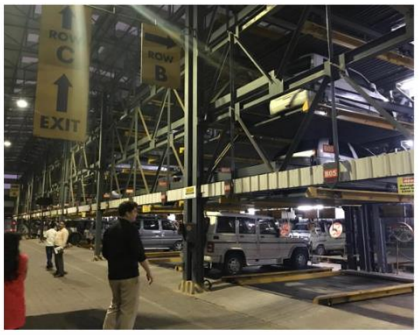
The 7 multi level car parks planned in and around the city center of Coimbatore according to the CMP can partly be designed with a non-concrete, but metal-based structure, which would allow for a more efficient use of the space. Additionally, these multi-level car parks need to be made multi-use, so that it serves for multiple purposes to increase revenues and improve the business case. The parking system can be automated to allow for higher capacity and denser packaging. Additional transport hot spots like bus stops, train stations and commercial buildings can also be equipped with such parking systems.

Objectives:

- Reduce on-street parking
- Efficient use of public space
- Cost reduction for construction phase

Locations:

Old Passport office premise, VOC Park ground, Cross Cut Road, Town Hall, D.B. Road, Thiyagi Kumaran Market, Ukkadam Old Fish Market Omni Bus Stand, Codissia, Pollachi Bus terminal, Railway Station



Solution 2: Multi-level car parks

Components	Stakeholders
• Multilevel parking structure • Digital ticketing • Monitors to show space availability • Possibility of using linear puzzle model from Sieger for shops • Shuttle services from car parking spots to nearby hotspots • Possibility to reserve parking with barrier • Linked to intelligent parking management to provide remote monitoring and booking	• Traffic police • RTO • Municipality • Technology + service providers • Malls/theaters • Parking aggregators • Car manufacturers

Possible funding options	Preconditions
• BOT (Built operate transfer) Model does not work as it entails 10 year lockin and low parking fees makes it challenging to get a return • The Car park could be used for multi-use (e.g. shops, micro hubs) to reduce losses incurred • Dynamic pricing should be allowed to finance the model	• Multi level car parks in the city should be mandated for all commercial complexes. • Regulations to push Ola/Red Taxi/Uber and other taxi providers to use the parking spaces instead of streets for waiting for customers

Solution 3: Intelligent parking management system

Connecting multi level car parks and additional commercial building parking spaces through an information system using the proposed digital infrastructure of the planned traffic command and control centre.

Description and Objectives

Based on information from the planned 2.500 security/traffic cameras (by the Transport Commisioner) and real time occupancy data of the in the CMP 7 planned managed parking areas, information shall be distributed to the travellers to reduce time for searching parking spots. Studies suggest that up to 30% of inner-city traffic is caused by circulating traffic looking for parking facilities. Mounted information systems for the availability of parking spots together with an upgrade of existing parking facilities could therefore have immense impact on congestion.
Each MLCP can store up to 300 cars, 350 two-wheelers. Local technology provider Clancor Technovates have suitable solutions which can also be used for piloting. This app can be extended to commercial parking spaces in the city as well.

Objectives:

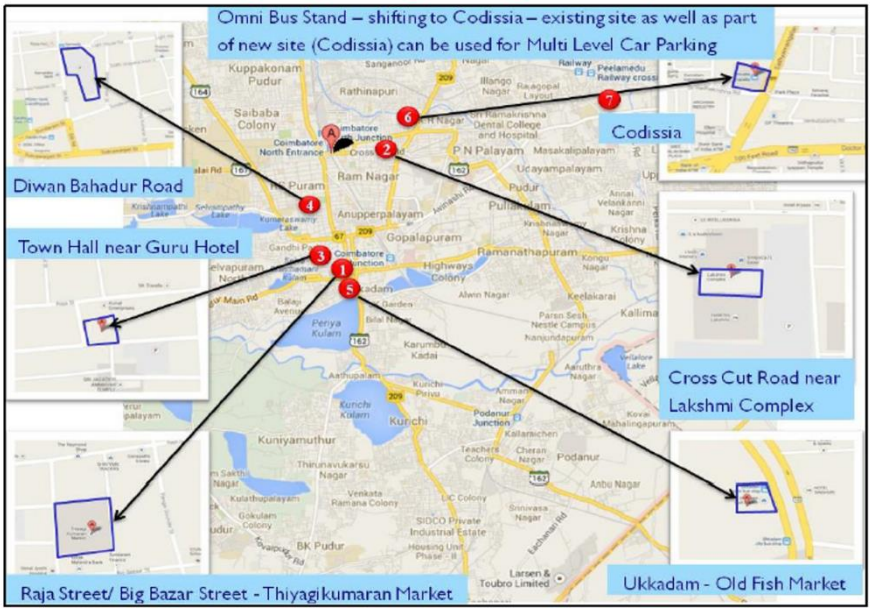
- Improve parking, reduce travel time
- Reduce congestion in commercial/city center areas

Solution 3: Intelligent Parking Management System

Components	Stakeholders
• Parking sensors • Mobile application to remotely identify and reserve parking spaces; aggregating parking availability from commercial buildings • Automated/ digital ticketing • Design and construction of MLPS • Commercial spaces and marking of spaces • Traffic cones and boom barriers • Man power resources • Shuttle service from MLCP to shopping areas	• Traffic police • CCMC • Technology + service providers - Clancor, Sieger, Bosch • Parking aggregators • Car manufacturers • CREDAI • IGCFG • Judiciary and RTO (Municipal Magistrate) • Commercial establishment

Next steps	Possible funding options	Preconditions
• DPR for other 4 MLCPs • NVAT should increase penalties • RTO should incorporate the use of digital services • Designated areas for parking should be pre-selected • Access possibility to combine MLCPs with commercial establishments for additional revenues • SPV could be setup to manage parking in the city • Proposal to connect RTO and DPP	• Parking fees and parking tax (depending on number of cars owned) • Tendering (Bangalore Airport) • Dynamic pricing • Association of commercial establishment • PPP Model • Soft Loan Model with SPV setup • Donor agency funding (e.g. KFW)	• Shuttle busses from parking spots to nearby shopping places • Parking fine for parking on street- regularized parking on streets • Demarcation of parking spaces in the city • Parking fees should be strictly monitored by the traffic police • A new penalization act • A proper info campaign • Proper substitute infrastructure to street vendors • RTO and police department have to be connected in one computer system

Solution 3: Intelligent parking management system



6.2.6 Solution Package "Improving logistiscs"

IMPROVING LOGISTICS

Reducing congestion and pollution caused by the logistic operations by revamping the logistic model

Logistic Terminals at the city boundaries: Building well equipped terminals at city boundaries to stop movement of big trucks within city limits during day time to ease out congestion.

Micro hubs in the city center for last mile logistics: Facilitating transfer of goods from electric tempos to electric cargo bikes for last mile delivery within the city.

Solution 1: Logistics Terminals at the city boundaries

Establishment of 4 well equipped accessible logistics terminals for decongesting the urban center

Description and Objectives

Well equipped logistics terminals at various entry points in the city will stop the movement of big trucks in the narrow city streets reducing both air pollution and commuting time for trucks. Electric tempos (smaller trucks) can transport the goods from logistic centre to micro hubs for last mile delivery.
At present the main logistics terminal for small truck companies is only available at the truck terminal in Ukkadam. This centre is not well equipped with facilities needed by drivers. With the city boundary expanding, the proposed logistic terminals would have to be located beyond these to ensure a future proof city. Additionally, a network of fast charging stations needs to be provided in the city to ensure smooth operation of EV distribution fleet. Land availability needs to be checked for the suggested locations, as the process of acquiring private land might be very complicated. Ideally temple land should be identified for this purpose as this would simplify the land acquisition process.

Objectives:

- Reduce congestion in the city center
- Reduce traffic/noise/pollution
- Provide suitable services for truck drivers to improve their comfort and security

Suggested locations for logistic terminals:

- Karumathampatti on Avinashi road
- Narasimhanaickenpalayam on Mettupalayam road
- Chettipalayam (based on the proposed Truck Terminal) or at Malumichampatti on Pollachi Road
- Additional suggestion: Sathy road to cater to Special Economic Zone cargo traffic on the road.

Suggested locations for Fast charging points:

- Petrol Station at Ukkadam (managed by Lorry owners association)

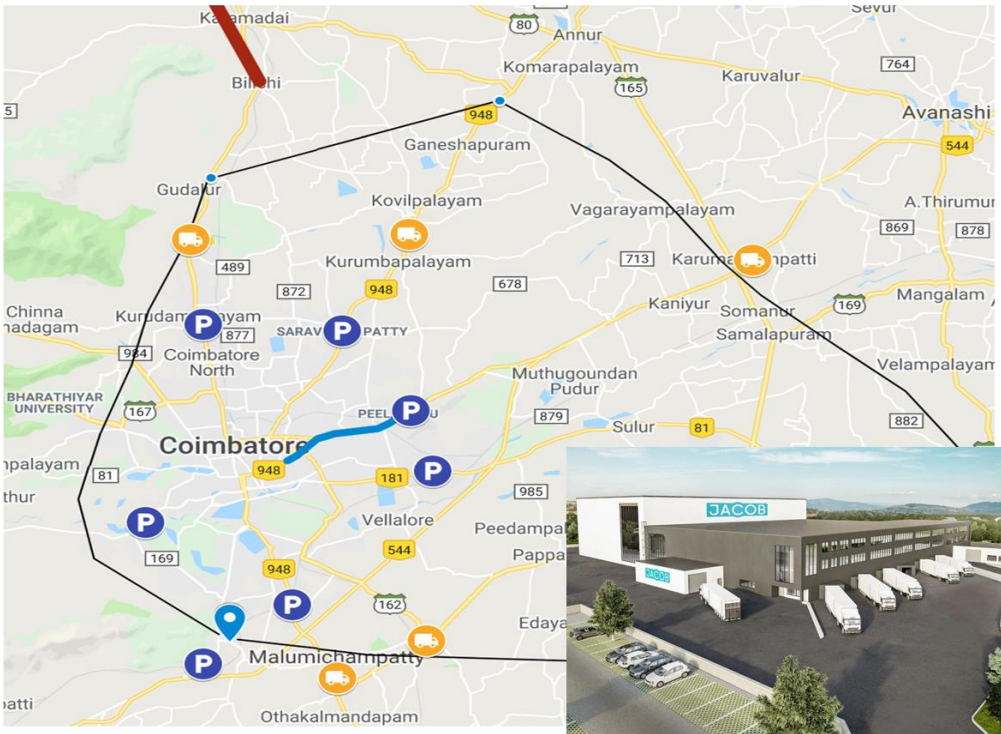
Solution 1: Logistics Terminals at the city boundaries (a)

Components	Stakeholders
• Charging infrastructure for small and medium sized trucks (fast and slow) • Restroom for drivers • Low cost motel/Sleeping facility • Full security provision for trucks/locker facility for truck drivers to keep valuables • First aid and medical services • Restaurant. Good hygienic foods provided. • ATM • Mechanical maintenance room for big trucks • Fast charging stations in the city centre at bunks and roads • Smooth exit and entry points for truck terminals avoiding traffic at junctions • Warehouses/Godowns • Office space for lorry booking agents (750 in Coimbatore) • Smart Parking, RFID Distribution • Cold storage for perishables (for the one on Mettupalayam road) • Water service station • Dedicated space for bus and transporters • Material handling equipment • Weigh bridge	• Lorry owners association • Booking agents • Goods transport • Parcel service • Trailer association • LCV association • Sanitary department • Local panchayat • KFW • Electricity board • Traffic Police + RTO • Town planning • LPA • Traders association • Private logistic operators like ABT, DHL

Solution 1: Logistics Terminals at the city boundaries (b)

Next steps	Possible funding options	Preconditions
• Feasibility study needs to be conducted to check if electric vehicles satisfy the load and battery requirements • A special purpose vehicle needs to be setup to regularise the subsidies for electric tempos • PPP model for financing the operations needs to be identified in collaboration with banks	• Currently at the Truck Terminal in Ukkadam truck owners pay 20 INR/day. They are willing to pay 75-80 INR for better facilities • Additionally, truck owners can pay an yearly membership fee which gives them reduced day price to encourage more users to use regularly • Revenues will also be gained from charging and other facilities like food, shops etc. • When big providers rent dedicated space in the terminal they will pay a rent • PPP model for financing needs to be established with a bank for initial investment • Subsidy based on carbon credits needs to be provided for the Electric tempos/trucks - based on current FAME subsidy for passenger EVs	• Fast charging network for the E-trucks and tempos within the city to ensure smooth operations • Good accessibility to the terminals via public transport from different parts of the city for employees to commute • Good road infrastructure around the terminal for the trucks to easily access the location • Good food facilities along the way. Healthy hygienic food offered • Good food facilities shall be provided at Tollways too • Allow Full Truck Loads within the city only during the night time • Low emissions zone in city • Cargi should only be allowed in terminal including for busses carrying cargo • Wholesale shops in the city need to be aligned to have a robust system • Electric tempos need to be subsidised

Solution 1: Logistics Terminals at the city boundaries



Suggested locations for Coimbatore

Source: https://www.viastore.com/en-us/news/pipework-systems-expert-builds-new-logistics-center/ http://wikimapia.org/29194639/Saravanampatti-Vishnu-s-Warehouse#/photo/3828626

Solution 2: Micro hubs in the city centre for last mile logistics

Last mile distribution of smaller loads with bikes and E- cargo bikes

Description and Objectives

The city can identify properties located in the centre and/or establish partnerships with companies, which already have storage and delivery stations (e.g. shopping, supermarkets) which could be rented out to the logistic companies and transformed into cross-docking center. Equally, the planned parking stations included in the CMP can be efficiently used by sharing the space with local delivery companies who could use part of the parking space for package storage. Near markets (e.g. fish market and in Gandhipuram), industrial multi-level storage facilities of the same type as multi-level car parks can be used to reduce the need for expensive floor space.
Final deliveries can be done with e-cargo bikes.

Objectives:

- Promote outsourced distribution in the city center, especially around Gandhipuram
- Reduce the number of trucks in the center of the city
- Reduce the number of kms per delivery
- Reduce traffic/noise/pollution
- Promote economic development - smart distribution

Possible Locations:

Fun Mall Parking, Multi Level parking planned for city, existing logistic terminals in Shukrawar Peth

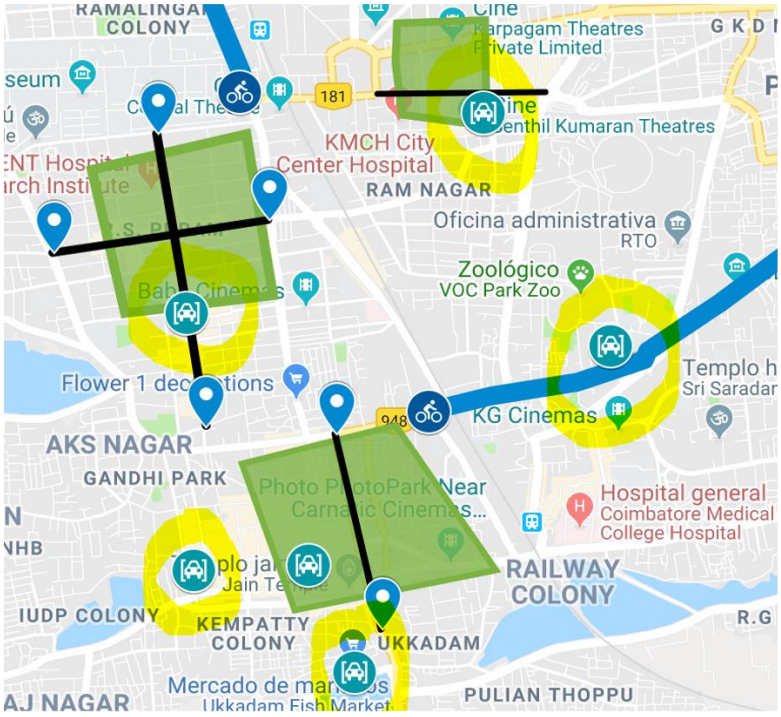
Source: http://triangulum-project.eu/

Solution 3: Micro hubs in the city centre for last mile logistics

Components	Stakeholders
• Space for transfer of goods and handover • Possibility to reserve the space in hub in advance • Facilities for loading and unloading the tempos	• Private Parcel providers (ABT, TVS) • Last mile delivery companies • Logistic companies • Goods and Transport Association • Lorry Booking agents

Next steps	Possible funding options	Preconditions
• Identifying a model where multiple handover of goods does not increase delivery price	• Parking fees for the space • Renting fee for the space	• Logistics terminals such that big cargo does not enter city and there is a need for micro stations • City centre to be announced as environmental friendly zone to promote use of sustainable modes for last mile delivery

Solution 3: Micro hubs in the city centre for last mile logistics



The planned multi-level parks could be planned as micro hubs too.

Source: © / Deutsche Post AG
https://blog.zhaw.ch/verkehrssysteme/studierende-entwickeln-micro-hub-system-fuer-urbane-logistik-in-winterthur/ ;
https://www.logistik-heute.de/Logistik-News-Logistik-Nachrichten/Markt-News/17902/Hamburg-School-of-Business-Administration-untersuchte-das-Modell-von-UPS-Let

6.2.7 Solution Package "Intelligent transport management

Intelligent transport management

Reduce congestion in city and maximize use of existing infrastructure

Smart Traffic Lighting incl. anti-bus bunching scheme:
Implementing a smart system to prioritise public transport and reduce commuting time.

Solution 1: Smart traffic lighting incl. anti-bus bunching scheme

Installing a bus priority system in traffic lights building on planned command and control centre, security cameras that levels the headway between the busses in the urban centre (priority bus lines: future BRT-lines and lines 5 & 7)

Description and Objectives
An upgrade in the bus fleet should be complemented by an improvement in the bus service reliability (current delays between 30 to 75 minutes not uncommon according to bus terminal operators). Managed traffic lights allows to optimise each junction and the traffic flow between junctions. It can create so-called "green waves" where vehicles are behind schedule and stopping them where they are ahead of schedule. It will build on the information gathered by the planned 2.500 traffic and security cameras by the TC (proposal submitted) on real time traffic information. The system can run on predefined schedules or (close to) real time algorithms. It is meaningful to combine the traffic lights with real time sensors: e.g. traffic cameras, inductive loop detectors. The sensors should be able to distinguish between different vehicle types. The collected data can also be used for further mobility planning. The implementation should be focused on the new rapid bus routes. **Objectives:** ● Improve punctuality of bus services ● Improve overall traffic flow ● Collect data about road traffic flows

Solution 1: Smart traffic lighting incl. anti-bus bunching scheme

Components	Stakeholders
• GPS and RF sensors • Digital message sign system • One radio dispatch system • One vehicle tracking device Traffic cameras • Inductive loop detectors • Sim with public IP • Centralized Traffic Command center • Design and Construction of MLPS • Remote sensor controlled lights • Public addressing system	• CCMC • Traffic police • TNSTC • Technology + service providers • Private bus operators • Chamber of Commerce • Industries Groups • Business Groups abd app vendors (Bosch, Clancor technologies, CleanPark, etc.)

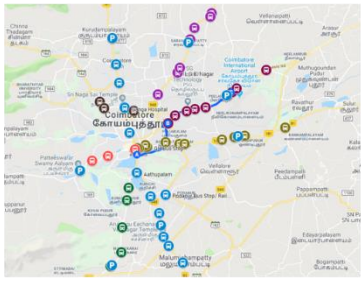
Next steps	Possible funding options	Preconditions
• Decision on scope of work to include in the project • Decision on outsourced application or customized app development • Preparations of RFI/EOI documents as required	• Donor Agencies • Smart City Funds • Private investors	• A fully functional traffic command center established • About 2500 CCTV cameras installed across Airport to Sukravarpet Express corridor • A dedicated bus lanes in operation • Traffic signals are connected to central controller • CCTV cameras are installed on the route

Solution 1: Smart traffic lighting incl. anti-bus bunching scheme

CURRENT STATE

FUTURE STATE

PRIORITY ROUTES



Source:
Sound Transit
https://sgwash.org/images/posts/201811-181834.jpg
https://www.thehindu.com/news/cities/Coimbatore/bus-services-resume-ahead-of-pongal/article22434473.ece

6.2.8 Solution Package "Smart solid waste management"

Smart solid waste management

Upgrading the solid waste collection facilities to reduce air pollution and congestion in the city

Smart door2door waste collection: collecting three types of separated waste directly at the source

Intelligent processing of organic waste for agriculture: efficient technology can help to quickly transform organic waste into valuable fertilizers for agriculture

Solution 1: City wide smart door2door waste collection

Scaling up differentiated door to door collection with electric vehicles

Description and Objectives

The waste collection service is very costly and the Corporation needs to find ways to increase the efficiency of the system and reduce costs. Currently collecting waste has been done using static routes and schedules where containers are collected every day/week regardless of fill-level. Also the city needs to introduce the model of separation at the source and promote recycling within the city. Effective waste management can improve the livability and quality of live in public spaces around the city.

In the piloted system, three different kinds of waste (wet, dry and sanitary) are collected with 52 e-vehicles in 5 waste hubs (one in each zone) and 100 micro composting centres (one in each ward). It is planned to have 865 BOVs (2 Ton capacity) and fossil fuel based 65 LCVs in operation. Collection vehicles should be fully fledged and controlled through a designated control center (Integrated waste management using GPS).

Update:

- In February, the municipality planned to open a new tender based on existing Smart City funding. However, owing to challenges with registration of electric vehicles in state of Tamil Nadu and performance deficiencies of the BOV pilot project, it was decided to switch the focus to the LCVs based solutions. Additionally, with recent fires at the Vellore landfill and strict regulations from state and national government agencies, the city needs to identify an end-to-end waste management plan.

Objectives:

- Reduce waste and operation costs
- Reduces emissions, road wear, noise pollution and work hours
- Environmental impact (less CO2, no overfull containers, less scattered waste, better hygiene)
- Increased environmental awareness
- Enhance the city image

Solution 1: Smart door2door waste collection

Components	Stakeholders
• Communication and citizen awareness • Process drivers • E-vehicles and LCVs • Segregation at source • Innovative recycling • Best practices sharing • Promotions/ Incentives • Stakeholders engagement • Capacity building • Battery charging systems	• CCMC/CSCL • Donor Agency • Residents/ Community/RAAC • Apartment Owners Association • Chamber of Commerce • Local manufacturers of BOVs

Next steps	Possible funding options	Preconditions
• Solid waste management master plan should be initiated and conducted in the form of study • The proposed intelligent waste management should be focused on monitoring of LCVs • A respective proposal will be initiated by the end of April 2019	• Vehicle financing via government backed development loan (4-8M EUR) • For initial planned project funding was secured through Smart City funds • KFW is interested in the full chain financing • TN Solid waste management fund • Swachh Bharath Mission grants	• Collecting from source • Daily collection scheme • Dry waste selling (vendors) • Suggested 3 way separation: wet, dry and sanitary • Governance aspects (policies, organisational issues, finance) • Corporation monitoring/ Administration of third party • Promotions/ Incentives to attract source based segregation and more awareness

Solution 1: Smart door2door waste collection

Solution 2: Intelligent processing of organic waste for agriculture

Efficient technology can help to quickly transform organic waste into valuable fertilizers for agriculture

Description and Objectives

A great part of the waste composition in Coimbatore is organic. If properly separated at the source, and with separate collection, this can be processed to valuable resource for agriculture. With simple efficient technology, the organic residues can be processed in a way that, the water is filtered from it. The dry residues can be then shredded and processed so in a faster way into compost. The water extracted from it before, can be also used as fertilizer for the plantations.

Construction of 67 micro composting centers (MCC) within 5 zones in the city is proposed. Each center has 2T. capacity that should be enough to sustain source based segregation and collection, local micro composting, and ensure no further waste dumping at Vellalore waste processing.

Objectives:

- Reduce the amount of waste going to landfills and pollution
- Increase community awareness on source segregation and composting
- Help farmers with the supply of compost produced from the collected organic waste
- To have waste management near source through MCC

Solution 2: Intelligent processing of organic waste for agriculture

Components

- Best practice sharing
- Promotions/ incentives
- Stakeholders engagement
- Process Driven MCCs
- Capacity Building

Stakeholders

- CCMC/CSCL
- Waste collection agency
- Donor Agency
- Residents/ Community/RAAC
- Apartment Owners Association
- Chamber of Commerce

Next steps

- Final workshop in April 2019 concluded the need for a solid waste management master plan study
- It should include components like transportation, collection, disposal and monitoring of waste

Possible funding options

- CSCL Smart city funds
- TN Solid waste management fund
- Swachh Bharath mission grants
- KFW is interested in the full chain financing
- Additional study on waste management in Coimbatore could be supported by KFW

Preconditions

- CCMC prioritization of facilities
- MCC pilot success and learnings
- Land availability for MCC within CCMC ward zones

Technical solutions

Implementing overarching solutions which integrate and support different mobility projects

Mobility Card: Developing a prepaid transport card which allows multimodal transportation.

Smart App for transport: Development of a Mobility App that integrates data for all urban modes of transport and enables easy transit.

Indoor navigation system for mobility hubs: Installing beacons and information screens at mobility hubs to enable smooth transfer between different transport modes.

Solution 1: Mobility Card

A multimodal transport card which promotes intermodality for commuters

Description and Objectives

Considering the divergent and scattered commuter movement in the city, it is essential for commuters to use multiple modes of public transport to reach final destinations including busses, shared bikes/cars, railways etc. An integrated access possibility to use and pay for the different services to reach final destination would increase uptake of public transport. Development of multimodal transport card which allows commuters to pay through a single prepaid card for journeys in several different modes of transport is thus needed which can also support futuristic cashless goals. The card can be developed in collaboration with NPC (National Payment Corporation) and C-DAC which would reduce overall transactions costs, ease settlements of costs among different players and standardise card payments across the country. Chalo App could be used as an example.

Objective:

- To increase usage of public and shared mobility
- Increase flexibility with use of multimodal transportation
- Promote cashless use of public transport

Initial Pilot Use Case:

- Suggestion to start an initial pilot with local taxi company
- like Red Taxi, shared bike provision and private bus companies

Solution 1: Mobility Card

CURRENT STATE

FUTURE STATE

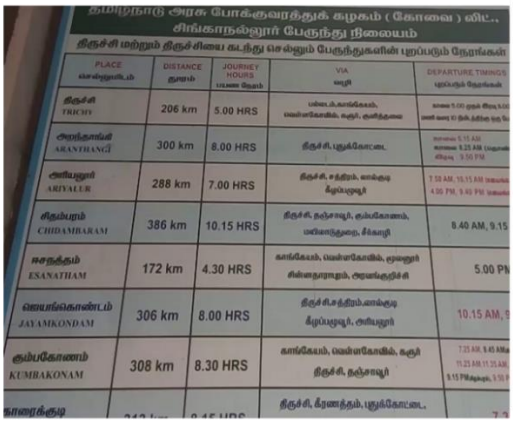
Source: https://www.skyscrapercity.com/showthread.php?p=87850197
https://www.vvs.de/polygocard/mit-der-polygocard-wochen-und-monatstickets-flexibel-am-db-automaten-kaufen/

Solution 2: Smart App for transport

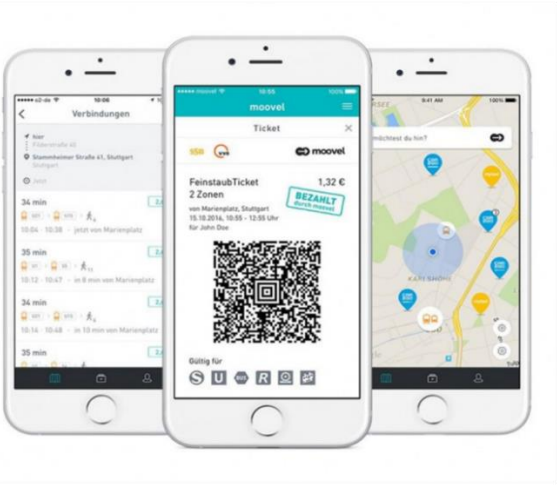
Development of a Mobility App that integrates data for all urban modes of transport, from buses, trains, walking, cycling to driving, with an emphasis on public transport.

Description and Objectives
With plans to provide multimodal transport options to citizens, it is essential to provide the citizens with information to choose the best possible connection for transit from point A to B. Considering the penetration of smartphones in the city of Coimbatore, a mobile app, which integrates data from all modes of transport and suggest various alternatives to transit from point A to B would improve the accessibility of intermodal options. Additionally, ticketing option could be integrated in the app for multimodal use. **Objectives:** ● Simplify multimodal transit ● Increase accessibility and awareness of public transport options ● Enable online ticketing for public transport

Solution 2: Smart App for transport



CURRENT STATE



FUTURE STATE

Source: https://www.youtube.com/watch?v=e1MZGrPIP88
https://www.moovel-group.com/en/press/feinstaubalarm-mit-moovel-im-nahverkehr-50-prozent-guenstiger-fahren-und-mit-etwas-gl-ck-kostenfrei

Solution 3: Indoor navigation system for mobility hubs

Indoor information system for the mobility hubs, piloting at Coimbatore Junction and the first bus-centered mobility hub introduced.

Description and Objectives

In order to efficiently navigate through mobility hubs, a public screen based real-time information system can be installed. Jointly with the right sensors and algorithms/management capabilities it can significantly increase the efficiency (i.e. throughput) of mobility hubs. Instead of a screen based navigation system, a smartphone based information system could be used. Mobility hubs are mostly points of interchange in which travelers have to go from one vehicle to another while not congesting footpath/ticketing or baggage facilities. High quality and available information allow travellers to make more informed choices and therefore provide more capacity to the infrastructure. The collected sensor data can also be used to adjust and improve the network and indoor-navigation. A beacon-based system could also enable personalised data-based services such as advertisement on the smartphone.

Objectives:

- Improve efficiency of mobility hubs
- Providing opportunities for economic growth

Components:

Maps showing optimised cycling route, navigation, bike sharing,
Safety centric – feedback option, intermodal, gamification and rewards component

6.2.10 Solution Package "Smart governance"

SMART GOVERNANCE

Setting up regulatory norms which support the improvement in overall mobility

Creation of Metropolitan Mobility Authority: Establishing an authority to coordinate activities, enhance collaboration and facilitate implementation of mobility projects.

Creation of bus-only lanes: Setting up exclusive lanes for buses to make public transport more fluent and attractive.

Promotion of high occupancy in private cars: Allowing private vehicles with higher occupancy to use bus lanes during peak hours.

Creation of a low emission zone in the urban area: Declaring a low emission zone in the urban center to disincentivise the use of private vehicles, promote public transport and reduce pollution.

Flexible assigning of traffic lanes: Prioritising sustainable modes of transport by providing special road privileges during peak hours

Solution 1: Creation of a Metropolitan Mobility Authority

Establishment of a Metropolitan Mobility Authority to coordinate activities, enhance collaboration and facilitate implementation

Description and Objectives

The City has so far not established a local body to coordinate all activities related to mobility. This would allow for overall collaboration and a better coordination of the activities and stakeholders. Furthermore it would allocate additional decision making power to the Corporation, which would facilitate implementation.

Objectives:

- Overall coordination of all authorities and departments related to mobility
- Hand over some decision power to the local administrations, regarding roads, taxes, fees etc.
- Institutionalise and enhance and expand already existing co-operations
- Warranty the efficient implementation after project idea development
- Initiation of a continuous, long-term process
- Regular exchange of relevant stakeholders
- Exchange of information
- Push on the relevant projects of the mobility city lab and beyond

Solution 2: Creation of "bus only" lanes

Exclusive lanes for buses to make public transport more fluent and attractive

Description and Objectives

In wide roads and highways Coimbatore should create "bus only" lanes to promote public transport. The lane could also be used by e-vehicles and cars with a occupancy higher than 3. A first pilot can be implemented in the upcoming flyover on Avinashi road. This would be a good complement to the suggested park & ride station in that area.

Objectives:

- Promote public transport
- Make traffic more fluent
- Secure the success of implementation of P&R

Suggested Locations:

Along major arterial roads in the city to promote faster transit. Additionally, also in newly planned flyovers, dedicated lanes which facilitate express routes should be considered.

Source: https://www.yorkregion.com/news-story/4886741-section-of-bus-only-lane-opens-in-markham/

Solution 3: Promotion of high occupancy in private cars

Preferential transit during peak hours for private vehicles with an occupancy higher than 3

Description and Objectives

To promote high occupancy in cars, Coimbatore could emit a decree so that cars that have with an occupancy of 3 people or more can use the lanes that are exclusively for buses during peak hours .

Objectives:

- Encourage car owners to give rides to other people
- Promote carpooling initiatives
- Reduce the number of cars circulating
- Change the culture of cars as a mean of transport

Source: https://www.bizjournals.com/denver/blog/earth_to_power/2016/07/free-ride-is-over-on-i-25-north-express-lanes.html

Solution 4: Creation of a low emission zone in the urban area

The creation of a zone of low emissions in Coimbatore will reduce pollution and decongest the urban center and improve air quality

Description and Objectives

The suggested measures to improve public transport, connectivity and road infrastructure, need to be complemented by accurate regulations to disincentivise the use of private vehicles. A low emission zone would help to create a transformation and contribute to a change of mentality in the city. This environmental zones would need to be declared by the corporation and enforced by the traffic commissioner. The mounted cameras, part of the command and control centre, can be used to supervise and control the efficient implementation of the measure.

Objectives:

- Decongest the city centre
- Promote the use of public transport
- Promote the use of bicycles
- Improve air quality and fight noise pollution

Suggested elements:

- Declaration of the low emission area
- Installation of air quality and temperature sensors
- Control and monitoring system
- Gradual restriction of vehicle traffic

Umweltzone in Berlin (Germany)

Source:https://www.berlinstadtservice.de/xinh/Umweltzone.html

Solution 5: Flexible assigning of traffic lanes

Building on the existing time-based block of the city centre for lorries, streets and traffic lanes in city are assigned to sustainable use of transportation modes only.

Description and Objectives

Lorries and goods transport vehicles often block roads in the narrow streets of the city centre causing congestion and unsafe traffic environments. The existing policy of allowing lorries into the centre only at nighttimes, will be extended. Road-side parking could be permitted only outside peak-hours. The system can run on predefined (scheduled) schemes, smart algorithms dedicated to improve optimise the system according to the rules set or being managed manually by a traffic controller. They can display lanes direction, speed limits, road closures and other information.

Objectives:

- Improving traffic flow
- Informing travellers about traffic status

7. The way forward – Roadmap

7.1 Steps forward / Coimbatore mobility system

Mobility is unquestionably one of the main concerns of the city administration. It is not only one of the main source of pollution but also very expensive and accounts for huge amounts of energy consumption. Today, cities are completely dependent on mobility dynamics and processes. When a city is striving to transform itself into a smart and sustainable city, mobility is inevitably one of the aspects that need to be mastered. Mobility is a very complex topic and has to be treated as such. It is imperative to know how to best use the available knowledge and the existing technology to shape the future-oriented mobility of tomorrow.

7.2 Roadmap

By applying the Morgenstadt City Lab methodology to address the key mobility challenges in Coimbatore, 32 unique project ideas across 10 thematic packages, presented in the chapter above, were co-created together with the key mobility stakeholders from the city. The project ideas were based on detailed and systemic analysis of the city profile through the strategic documents from the city and feedback from several public and private stakeholders. As such, each of the project ideas is relevant to the city context and would play a pivotal role in transforming the city from a mobility perspective.

However, each of the projects needs different planning and execution times, has diverse regulatory constraints and varying levels of stakeholder interest. Additionally, several projects are interdependent on each other, wherein implementation of one before initiating the other is key to the success of both. Hence, there was a need to prioritize the 32 project ideas and create a roadmap which can serve as a guideline towards uptake and implementation of project ideas.

7.3 Methodology for roadmap development

At its core, the focus was to assess all the project ideas in a standardized and unbiased way. The process involved selection of criteria for prioritization, allocating specific weight to each criterion, and grouping of interdependent projects.

7.3.1 Selection of Criteria

The following criteria were identified as key towards identifying the position of the project in the roadmap. The criteria were recorded after the Innovation workshop:

i. City Interest

Description: The City interest expresses how well the project idea aligns with the vision and developments goals of the city. It is a key criterion

which takes into account the perspective of the municipal representatives and decision makers and brings forward projects which address key challenges in the city.

City Interest	
low	Not very relevant for the city at present
medium	Aligns with goals, aspirations, and visions of the city and there is interest in the implementation
high	Aligns very well with the sustainable development goals of the city, aspirations, and visions. There is a high interest in implementing and include in current and future plans.

Contributor: The city interest was rated by the Smart City SPV team of the Coimbatore Municipal Corporation who is responsible for the implementation of the Smart Cities mission of the Government of India and actively participated in the entire Mobility city lab.

During the final event on 3rd April 2019, the vision and priorities from the perspective of newly appointed Municipal Commissioner, Mr. Sravan Kumar and his team were also taken into account. The priorities, as discussed by the participants during the final event, are in Annex 3. The inputs for city interest have thus been adapted after the final event.

ii. Aspirations of the city

Description: The Aspirations of the city indicate on a comparative time scale when a city would like to have a project idea implemented based on its goals, priorities, and vision.

Aspirations of the city	
short term	Aligns with the short term goals and priorities of the city
medium term	Aligns with the medium-term goals and priorities of the city
long term	Aligns with the long term goals and priorities of the city

Contributor: The Aspirations of the city was rated by the Smart City SPV team of the Coimbatore Municipal Corporation who is responsible for the implementation of the Smart Cities mission of the Government of Indian and actively participated in the entire Mobility city lab.

iii. Stakeholder Engagement

Description: Stakeholder Engagement indicates the extent to which the key stakeholders are interested in the project idea and willing to be on board for implementation.

Stakeholder Engagement	
Low	Based on interviews carried out, low interest in the implementation
Medium	Interviewed stakeholders showed interest, agreement with proposals and alignment with the project goals.

High	Majority/all of the interviewed stakeholders showed high interest, agreement with proposals and aligned with the project goals

Contributor: The indicator was rated by the Assessment team who interviewed the key stakeholders in each of the projects.

iv. Time for full Implementation

Description: The criterion demonstrates the estimated time required to complete the full implementation of a project idea. It helps to differentiate between the quick wins and the long term investment projects.

Time for full Implementation	
Short Term	< 1 year
Medium Term	1 - 3 years
Long Term	> 3 years

Contributor: The indicator was rated by the Assessment team including the Mobility experts, with previous experience in such projects, together with the inputs from the local stakeholders.

v. Regulatory Constraints

Description: The criterion indicates how well the current regulations support the project idea. It highlights project ideas which need stronger political willingness and regulatory changes to facilitate successful implementation.

Regulatory Constraints	
Low	Regulations are not a major obstructing factor
Medium	The implementation can be partially depending on regulatory adaptations and changes
High	For further development, regulatory preconditions need to be guaranteed to enhance commitment. 1

Contributor: The indicator was rated by the Assessment team mainly based on the Mobility City profile of Coimbatore developed as part of the project along with inputs from local stakeholders.

vi. Participant Votes from Innovation workshop

Description: Towards the end of the Innovation Workshop (described in chapter 4), each of the participants received 5 votes to select project ideas, which from their perspective, were key to addressing the mobility challenges in Coimbatore. The workshop, where more than 40 representatives from different public and private institutions in Coimbatore participated, well represented the key mobility stakeholders in the city along with associations representing the local residents.

The number of votes received by each project ranged from 3 to 23. Hence the votes were divided into the following three criteria.

Participant Votes from Innovation workshop	
Low	< 10
Medium	10 - 17
High	18 - 23

Contributor: The indicator was rated by the participants of the Mobility City Lab innovation workshop held on 28th November 2018.

After the On-Site assessment and innovation workshop, each project idea was assessed based on the above-mentioned criteria. The table in Annex 2 provides an overview of the project assessment.

7.3.2 Preliminary Ranking

The project assessment formed the basis for ranking the project ideas based on the selected criteria. However, each criterion did not have equal weight in deciding the priority of a project. For e.g. the aspiration of the city clearly was more important than regulatory constraints as with enough backing the regulations could be modified to facilitate positive changes in the mobility scenario of the city. Thus, the criteria were given following weightage:

Table 13. Preliminary ranking criteria

Criteria	Weightage	Reasoning
City Interest	3	The criterion plays a key role in indicating projects which fit the vision and goals of the city. It brings forward key transformational project ideas and hence is considered very important.
Aspirations of the city	3	The criterion helps align the project ideas to the city development time line and hence is considered very important.
Stakeholder Engagement	2	Approval from stakeholders plays a key role in ensuring the successful implementation of the project. It helps identify projects which could be initiated consensually and have aligned goals amongst the stakeholders.
Time for full Implementation	1.5	This helps identify quick win project ideas which can create initial interest in the city. However, the guideline needs to have a mix of quick win and long term investment projects.
Regulatory Constraints	1.2	Though having supporting regulations helps faster execution of a project, the regulatory framework could be (and needs to be) updated by the municipal government when there is a strong need identified towards improving the mobility scenario in the city.
Participant Votes from Innovation workshop	1	The participatory vote gives a good idea of the projects considered important by the key stakeholders. However, since the votes were limited to participants who could be physically present at the workshop, it has been given lower weight to avoid bias.

All project ideas were given a score from 1-3 (3 – high priority; 1 – low priority) for each criterion. These scores were used to define the preliminary ranking.

Hence, the Preliminary ranking was based on the following equation:

*(City Interest + Aspiration of City)*3 + *Stakeholder Engagement* *2 + *Time for Implementation* * 1.5 + *Regulatory Constraints* * 1.2 + *(Workshop Votes)* * 1

The table in Annex 3 provides the preliminary ranking.

- **Interdependent projects**

The preliminary ranking prioritized the project ideas based on the selection criteria and weightage assigned to them. However, some of the projects are interdependent, which implies that implementation of one is necessary before the successful implementation of another. One of the key dependencies is based on the provision of supporting infrastructure or governance framework before rolling out a project which would use it extensively. Such project dependencies were taken into account before developing the final roadmap.*7.3.3 Results*

Based on the above-described methodology, the 32 project ideas developed through the City Lab process along with the respective governance and technical solutions have been prioritized. In some cases, considering the dependencies of the project ideas on each other, they have been grouped together under one priority adding up to 14 levels in the Roadmap.

1. **Creation of Metropolitan Mobility Authority**
   Establishment of a dedicated local body to coordinate all activities, authorities, and stakeholders related to mobility is the essential first step to ensure successful implementation of the interdependent and interlinked project ideas. It is hence, the first step towards improving the mobility of the future.

2. **Intelligent Parking Management System and Multi-Level Car Parks**

   The intelligent Parking Management System ranks high on the project assessment report owing to the dire need for organised parking in the municipality of Coimbatore.

   The project on Multi-level car parks needs to be implemented in close coordination with the Intelligent Parking Management System to ensure that the new parking spots being created could be found through the Parking Management System. Additionally, the currently limited space available in the city for parking necessitates these Multi-level car parks in the centre.

3. **Upgrading Bus stops, Upgrading Bus Fleet**
   Digital ticketing, Smart App for Transport, Mobility Card

Upgrading the bus stops in the Municipality is a short term aspiration of the city with high interest from the key stakeholders. The project needs to be linked to the bus fleet upgrade to ensure that components that are interdependent have been considered. For e.g., if the fleet is being upgraded to electric busses, the bus stops need to have necessary charging infrastructure to support this.

This is also partially linked with the Digital ticketing and Smart Mobility app for the city. Depending on the technology chosen, these projects require certain infrastructure, which needs to be taken into account while upgrading the buses and the bus stops.

4. **Smart door2door waste collection and Intelligent Processing of Organic waste**
   Smart door2door Waste collection is an important solution for the city considering that waste management is one of the main costs the city has to bear. While working on the waste collection, it is important to consider alternatives to process organic waste in a sustainable manner. Hence, project ideas need to be developed together.

5. **New Bus Routes and Ring Roads, Creation of Bus Only Lanes**
   To make the city more accessible via public transport, it is necessary to extend and densify the current bus network. In some cases, there is a need for new bus routes along existing roads. Such routes can be initiated in the near future with the addition of new bus stops and rerouting of existing busses or addition of new busses to the fleet.
   Additionally, opening up some roads would facilitate providing ring bus routes, which allows for peripheral transit without entering the city centre. This would reduce the congestion in the city centre and would promote long term sustainable transit.

6. **Logistic Terminals and Micro hubs for the Last mile**
   The Micro hubs in the city centre to facilitate last mile delivery is an important project for Coimbatore to reduce the number of trucks entering the city and lead the way to more sustainable last mile distribution options.
   However, to have micro-hubs in the city centre, it is essential that there are logistic terminals at the city boundaries which can then cater to the micro-hubs. The logistic terminals will additionally improve the overall working environment for the truck drivers providing them with necessary facilities while halting in Coimbatore.

7. **Creation of safe bike lanes, Bike Sharing scheme, Green Blocks, Creation of low emission zones**
   Promoting bike as a mainstream mode of transport has been on top of Coimbatore Municipality's agenda. Introducing bike sharing schemes

would be instrumental in promoting its uptake. However, having safe and dedicated biking lanes is essential for the success of the bike sharing scheme as the city streets are crowded with motorised transport, with narrow and obstructed footpaths.

Additionally, the Green Blocks project would help introduce model blocks within the city with a pedestrian and bike-friendly infrastructure. It would create awareness about sustainable transport modes and increase the uptake of such modes. This coupled with stringent regulations which facilitate the transition to sustainable modes: such as the creation of low emission zones, would support the uptake of non-motorised and sustainable modes of transport.

8. **Mobility hubs at train stations and bus stations, Indoor Navigation system**

   After the public transport system has been improved, and alternate modes of transport have been introduced, the next step would be to facilitate last mile connectivity through Mobility hubs at bus stops and train stations. This would increase the number of people using public transport for their daily commute. Additionally, bigger mobility hubs could be facilitated with Indoor navigation systems to improve the user experience.

9. **Intelligent Traffic Management, Promotion of high occupancy private cars, flexible assigning of traffic lanes**

   An intelligent traffic management system will facilitate a smoother flow of traffic at junctions and incentivise the use of sustainable transport modes. Through the system, buses and other sustainable modes could be prioritised to create the green wave effect. This could be further combined with promoting high occupancy in private cars by allowing them to use such dedicated lanes. Additionally, the Traffic Management System could be used to allow flexible assigning of traffic lanes during uneven traffic distribution.

10. **City wide AC charging Infrastructure & Public Electric Car sharing scheme**

    The City wide AC charging infrastructure would enable the use of Electric Vehicles for within city commute. The public car-sharing scheme would encourage the transition to electromobility.

11. **Introducing Commuter Rail Services**

    An electric commuter rail service which works parallel to the existing rail infrastructure, but provides better connectivity for within city commute at affordable prices would complement the public bus services. It is a

long term project which would cater to the future needs of the city and for travelers wanting to commute longer distances.

12. **Rail Link and revival of abandoned station**
    The proposed rail link connecting Coimbatore Junction with Irugur Junction would ease congestion at the central junction and provide a faster way to commute between south of Coimbatore to the East. The Rail link project is related to the abandoned stations project, as some of the stations are along the proposed rail link. These projects need to be developed together.

13. **Park and Ride station**
    A well-established public transport system from city limits would pave the way for park and ride stations which facilitate the use of public transport for commuters who do not have good last mile connectivity. The stations would complement the MRTS and the Commuter rail services.

* **Shared Electric Fleet**
  The shared electric fleet project idea is specific to particular institutions who are interested in providing such a service to their faculty/employees/students. Considering that most of the travel is a short distance, the charging infrastructure is only needed at the institution campus. Hence, this project can be implemented independently of the other project ideas.

7.3.4. Next Steps Discussed during the Final Event

After the preparation of the final report for the Mobility City Lab, a final event was held to present the results from the City Lab analysis and pre-feasibility studies. During the event, around 30 executive level representatives came together to agree on next steps for moving towards implementation. The participant list from the final event can be found in Annex 2.

During the event, based on the inputs from the new Municipal Commissioner, Mr. Sravan Kumar, and his team, the priority of the projects was analysed and adapted. Additionally, following key outcomes were defined.

1. **Decision to set up of a team to support delivery of City Lab Projects**

   The Municipal Commissioner, Mr. Sravan Kumar, decided to set up a cross-departmental team, of around 10 members, who will take up the responsibility of following up with securing financing and

implementation of the projects proposed in the City Lab Report. This will allow for successful and fast implementation of suggested projects.

2. Project Champions for the Projects

During the final event, Project Champions were assigned to each project discussed. The champions are responsible to initiate the next steps for supporting implementation of each project.

- Parking Management System and Intelligent Transport Systems: *Mr. Raj Khanna, Asst. Police Commissioner, Traffic Department*
- Intelligent Waste Management: *Mr. Sarvanamkumar, Exceutive Engineer, CCMC*
- Green Blocks: *Mr. Ravichandran, Town Planning Head, CCMC*
- Improving Bus Services: *Municipal Commissioner will assign a suitable representative at the earliest possible*.

3. Bilateral meeting between KfW and CCMC

A meeting was setup for 18th April 2019 in Delhi between KfW (the donor agency) and the Coimbatore City Municipal Corporation for discussing next steps and project alignment.

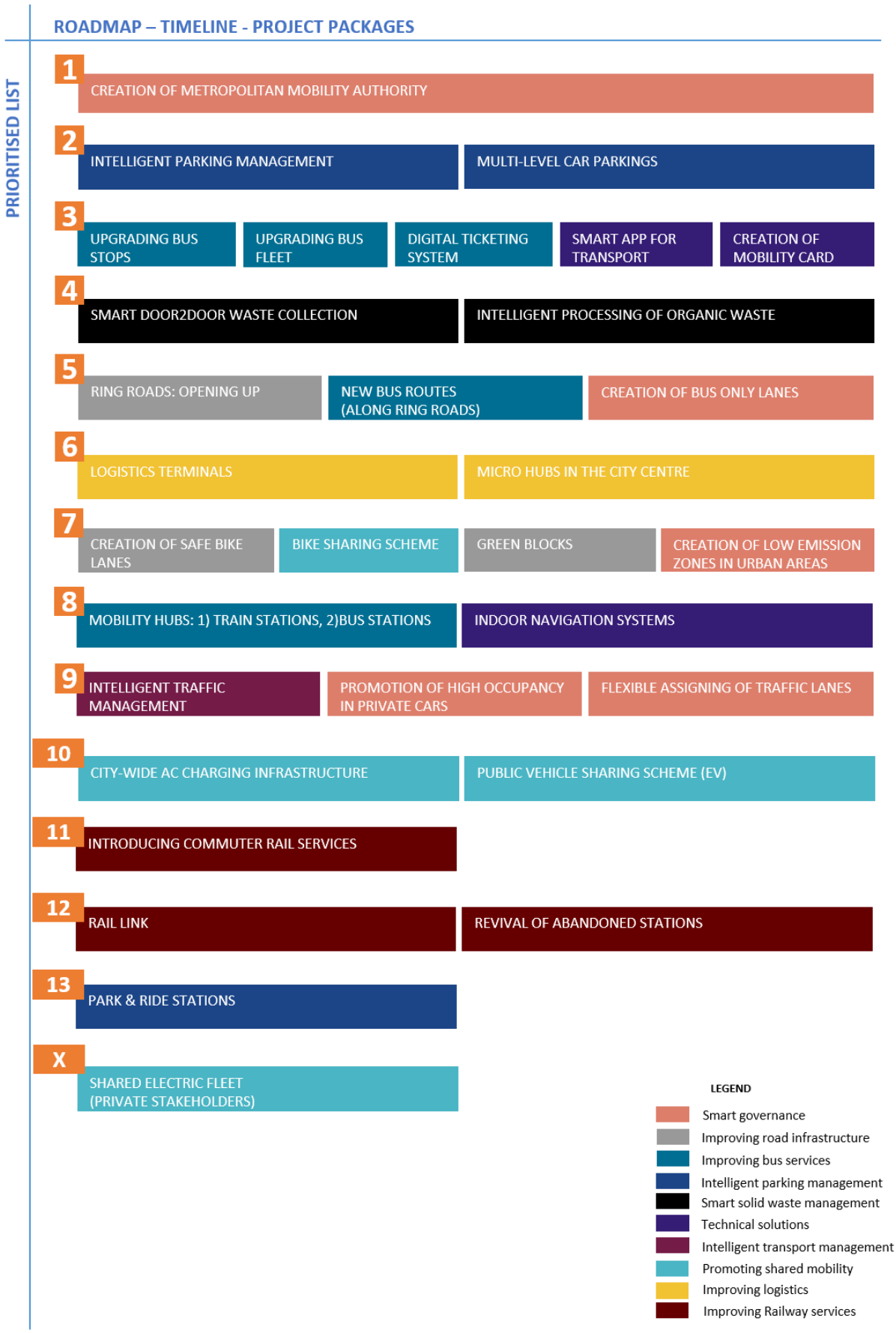


Figure 16. An organized project ideas roadmap for the city of Coimbatore

Annexes

Annex 1 - List of interviewed partners

Institution	Designation	Name
PUBLIC STAKEHOLDERS		
Coimbatore City Municipal Corporation (CCMC)	Comissioner	Dr. K. Vijayakarthikeyan, I.A.S
Coimbatore City Municipal Corporation (CCMC)	Executive Engineer	Mr. Sarvanakumar Naidu
Coimbatore City Municipal Corporation (CCMC)	Executive Engineer (Water Dept.)	Mr. Gnanavel
Coimbatore City Municipal Corporation (CCMC)	City Engineer	Mr. Lakshmanan
Coimbatore Smart City Ltd./Project Management Consultant (CSCL / PMC)	Transportation Expert	Mr. N. Babu
Highway Authority	Responsible for Trichy Road, Mettupalayam Road	Mr. Selvakumar
Highways Authority	Avinashi Road flyover	Rani
IC Centre for Governance - Coimbatore	Chief Operating Officer	Mr. S. Baskar
Local Planning Authority	Representative	E. Rajendran
PSG College of Technology	HOD, Automobile Engineering	Dr. S. Neelakrishnan ME, PhD, Ceng.
PSG College of Technology	HOD, Automation And Robotics	Dr. Vinod B.
PSG Institute of Advanced Studies	Director	Dr. P. Radhakrishnan
Residents Awareness Association of Coimbatore	Representative	Shri Swaminathan
Regional Transport Office (RTO)	Regional Transport Officer, North	Mr. K.Kumarvel
Regional Transport Office (RTO)	Regional Transport Officer, West	Mr. Raju
Tamil Nadu Agricultural University	Security Officer	A. Manikandan
Tamil Nadu Agricultural University (Estate office)	Asst. Executive Engineer	K.B. Ravi
Town Planning, CCMC	TPO Officer	Thiru. S. Ravichandran
Ukadam Bus Terminal	Assistant Manager	Mr. Vartharaj
WIR India	National Lead	Chhavi Dhingra
PRIVATE STAKEHOLDERS		
Clancor Technovates India Pvt. Ltd	CRM	Mr. Beeshma Chakkaravarthi
ABT Limited	Executive Director	Sudhan Manickam
ABT Limited	Chief Executive	N. Shanmugasundaram
Ampere Vehicles	Managing Director	Hemalata Annamalai
Clancor Technovates India Pvt. Ltd	Managing director	R. Ragunathan
Clancor Technovates India Pvt. Ltd	Director - Technical	S. Siddhiq Ahmed
Coimbatore Custom House and Steamer Agents Association	President	P. Subramaniam
Coimbatore Goods Transport Association	Secretary	S. Gopalakrishnan
Daimler India Commercial Vehicles Pvt. Ltd.	Senior Manager (Bus)	Prabhat Saxena
eQuadriga Software Pvt. Ltd.	Chairman & Managing Director	Leo Ananth J
ICCI	President	Lakshminarayanswamy
Interglobal Logisolutions Ltd.	COO	Dileep T. Abraham
Jayem Automotives Ltd.	Assistant Manager	Ashwanth S Jawahar
Jayem Automotives Ltd.	Managing Director	J. Anand
Jayem Automotives Ltd.	Senior Vice President	S. Venkataraman
Jayem Automotives Ltd.	Representative	Mr. Beena
Lorry Booking Agents Association	Secretary	Kaja Hussain
Lorry Owners Association	President	K. S. Kaliaperumal
Lorry Owners Association	Manager	Kannappan

Private Bus Operators Association	President	V.V. Babu
Private Bus Operators Association	Representative	Vijay Kumar
Red Taxi	Managing Partner	Manoj Subramaniyam
Reliant Energy	Partner	Sampath Kumar
Shanthi Social Services	Secretary	S. Srinivas
Sieger Parking	Managing Director	G. Radhakrishnan
Sieger Parking	General Manager - Marketing	Sunil K. Rao
The Indian Chamber Of Commerce And Industry	CEO	Ms. Prema
ZRUCC	Managing Partner	Shri C. Balasubramanian

Annex 2 - List of participants of the final event in Coimbatore on the 03.04.2019

Institution	Designation	Name
ACP Traffic Police	Assistant Commissioner of Police	Raj Khanna
Coimbatore City Municipal Corporation (CCMC)	Comissioner	J. Sravan Kumar, I.A.S.
Coimbatore City Municipal Corporation (CCMC)	Deputy Comissioner	S.Prasanna Ramasamy
Coimbatore City Municipal Corporation (CCMC)	City Engineer	A. Lakshmanan
Coimbatore City Municipal Corporation (CCMC)	Town Planning Officer	S. Ravichandran
Coimbatore City Municipal Corporation (CCMC)	Executive Engineer	K. SaravanaKumar
Coimbatore Smart City Ltd.	Project Manager (PMC)	A. Thirumurthi
Coimbatore Smart City Ltd./Project Management Consultant (CSCL / PMC)	Transportation Expert	Mr. N. Babu
Confederation of Indian Industry (CII)	Deputy Director	S Venkataraman
Confederation of Indian Industry (CII)	Convenor	R. Sivakumar
CREDAI	Representative	D. Abaishek
CREDAI	Representative	Mr. Gugan
CREDAI	Representative	R. Rajiv
CREDAI	Representative	Mr. Anajakrisinvan
Fraunhofer IAO	Project Manager	Marielisa Padilla
Fraunhofer IAO	Researcher	Nikita Shetty
Fraunhofer India	Manager - Electronics	Aditya Fuke
GIZ Smart-SUT	Urban Transport Expert	R. Parvathapuram
IC Center for Governance	Chief Functionary	S. Baskar
KFW Delhi	Young Professional	Archana Jayaraman
KFW Delhi	Senior Specialist UP & Mobility	Swati Khanna
KFW Frankfurt	Project Manager	Angelika Zwicky
KFW Frankfurt	Senior Expert for urban mobility	Ulrich Thomas
Residents Awareness Association of Coimbatore (RAAC)	Member of Managing Committee	R. Raveendran
Siruthuli	Representative	B. Saravanan
Studio Annexe	Architect	Srividhya Srinivasan
TNSTC CBE	Representative	D. Varadharan
TNSTC CBE	Representative	N.Ganesav
TNSTC CBE	Representative	R. Vasudevam
University of Stuttgart IAT	Scientific Assistant	Vladyslav Latypov
WRI/GIZ Smart-SUT	National Lead	Chhavi Dhingra
Coimbatore City Municipal Corporation (CCMC)	Comissioner	Dr. K. Vijayakarthikeyan, I.A.S

Annex 3 - Priority list for Project Packages with Mr. Sravan Kumar during the final event

PROJECT NAME	PRIORITY
Improving Bus Services	High
Green Blocks	Medium
Parking Management System	High
Intelligent Transport Management	Medium
Intelligent Waste Management	High
Improving Railway services	Low
Logistics terminals and Micro hubs	High
Park & Rides	Low
AC charging infrastructure	High
Public vehicle sharing scheme	Low
Creation of a metropolitan mobility authority	High
Low Emission Zone	Low
High occupancy in cars program	Low

Annex 4 - Project Assessment Table

Sr. No.	Project	Votes	Stakeholder Engagement	Regulations constraints	Time for full Implementation	City Interest	Aspiration of the city
	Improving Bus services						
1	Upgrading Bus stops	21	High	low	medium term	high	short term
2	New Bus routes	3	High	medium	short term	high	short term
3	Mobility Hubs at bus stations	8	medium	low	medium term	medium	medium term
4	Upgrading the Fleet	6	medium	low	medium term	medium	medium term
5	Digital ticketing	9	High	medium	short term	medium	medium term
	Shared mobility						
6	Public car sharing scheme	3	low	low	medium term	low	medium term
7	Bike Sharing Scheme	3	medium	low	short term	High	short term
8	Shared Electric Fleets	5	High	low	short term	medium	short term
9	City wide AC charging infrastructure	5	medium	medium	long term	high	long term
	Improving Rail Services						
10	Rail Link	12	High	high	medium term	low	long term
11	Revival of abandoned stations	2	Medium	medium	Medium term	low	long term
12	Introducing Commuter Rail Services	9	High	medium	Long term	medium	long term
13	Mobility Hubs at train stations:	5	medium	Medium	Medium term	high	long term
	Improving Infrastructure						
14	Ring Roads	17	medium	high	long term	high	long term
15	Safe bike lanes	6	low	high	medium term	high	short/medium term
16	Green blocks	4	medium	high	medium term	medium	short term
	Parking Management						
17	Park and Ride station	5	medium	low	medium term	low	short term
18	Multi-level parking	11	medium	low	short term	high	short/medium term
19	Intelligent Parking Management System	18	High	medium	short term	high	short term
	Improving Logistics						
20	Logistics Terminals at city boundaries	15	High	medium	medium term	high	long term
21	Micro hubs for last mile	13	high	medium	short term	high	long term
	Intelligent Transport System						
22	Smart Traffic Lighting	4	low	medium	short term	high	short term

	Smart Solid Waste Management						
23	Door2Door Waste collection	23	High	high	medium term	high	short term
24	Intelligent processing of organic waste	5	medium	low	short term	high	short term

Annex 5 - Preliminary Ranking Table for the Roadmap

Project	Votes	Stakeholder	Regulations	Implementation time	City Interest	City Aspiration	Total
Intelligent Parking Management System	3	3	2	3	3	3	33,9
Upgrading Bus stops	3	3	3	2	3	3	33,6
Door2Door Waste collection	3	3	3	2	3	3	33,6
Microhubs for last mile	2	3	2	3	3	3	32,9
New Bus routes	1	3	2	3	3	3	31,9
Logistics Terminals at city boundaries	2	3	2	2	3	3	31,4
Bike Sharing Scheme	1	2	3	3	3	3	31,1
Intelligent processing of organic waste	1	2	3	3	3	3	31,1
Shared Electric Fleets	1	3	3	3	2	3	30,1
Ring Roads	2	2	3	1	3	3	29,1
Multi-level parking	2	2	3	3	3	2	29,1
Mobility Hubs at train stations:	1	2	2	2	3	3	28,4
Smart Traffic Lighting (ITS)	1	1	2	3	3	3	27,9
City wide AC charging infrastructure	1	2	2	1	3	3	26,9
Rail Link	2	3	3	2	1	3	26,6
Green blocks	1	2	3	2	2	3	26,6
Digital Ticketing System	1	3	2	3	2	2	25,9
Introducing Commuter Rail Services	1	3	2	1	2	3	25,9
Safe bike lanes	1	1	3	2	3	2	24,6

Mobility Hubs at bus stations	1	2	3	2	2	2	23,6
Upgrading the Fleet	1	2	3	2	2	2	23,6
Park and Ride station	1	2	3	2	1	3	23,6
Revival of abandoned stations	1	2	2	2	1	3	22,4
Public car sharing scheme	1	1	3	2	1	2	18,6

Annex 6 - Photos

Photo 1. Kick-off event in CCML

Photo 2. Fraunhofer team with the former Commissioner of Coimbatore Dr. K. Vijayakarthikeyan

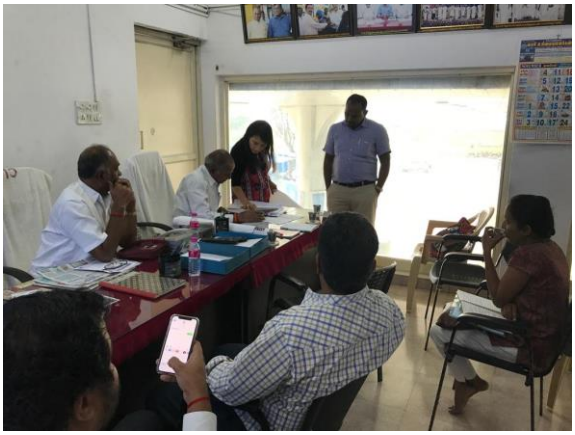


Photo 3. Interview during onsite

Photo 4. Bus stop in Coimbatore

Photo 5. Assessment of major transport roads in Coimbatore

Photo 6. Bus terminal in Coimbatore

Photo 7. Interview Jayem Automotives

Photo 8. Site visit to one of the lakes

Photo 9. Innovation Workshop, 28.11.2018

Photo 10. Innovation Workshop, 28.11.201

Photo 11. Project voting during the Innovation Workshop, 28.11.2018

Photo 12. Project shopping- Innovation Workshop, 28.11.2018

Photo 13. Final event in Coimbatore, 03.04.19

Photo 14. . Final event in Coimbatore, 03.04.19

Photo 15. Final event in Coimbatore, 03.04.19

Photo 16. . Final event in Coimbatore, 03.04.19

Photo 17. Final event in Coimbatore, 03.04.19

Photo 18. Final event in Coimbatore, 03.04.19

References

1. Atlas of Urban Expansion (2016): Coimbatore. Available online: http://www.atlasofurbanexpansion.org/cities/view/Coimbatore, last checked on 22.01.2019.
2. Babu, Gireesh (2018): Alibaba Group-backed bicycle-sharing company Ofo closes India operations. In: *Business Standard*, 2018. Available online: https://www.business-standard.com/article/companies/alibaba-group-backed-bicycle-sharing-company-ofo-closes-india-operations-118071100062_1.html, last checked on 15.11.2018.
3. Betz, Joachim (2007): Land und Bevölkerung. Bundeszentrale für politische Bildung, bpb. Online verfügbar unter http://www.bpb.de/9292/land-und-bevoelkerung, last checked on 25.04.2018.
4. BMZ (2018): Situation und Zusammenarbeit. Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung, BMZ. Online verfügbar unter http://www.bmz.de/de/laender_regionen/asien/indien/zusammenarbeit/index.html, last updated on 21.02.2018, last checked on 25.04.2018.
5. Coimbatore City Municipal Corporation (2017): Preparation of DPR for the proposed integrated bus terminus at Vellalore, Coimbatore (1), last checked on 13.11.2018.
6. Coimbatore District Profil (2016), last checked on 11.04.2018.
7. Coimbatore Municipal Corporation: Citizen's Charter, S. 1–47, last checked on 11.04.2018.
8. Finanzen.net GmbH (2018): Indische Rupie in Euro Währungsrechner. finanzen.net GmbH. Available Online: https://www.finanzen.net/waehrungsrechner/indische-rupie_euro, last checked on 26.09.2018.
9. GIZ (2018): Indien. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. Available Online: https://www.giz.de/de/weltweit/368.html, last updated on 27.03.2018, last checked on 27.03.2018.
10. Gokul (2015): Coimbatore Report - City Development Plan - Vokume 1, last checked on 30.11.2018.
11. Google Maps (2019): Bus terminals of Coimbatore. Online supplemented by the author. Available online: https://www.google.com/maps/d/edit?hl=de&mid=1_FT985nd0zD9khbu1TkPaSXOGrikbUm9&ll=11.009575325669825%2C76.98936555449222&z=14, last checked on 30.02.2019.
12. Gupta, Shivanshu; Huddar, Neeraj; Iyer, Balaji; Möller, Timo (2018): The future of mobility in India's passenger-vehicle market. Hg. v. McKinsey & Company. Available online: https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/the-future-of-mobility-in-indias-passenger-vehicle-market, last checked on 15.11.2018.
13. ICRA Management Consulting Service Limited (2015): Comprehensive Mobility Plan for Coimbatore Local Planning Area, last checked on 11.04.2018.
14. ICRA Management Consulting Service Limited (2015): Comprehensive Mobility Plan for Coimbatore Local Planning Area, last checked on 11.04.2018.
15. ITDP (2013): Sustainable Cities through Transport, last checked on 04.12.2018.
16. ITDP (2013): Sustainable Cities through Transport, last checked on 04.12.2018.

17. ITDP (2015): Coimbatore Rapid Mass rapid transit feasibility study (DRAFT). Available online: https://www.itdp.in/wp-content/uploads/2014/10/Coimbatore-BRT-PFS-150609.pdf, last checked on 30.01.2019.
18. KfW (2018): KfW weltweit: Die Förderung der Entwicklungs- und Schwellenländer. Kreditanstalt für Wiederaufbau -Entwicklungsbank. Online verfügbar unter https://www.kfw.de/KfW-Konzern/Über-die-KfW/Auftrag/Entwicklungsfinanzierung/, last updated on 25.04.2018, last checked on 25.04.2018.
19. Krishnaveni, J. (2017): Kovai Kulangal Padukappa Amaippu, last checked on 04.12.2018.
20. Kühlken, Heide (2016): Projektinformation. Kreditanstalt für Wiederaufbau - Entwicklungsbank. Available online: https://www.kfw-entwicklungsbank.de/PDF/Entwicklungsfinanzierung/LÃ¤nder-und-Programme/Asien/Indien_TamilNadu_DE_Aug2016.pdf, last checked on 25.04.2018.
21. Liehr, Stefan (2018): Smart Water Future India - First propals for - Indo - german cooperation on water management in Coimabtore. Traide; Drees&Sommer; Insititut fpr sozial-ökologische Forschung; Fraunhoger IGB, 2018, last checked on 30.11.2018.
22. Madhavan, Ananad (2015): City-wide Concept Plan for Coimbatore. Available online: https://payment.ccmc.gov.in/DwnldForms/SMARTCITY/SMART_CITY/f.%20Report%20on%20City%20wide%20Concept%20Plan.pdf, last checked on 19.04.2018.
23. McKinsey & Company (2017): The future of mobility in India: Challenges & opportunities for the auto component industry.
24. Ministry of Urban Development (2016a): Handbook of urban statistics. Hg. v. Government of India. Available online: http://mohua.gov.in/pdf/5853c4c9864675832b25ba492dhandbook%20of%20urban%20statistics.pdf.
25. Ministry of Urban Development (2016b): India Smart City Profile Coimbatore. Government of India. Available online: http://smartcities.gov.in/upload/uploadfiles/files/TamilNadu_Coimbatore.pdf, last checked on 22.01.2019.
26. Mohr, Marius (2018): Smart Water Future India – Motivation and objectives. Fraunhofer IGB. Coimbatore, 2018.
27. Nagl, Anna (Hg.) (2011): Der Businessplan. Dordrecht: Springer.
28. NIUA (2015): India Smart City Mission. Annexure 1. Available online: http://smartcities.gov.in/upload/uploadfiles/files/CMBAnnexures.pdf, last checked on 27.09.2018.
29. Pooja Kiran (2018): Travel around Coimbatore in Rentals by Ola. Available online: https://blog.olacabs.com/travel-around-coimbatore-in-rentals-by-ola/.
30. Pradeep, Jeena (2015): Comprehensive Mobility Plan for Coimbatore Local Planning Area. Final Report. Hg. v. Tamil Nadu Urban Infrastructure Financial Services Limited und ICRA Management Consulting Services Limited, last checked on 17.04.2018.
31. Statista (2017): Europäische Union - Bevölkerungsdichte bis 2017 | Statistik. Available online: https://de.statista.com/statistik/daten/studie/248947/umfrage/bevoelkerungsdichte-in-der-europaeischen-union-eu/, last checked on 31.08.2018.

32. Statista (2018): Indien - Bevölkerungsdichte bis 2017 | Statistik. Available online: https://de.statista.com/statistik/daten/studie/170734/umfrage/bevoelkerungsdichte-in-indien/, last checked on 31.08.2018.
33. The Hindu (2018): Rainwater harvesting structures raise groundwater table. In: *The Hindu* 2018, 2018. Available online: https://www.thehindu.com/news/cities/Coimbatore/rainwater-harvesting-structures-raise-groundwater-table/article22832404.ece, last checked on 15.11.2018.
34. The Hindu (2019): Public can now post traffic violations on 'Police E-Eye' app. In: *The Hindu*, 2019. Available online: https://www.thehindu.com/news/cities/Coimbatore/public-can-now-post-traffic-violations-on-police-e-eye-app/article25937465.ece, last checked on 10.01.2019.
35. The Times of India (2018a): Fatal accidents have come down in rural Coimbatore but not city. In: *The Times of India* 2018, 2018. Available online: https://timesofindia.indiatimes.com/city/coimbatore/fatal-accidents-have-come-down-in-rural-coimbatore-but-not-city/articleshow/62320028.cms, last checked on 30.01.2019.
36. The Times of India (2018b): Ofo cycles go off the road, may come back with nominal fee. In: *The Times of India*, 2018. Available online: https://timesofindia.indiatimes.com/city/coimbatore/ofo-cycles-go-off-the-road-may-come-back-with-nominal-fee/articleshow/64486166.cms, last checked on 15.11.2018.
37. TTK Maps (2015): City map of Coimbatore. Available online: https://www.mapsofindia.com/maps/tamilnadu/coimbatore.htm, last checked on 13.11.2018.
38. Weskamp, Alyssa (2018): Smart Water Future India - Prelimanry result of city analys city. Fraunhofer IGB. Coimbatore, 2018.
39. Zoomcar India Private Ltd (2017): Zoomcar [Official Website]. Available online: https://www.zoomcar.com/coimbatore/.

Fraunhofer Institute for
Industrial Engineering IAO
Nobelstrase 12
70569 Stuttgart
www.iao.fraunhofer.de

Marielisa Padilla
Phone: +49 711 970-160
marielisa.padilla@iao.fraunhofer.de