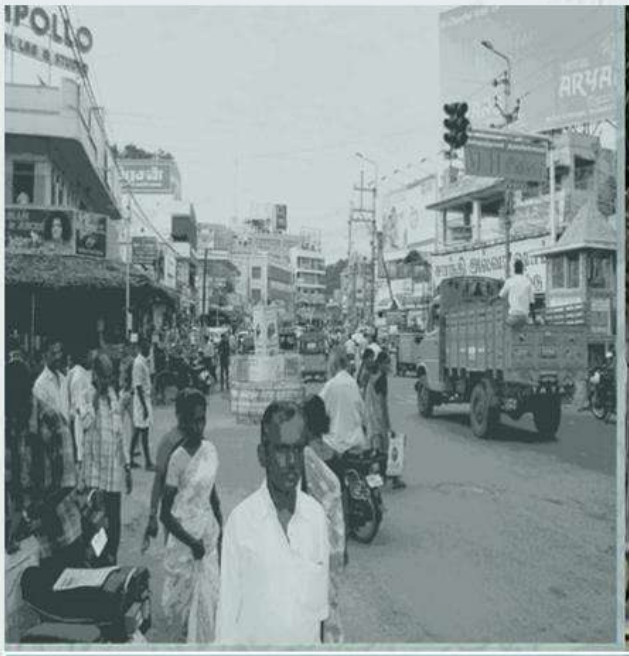
COMPREHENSIVE MOBILITY PLAN

TIRUNELVELI - LOCAL PLANNING AREA

FINAL REPORT VOLUME 1 (Part A) – CMP Main Report



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ABBREVIATIONS

CMP	Comprehensive Mobility Plan
CPKM	Cost Per Km
DPR	Detailed Project Report
ELCOT	Electronics Corporation of Tamil Nadu
EPKM	Earning Per Km
GAD	General Arrangement Drawings
GIS	Geographical Information System
GoI	Government of India
GoTN	Government Of Tamil Nadu
IL & FS	Infrastructure Leasing and Financial Services
IPT	Integrated Public Transport
IT/ITES	Information Technology and Information Technology Enabled Services
ITS	Intelligent Transport System
JnNURM	Jawaharlal Nehru Urban Renewal Mission
kmph	Kilometers per hour
MLCP	Multi-Level Car Parking
MLTP	Multi-Level Two Wheeler Parking
MoHUA	Ministry of Housing and Urban Affairs
MRTS	Mass Rapid Transit System
NA	Number of Accidents
NH	National Highway
NMT	Non-Motorized Transport
NPI	Number of People Injured
NPK	Number of People Killed
PBS	Public Bike Sharing Schemes
PT	Public Transport
SEZ	Special Economic Zone
SH	State Highway
SPV	Slow Moving Vehicle
TNUIFSL	Tamil Nadu Urban Infrastructure Financial Services
TSRTC	Tamil Nadu State Road Transport Corporation
UMTC	Urban Mass Transit Company
URDPFI	Urban and Regional Development Plans Formulation and Implementation

EXECUTIVE SUMMARY

BACKGROUND

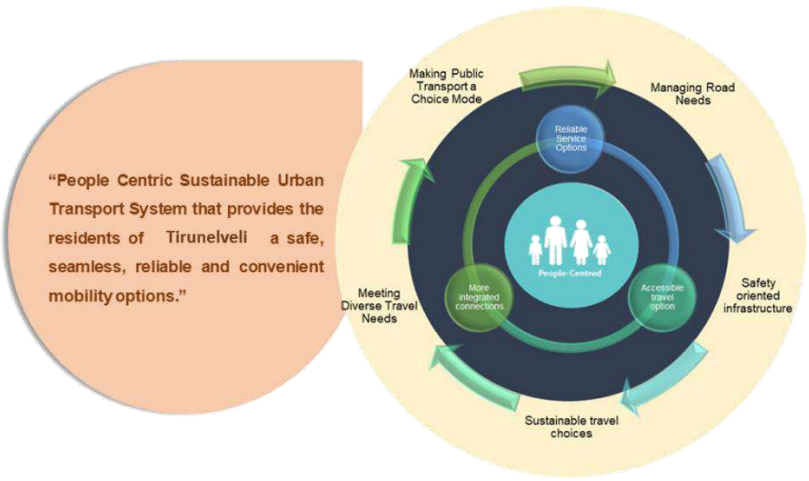
Tirunelveli city, has seen a growth in population, increased urban sprawl, vehicle ownership, traffic volume and economy far greater than what was thought likely and it is fair, proper and reasonable to anticipate the concomitant transport problems such as congestion, pollution and environmental hazards. To solve the traffic and transportation issues, it is proposed to conduct a comprehensive transportation study to prepare long-term urban transport strategy for an improvement of people's mobility and to identify specific proposals for upgradation of transport infrastructure / facilities to ease the congestion level. The study is designed to provide the broad parameters for the long term development of transport infrastructure setting objectives for the next two decades.

In this context, **Tamil Nadu Urban Infrastructure Financial Services Limited (TNUIFSL)** has awarded the study of preparing the Comprehensive Mobility Plan (CMP) to **Urban Mass Transit Company Limited (UMTC)**. Transport proposals will be developed by integrating land use and transport and the Study shall come out with a plan for the safe and sustainable mobility needs of the people of Tirunelveli. This Study will develop a perspective plan for sustainable urban transport over a 20-year horizon period.

STUDY OBJECTIVES

The objective of the current study is to prepare a comprehensive mobility plan for **Tirunelveli Local Planning Area for the period 2022–2042 in line with the NUTP, 2006, which focuses on the mobility of people and not vehicles** and on the need for **promoting safe pedestrian movement, bicycle movement and public transport, integration of land use and transport planning.**

The CMP provides a vision for urban transport in the city with development (both technological and planning strategy) options and investment requirements to provide a desirable level of mobility and accessibility to all sections of the citizens while focusing on minimizing carbon emissions. It relies on the 'avoid, shift and improve' framework, i.e., avoid motorized trips, where possible or give options for using shared/public transport, encourage a shift to low-carbon modes, and improve the efficiency of motorized vehicles.



Urban Mass Transit Company Limited

SCOPE OF THE STUDY

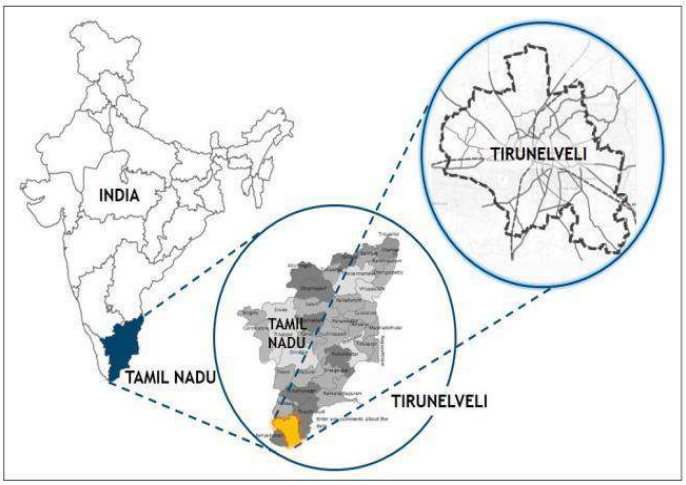
The scope of work for the study is as per the Terms of Reference (ToR) and revised toolkit for Preparing Comprehensive Mobility Plans by the MoHUA. The **detailed scope of work,** as defined as part of this study, is to:

1. DEFINE SCOPE AND STUDY AREA
2. COLLECT DATA AND ANALYSE URBAN TRANSPORT ENVIRONMENT
3. PREPARE AND EVALUATE URBAN TRANSPORT DEVELOPMENT STRATEGY
4. DEVELOP URBAN MOBILITY PLANS
5. PREPARE IMPLEMETATION PROGRAMME
6. STAKEHOLDER CONSULTATIONS

STUDY AREA PROFILE

The City of Tirunelveli is the sixth largest city (in terms of population) in Tamil Nadu located in the Tirunelveli district and functions as the administrative headquarters of the district. It is situated at a distance of 700 km south west from the State Capital Chennai. It is located in the southern-most tip of the Deccan plateau. Tirunelveli is an important junction in the National Highway No 44, connecting India from the North to South (Kashmir to Kanyakumari).

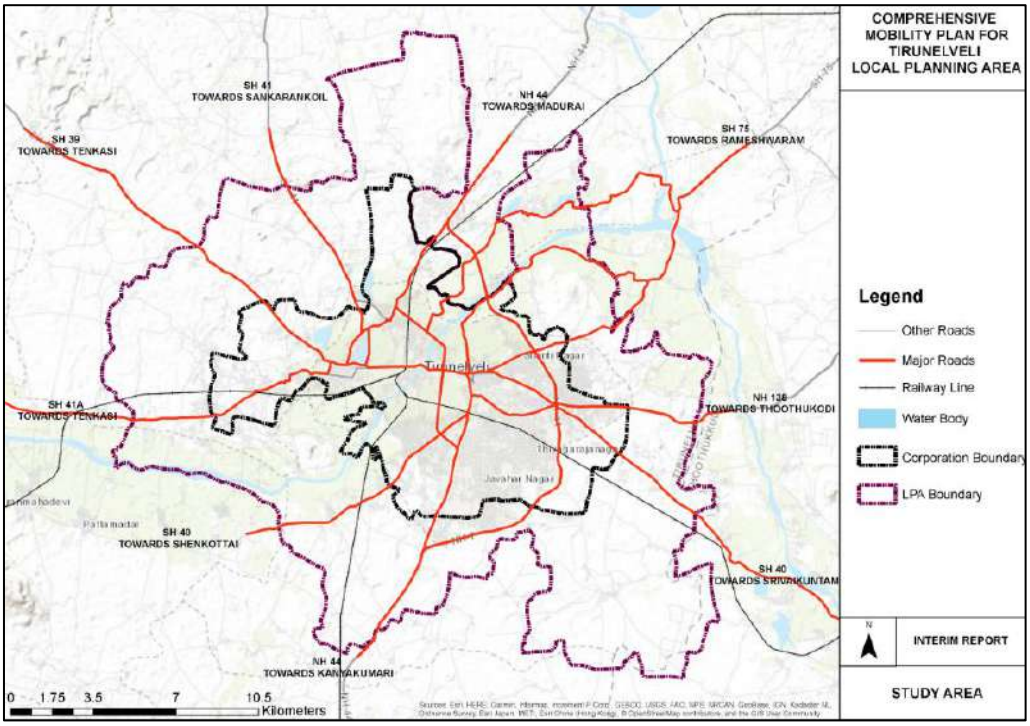
Figure 0-1 Location and Regional Setting of Tirunelveli



The present Tirunelveli Municipal Corporation Area consists of four zones namely Palayamkottai, Tirunelveli, Melapalayam, Thachenallur and 55 wards and the Local Planning area consists of 44 villages along with these wards. Thamirabarani River roughly divides the city into the Tirunelveli quarter and the Palayamkottai area. While Tirunelveli quarter remains as the culturally important focal point of the city, Palayamkottai is known as the oxford of the south India, because of the presence of a number of important educational institutions.

The Master Plan, 2021 has identified **353.78 sq. km** as the developable area. In cognizance of that, the study area considered for the current study **is the developable area identified as per Master plan, 2021.**

Figure 0-2 Study Area- Tirunelveli LPA



The current Local Planning Area of Tirunelveli constitutes the Tirunelveli Municipal Corporation consisting of 55 wards and, 44 villages falling in Palayamkottai Panchayat Union and Manur Panchayat Union.

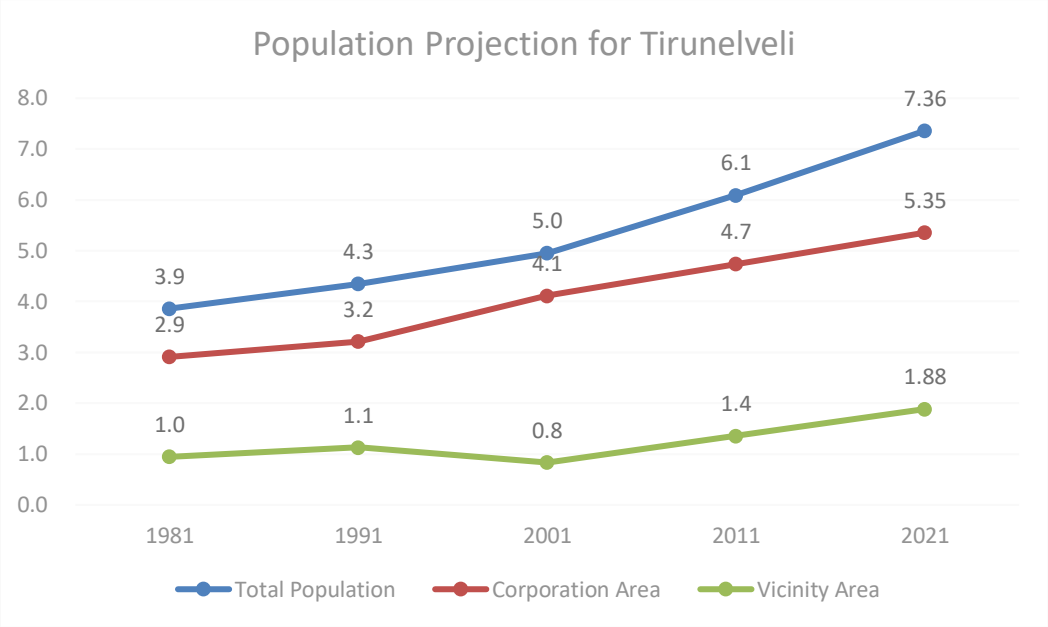
For analysis, the study area has been divided into **73 Internal Zones and 14 External Zones.**

GEOGRAPHICAL POPULATION DISTRIBUTION IN THE STUDY AREA

For the current study, **the estimated population for the considered study area for the base year (2022) is 7.3 lakhs.**

The decadal growth rate has been calculated at 18% and the population density of the study area is about 43.6 persons per hectare (ppha) for corporation area and 3.4 persons per hectare (ppha) for the vicinity area. The corporation area had registered a steep variation during the decades of 1971-1981 and 1991-2001 at 20.78% and 28.12% respectively. This may be attributed to various aspects like the formation of the Corporation and inclusion of other public and private offices and Institutions etc.

Figure 0-3 Population Growth Trend in Tirunelveli LPA



The settlement structure of Tirunelveli is common to many large South-Asian conurbations, reflecting various economic and political decisions, however Tirunelveli has a multimodal character to it as the city has also emerged around other adjacent activity nodes like Palayamkottai, Melapalayam etc. The core area, Tirunelveli town- Pettai is well developed and almost at saturation, whereas all new developments are along the major links of the city.

Therefore, unlike other cities, several chunks of saturated land parcels separated by large vacant spaces is the unique characteristics of this city. Nevertheless, city can be seen growing towards east towards the side of Srinagar Kanyakumari National Highway and Thoothukudi. (Refer Figure 0-4)

Figure 0-4 Zones in Tirunelveli corporation, Existing Vacant Spaces in the corporation and road network pattern

The industrial activity in the city developed towards the North-East along NH-44. Many technical universities have also come up in the western and southern side of the city.

ECONOMIC CHARACTERISTICS

The economic base of Tirunelveli LPA mainly constitutes of the service sector activities like administrative services (district headquarters) many educational institutions, agricultural marketing and service, tourism, banking, technical training, agro machinery repairs and educational services etc., followed by the contribution of small scale industrial activities.

A good proportion of population in Tirunelveli city are employed in the service sector. Work force participation rate in Tirunelveli was 38.5% (corporation) for the year 2011. A high percentage in the secondary sector is estimated in the upcoming years based on the influence of the Industrial growth of Thoothukudi on Tirunelveli. The Work Force participation rate is provided in Table 0-1.

Table 0-1 Worker Population, Tirunelveli LPA

S. No.	Details	Details	2001	% of total population	2011	% of total population
Corporation Area	Population		4,11,831		4,73,637	
	Work Force Participation Rate (WFPR)		37.4%		38.5%	
Vicinity Area (LPA excluding corporation limits)	Population		82,830		1,35,827	
	Work Force Participation Rate (WFPR)		54%		44%	

Workforce participation rate as computed for the study area for the year 2022 is 39.75%[1] and the working population estimated from the WFPR is about 292,268.

LAND USE

The existing master Plan for the Local Planning Area was taken up to a plan period till 2021. The existing Tirunelveli L.P.A. includes three municipalities, one town panchayat and sixty-seven revenue villages. The L.P.A. extends over an area of 35377.80 hectares[2]. (Refer Figure 0-5). About 59% of the LPA is currently under Agricultural land use under the entire LPA. The Land Area Allotted for transport and other related activity is almost nil. The Land use for the LPA area for the year 2042 is under preparation.

[1] *UMTC projections*
[2] Master Plan for 2021

Figure 0-5 Land Use Map - Tirunelveli LPA, Master Plan, 2021

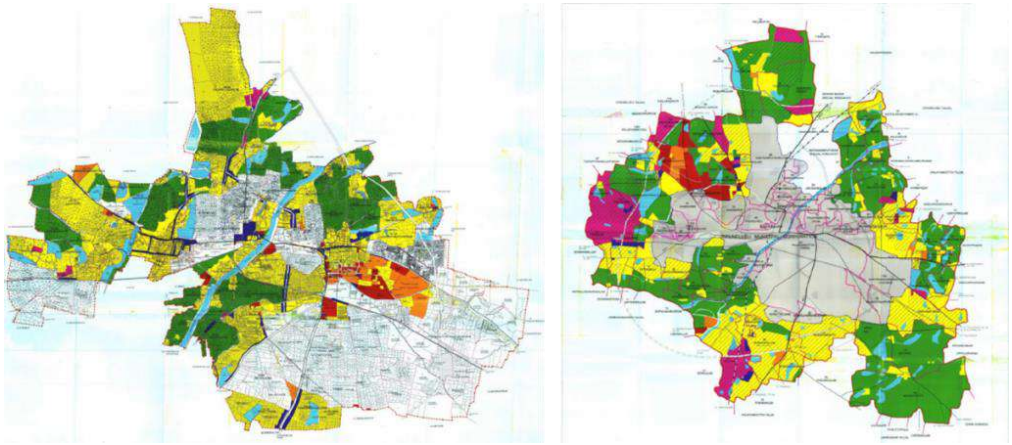
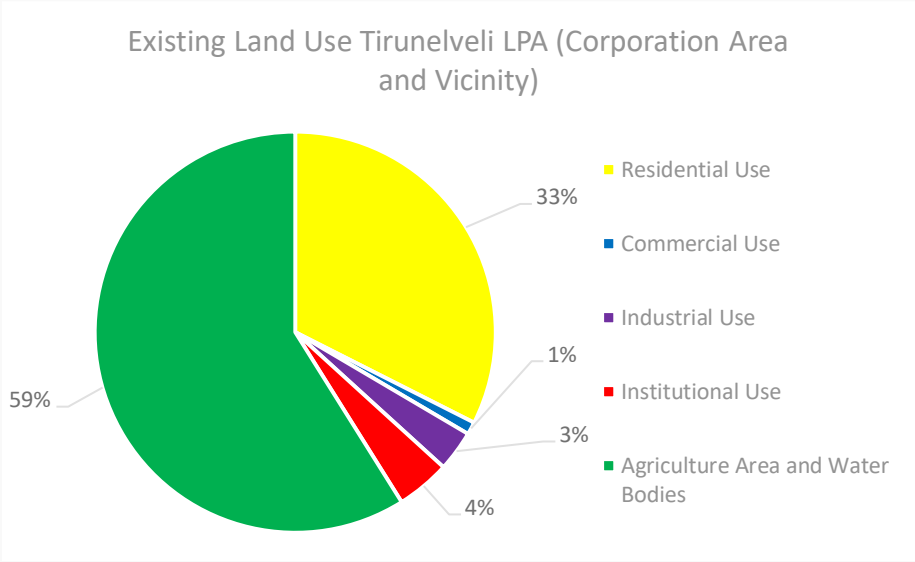


Figure 0-6 Existing Land Use- Tirunelveli LPA, Master Plan, 2021



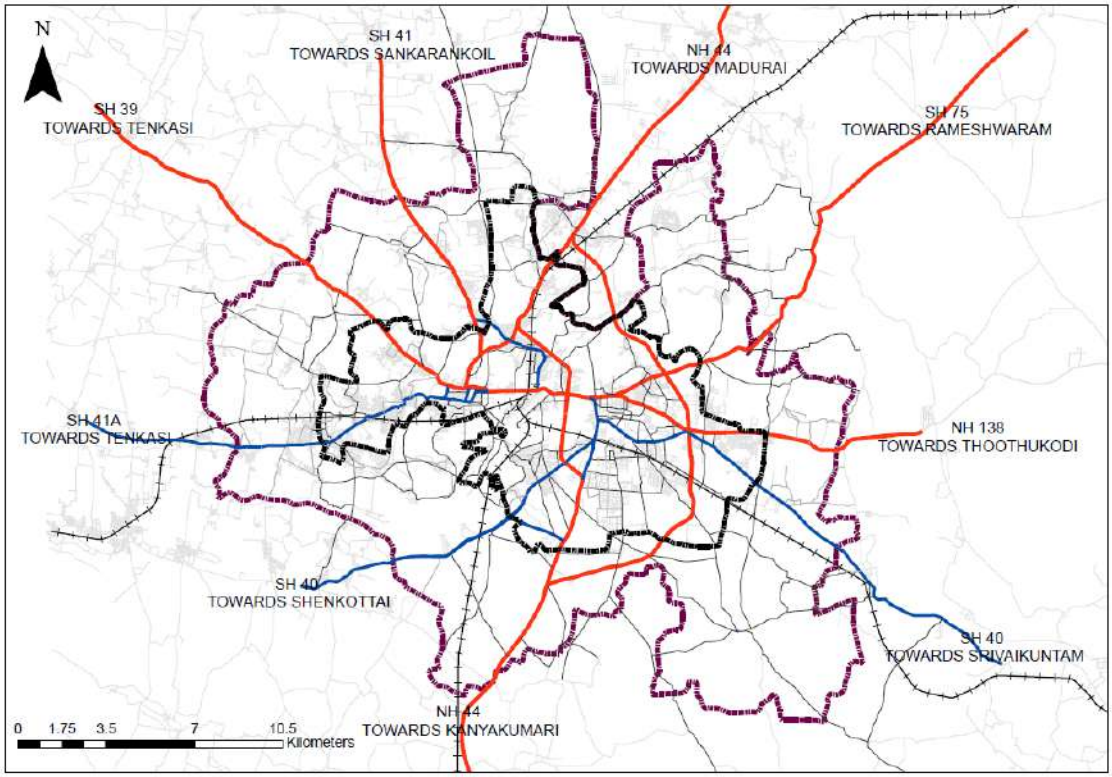
TRAFFIC AND TRANSPORTATION SYSTEM CHARACTERISTICS

Tirunelveli is well connected to its neighboring settlements via road and rail. It also lies in close proximity to Thoothukudi Port and Airport, which offers daily flights to Chennai and Bangalore. Road network in Tirunelveli with 9 radials emerging from the heart of the city provides good connectivity to all major urban canters situated around the city. Out of these, two are National Highways - NH 44 and NH 138 and six are state highways, SH 75A, SH 75, SH 41, SH 40, SH 41A and SH 39. Almost 10 railway Stations can be found in and around Tirunelveli Urban Area, out of which Tirunelveli Junction acts as the most important one. It is also an important node in the railway routes of Southern Railway, where the Tenkasi line and Tiruchendur line meet with Kanyakumari Maniachi line.

During the course of the present study, it was observed that while TNSTC caters to regional transit needs of the city as well as intra-city bus transport needs in Tirunelveli. Within the city, transit needs are also provided through intermediate public transport like private auto rickshaws. There has been a steady increase of IPT registrations in Tirunelveli over the years,

barring the recent downward trend, attributed largely to the Covid-19 pandemic. The presence of these vehicles has led to the chaotic situation on the roads.

Figure 0-7 Major Roads



EXISTING TRAFFIC & TRAVEL CHARACTERISTICS

The existing travel and transport characteristics of the study area were assessed through primary surveys to understand the trip patterns, travel demand, transport infrastructure needs, mobility issues and to develop Travel Demand Model. The data pertaining to the origin, destination, mode choice, socio-economic characteristics, cost, distance and user preference were also collected in order to understand traffic and travel characteristics within the study area. The major traffic characteristics of the Study area, as analyzed, are as given below:

Road Network Inventory

In Tirunelveli, 99 km of the roads are arterial roads, 58 km sub- arterial and 377 km of collector roads. Out of the surveyed network of roads, about 30% of the roads have RoW lesser than 12 m followed by 29% having RoW of 12-18 m. 70% of the city's road network does not possess footpaths. Proper road marking was not seen in 60% of the roads.

Terminal surveys

Terminal Surveys were carried out at railway station and bus terminals in the city and the following was observed:

- **Railway Station:** Close to 10,000 passengers were using the Tirunelveli Junction station for their trips, with about 1,061 passengers traveling during the peak hour.

Approximately 24% of the commuters boarding and alighting at the railway station were travelling for religious purpose followed by 16 % work trips and the most preferred motorized access as & egress mode at the terminal is the two wheeler with 32%.

- **Bus Terminals:** Passenger count was carried out at all major bus terminals at Tirunelveli. The survey data shows that the Vannarpettai caters to about 30334 passengers per day, while New MGR bus stand caters to 22140 passengers per day. The most preferred access and egress modes at the all the terminals were city bus and walk.

IPT Survey

- The IPT demand in the city is being catered to primarily by auto rickshaws, and shared and hired auto-rickshaws.
- About 60% are self-owned vehicles while 12.4% are rented.
- About 10 to 15 trips are made by the IPT operators per day
- Safety issues related to Public Transport was the major reason conveyed by the IPT users for not using Public Transport services.

Classified Volume Count

Outer Cordon

- Outer Cordon volume counts were carried out at 9 cordon locations. The daily traffic (24hr) at the cordon locations ranges from 4,000 vehicles to 20,000 vehicles. Major flow observed on NH 44 destined towards Nagercoil & Kanyakumari. 23,473 PCU per day traffic observed near Pandarakulam Essaki Amman Temple, which is a gateway to Tirunelveli for vehicles coming from the North. 76% of traffic consists of passenger vehicles. Least Volume of traffic was observed near Vaivesapuram check post. The average daily traffic entering the city is 6843 and the average daily traffic leaving the city is 6722.
  The general peak period for Outer Cordon locations in Tirunelveli is observed to be between 8:00 hours and 10:00 hours in the morning and 17:00-19:00 in the evening for the traffic moving in and out of Tirunelveli.

Screen Line

- Screen line volume counts were carried out at 7 locations, with the maximum traffic being observed on the Kokkirakulam Bridge. The maximum peak hour volume is observed between 09:15 am and 10:15 am. **Private and IPT vehicles account for 72% and 5%** while **NMT vehicles** in city is around **2% and Public Transport vehicles is 2%.** 1% share of public transport is attributed to the inter-city bus services operated by TNSTC and private operators

Mid-Block

- Mid-block volume counts were carried out at 7 locations, All the six mid-block locations show less variation throughout the day. As most of these mid-block locations are around heavily congested junctions in the city, traffic flow is moderate

to high throughout the day. Maximum peak hour volume is observed on South Bypass Road at MB 4 between 18:00 and 19:00, followed by MB 3 (SH 39).

Turning Movement Count at Junctions

- Chellapandyan Flyover Junction, Reliance Petrol Pump Junction, Tirunelveli Old Bus Stand Road Junction and GIC Chowk carry more than 85,000 vehicles (80,000 PCUs) per day and more than 7,000 vehicles during peak hour. Town Arch Junction, Veerapandiya Kattabomman Statue Junction and Trivandrum Road-South By Pass Road Junction serve more than 60,000 vehicles every day.
- On average, the composition of private vehicles on all these junctions ranges from 77% to 87%.

Origin – Destination Survey

Outer Cordon

- The highest vehicular flow share is external to external flow at 53%, followed by external to internal flow at 24%. About 20% of the total flow is Internal to external flow. Almost 48% of the trips were observed to be daily trips. While these daily trips can be broadly attributed to the institutional nature of the city. Other trip frequencies with a substantial share include occasional and weekly trips.
- Work trips account for 39%, followed by 16% of other trips. 14% of Social Trips and 12% of Shopping trips, which make up the larger share of the total trips.
- On analyzing the commodity types in goods vehicles, highest (32%) were vegetables/commodities, followed by sand bricks and cement

Screen Line

- The highest vehicular flow share is external to external flow at 39%, followed by 14% external to internal flow, and 13% internal to external flow. Internal to internal or local traffic constitute 7% of the total flow. Almost 61% of the trips were observed to be daily trips including one-way, twice and more. About 29% are weekly and 7% are occasional trips.
- Work trips account for 36%, followed by other trips at 17% and social trips at 12%. Religious / Recreational trips and educational trips accounted for 10% of the total share.

Speed and Delay

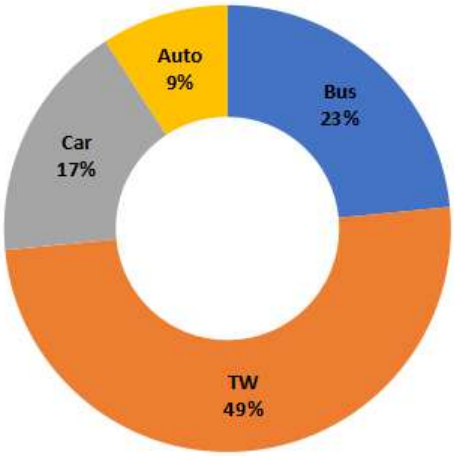
In Tirunelveli it is observed from the analysis that average journey speed in the city is 27.5 kmph and average running speed is 33.3 kmph. The journey speed was observed to be in a range between 15 kmph and 22 kmph towards Tirunelveli Town (east) and between 22 kmph and 27 kmph towards Palayamkottai (west). The major reason of delay was the Row constrains in the network and bottle neck.

Household Survey

- The survey was carried out with a sample size of 2% of the total population, distributed within the study area.

- **Household size:** The average household size of Tirunelveli as per the household interview survey is 3.9
- **Household income:** The average monthly household income in the study area is Rs 16,768.
- **Trip Rate:** The trip rate with walk trips is 1.24 and without walk trips, it is 1.11.
- **Mode Share:** Two-wheelers account for 49% of the total trips, followed by Public Transport Trips vehicles (23%) and cars (17%). Walk trips account for 11% of the mode share.

Figure 0-8: Mode Share in Tirunelveli based on House Hold Survey



Parking Inventory Survey

On-street parking surveys were conducted near all major commercial establishments and activity nodes for a total road stretch of 2.56 km. Highest total parking accumulation was found in Car Street, Palayamkottai market & Vannarpettai Junction with the total accumulation ranging from 3032 to 1532. Tirunelveli new Smart City Bus Stand parking exhibits its peak during the day between 16:00 pm and 17:00 pm and the Palayamkottai New Bus Stand sees the peak between 9:00 am and 10:00 am but has a continuous parking demand throughout the day.

TRAVEL DEMAND FORECAST – DEMAND ASSESSMENT MODELLING

To ensure that mobility solutions for Tirunelveli are integrated to be people centric and are in conformity with sustainable mobility, the following goals have been targeted for the horizon year 2042:

Each zone within the study area has different socio-economic patterns, administration boundaries, and a different set of travel needs and transport infrastructure. To facilitate independent demand-supply analysis and planning for each of these zones, the study area has been divided into Traffic Analysis Zones (TAZs). For analysis, the study area has been divided into **73 Internal Zones and 14 External Zones.**

Household and roadside passenger interview data were used to develop the observed mode wise trip matrices. The external trips for cars, two wheelers, auto rickshaws, public transport and commercial vehicles were constructed based on the O-D survey conducted at the outer cordons. The model was built for peak hour, then it was validated across cordons and screen lines within a confidence range of +/-10%. For the current study, four horizon year scenarios were developed based on the future development directions and required transport network considering the various transportation improvements. The scenarios developed as part of the study are follows:

- **Scenario 1:** Business as Usual (BAU, Demographic Changes) Scenario
- **Scenario 2:** Do- Something Scenario (BAU + Committed Projects)
- **Scenario 3:** Sustainable Urban Transport Scenario (BAU + Committed Proposals + Proposed Projects + Transit-Oriented Development)

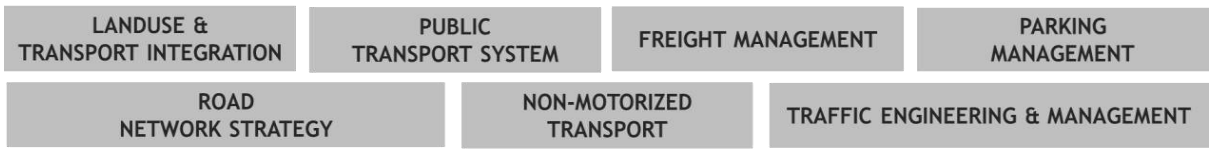
On assessing the impacts on transport and travel characteristics, Sustainable Urban Transport (SUT) scenarios were developed in line with the CMP vision and objectives. The development of the scenarios included socio – economic (land use transitions, population and employment) projections. Table 0-2 below shows a comparative statement of model output across the various scenarios discussed above. It is proposed that to improve the overall mobility of the city and at the same time reduce the transport related emissions, the city adopts Scenario 3, i.e. the Sustainable Urban Transport Scenario.

Table 0-2: Comparative statement of model output across the various scenarios

Mode	2032 BAU	2042 BAU	2032 Do something	2042 Do something	2032 SUTP	2042 SUTP
Two-Wheeler	46.91%	49.57%	43.21%	47.51%	29.53%	27.69%
Car	17.85%	18.86%	16.40%	18.04%	11.20%	10.49%
Auto-Rickshaw	8.88%	9.42%	8.08%	8.93%	5.48%	5.12%
PT	14.35%	12.83%	13.43%	12.16%	35.10%	37.24%
Cycle	2.48%	1.82%	2.22%	1.70%	3.13%	3.11%
Walk	9.53%	7.50%	16.66%	11.66%	15.57%	16.35%

MOBILITY STRATEGIES FOR TIRUNELVELI

In order to achieve the objectives of the Comprehensive Mobility Plan for Tirunelveli, a multipronged approach consisting of the various strategies, as given below, have been envisaged. It is important to note that each of the identified strategies is equally important and the order of listing does not imply priority. Each of the broad strategies includes sub-strategies, which are elaborated in the following sections:



Land use & Transport Integration

To achieve a balanced "Integrated land use and transport development", it is proposed that the city of Tirunelveli may be developed on the lines of ***Hybrid Development***. This model is proposed in Tirunelveli due to the following reasons:

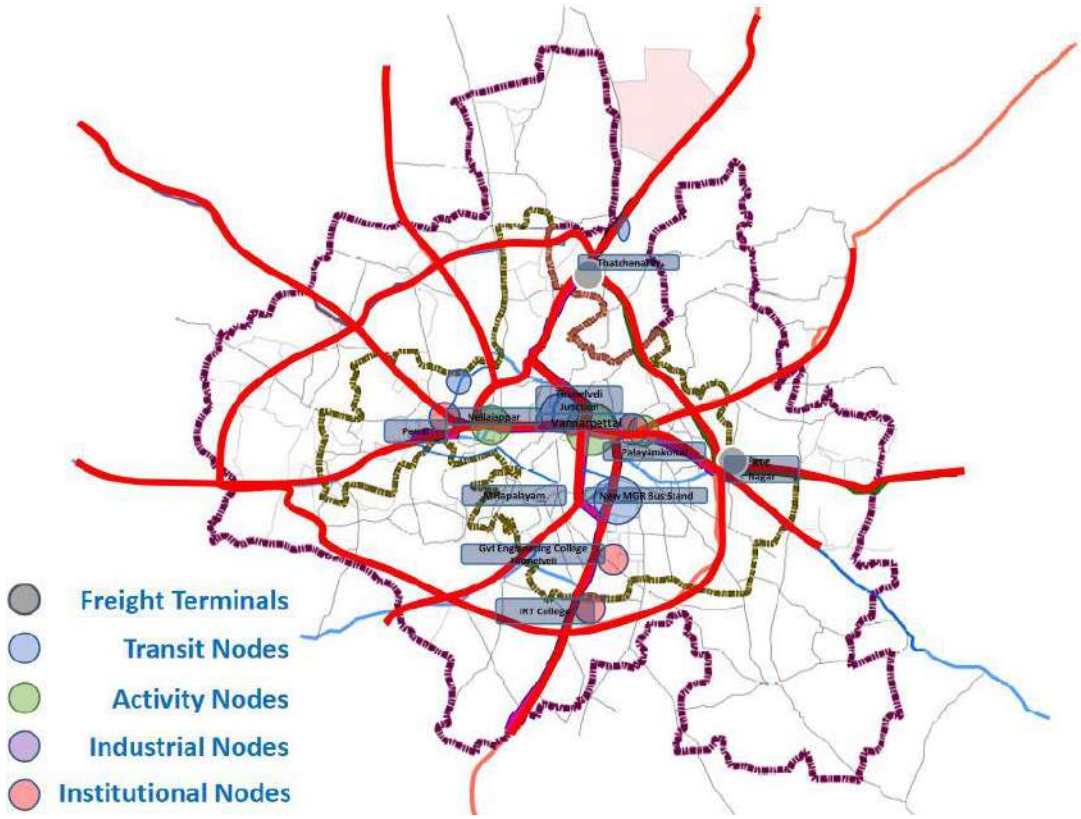
(i) Major activity area currently is focused in core areas (CBD) with mixed land use along roads.
(ii) In order to enhance and promote the high NMT mode share of the city and to retain the lower average trip length of the city;
(iii) To promote and provide a conducive environment for mixed-use development in the city.

To integrate transport and land use in Tirunelveli, the following are being proposed (refer to Figure 0-9)

(a) Develop each of the upcoming development areas as activity nodes.
(b) Identify and develop urban mobility corridors to connect the nodes.

(c) Promote high density/mixed use development along major hubs, national highways and bypasses to encourage short trips.
(d) Propose corridors for High Density Development

Figure 0-9: Proposed Hybrid City Development



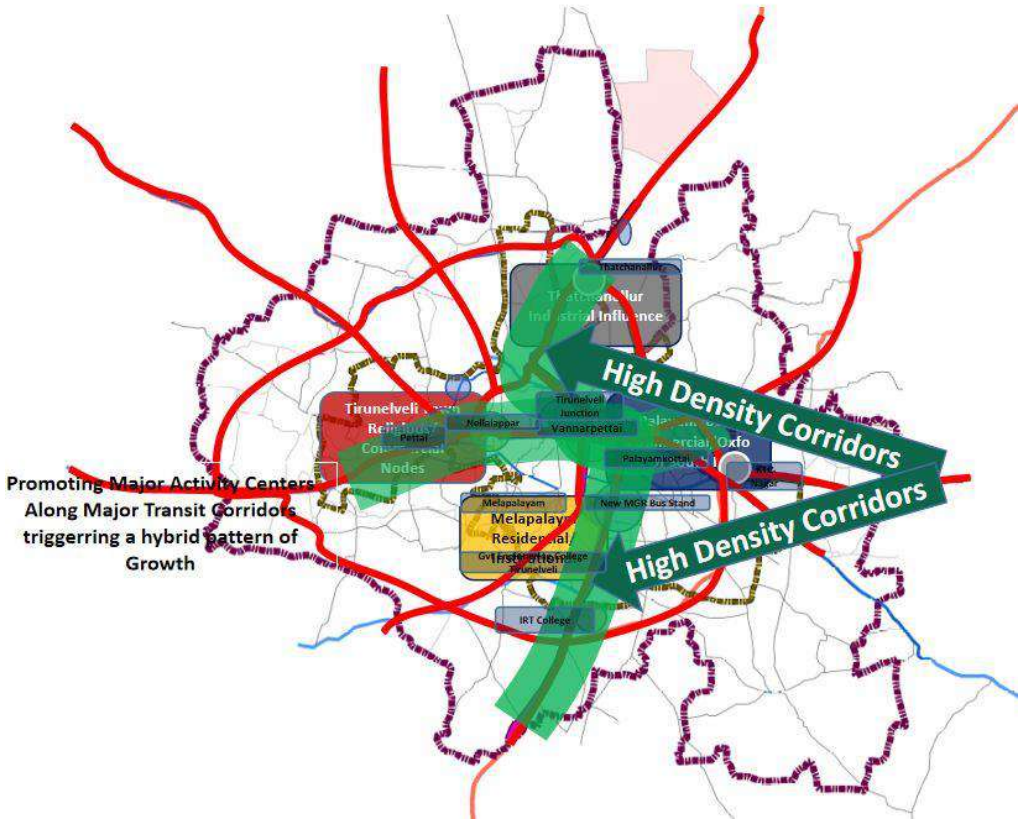
High Density Mixed Land Use

Thus. **High Density Mixed Land Use** zones are proposed to be developed which are as follows:

1. Tirunelveli town to Palayamkottai (East To West)
2. Palayamkottai to IRT Polytechnic College via Trivandrum Road.
3. Shankarnagar to New MGR Bus Stand Via Bypass

Future developments are expected along the cardinal directions of the study area, as mentioned above, especially the north- south corridor which has a lot of vacant land with development potential. The above proposed mixed use zones will, thus, aid this development to improve the accessibility of the region. The maximum permitted FSI in urban bodies of Tamil Nadu is 2 (without considering premium FSI). For the purpose of encouraging High Density Development, the mobility plan recommends an FSI up to 3 in all the influence areas of the high mass transit corridor.

Figure 0-10: Proposed Corridors for High-density Development



Road Network Strategy

Road improvement proposals are required to be developed such that they cater to all types of road users and help in decongesting the junctions, improving the PT speeds and safer NMT movements. The proposals of improving road network include:

- Development of network of roads
- Road widening
- River Bridge & Flyover Proposals

Development of network of roads

A total of 42 km of the additional road network is proposed for the city which includes, 33 km of roads proposed under Highways and 9.6 km proposed to complete the missing links and to attain the ring radial hierarchy for the city.

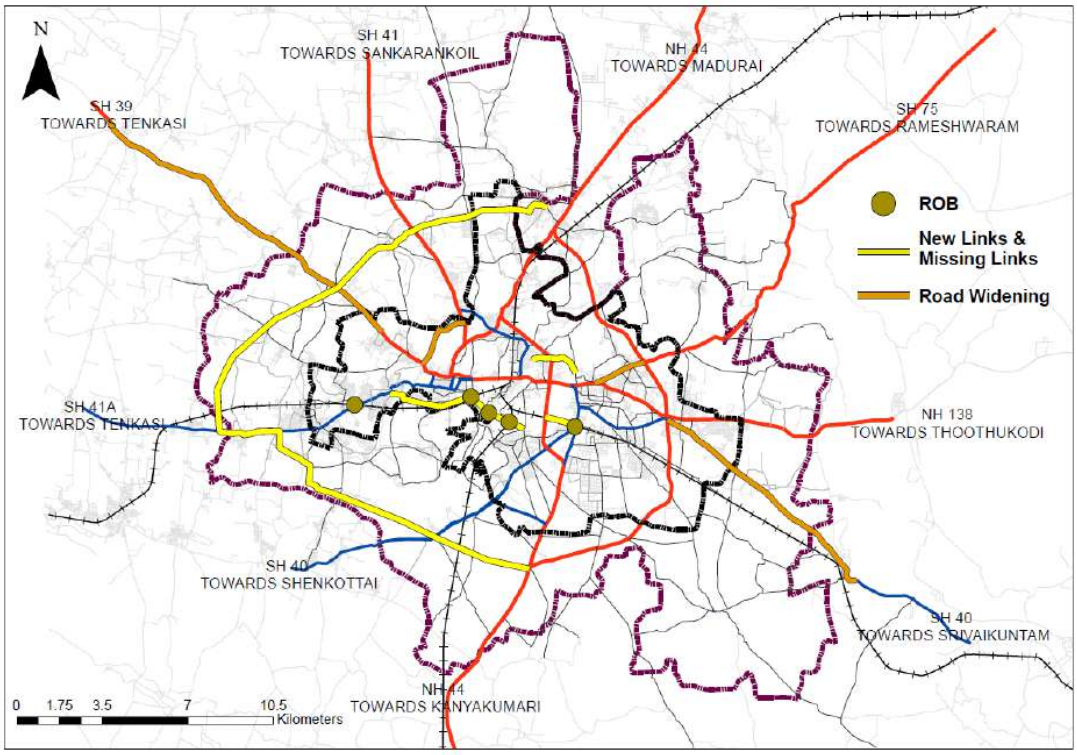
In addition to this, 5 river/rail over bridges have also been proposed for the city to complete the network.

Attributing the emerging industrial character in the vicinity of the city, and the heavy flow of freight traffic in the city, 22 km of the outer ring road- fright corridor is also proposed for the horizon year 2042.

Road Widening

A total of **30 km roads** have been proposed for **widening/upgrading in the Tirunelveli study area.**

Figure 0-11: Development of the Network of Roads



Public Transport Strategy

The following proposals are identified in this regard:

1) Replacement of the bus fleet.
2) Creation of supporting transport infrastructure
3) Dedicated high demand public transport corridor
4) Guidelines for organizing IPT System

Phased Expansion of City Bus Fleet

The city currently has a fleet of 587 buses (147 private buses and 440 TNSTC city buses) for a population of 14,64,422; which as per the urban fleet specification of 50 buses per lakh population falls short by 145 buses.
The CMP proposes a phased fleet expansion to estimate the fleet requirement to meet the horizon period population. The fleet requirement is given in the table below.

Table 0-3 Fleet Requirement for Horizon Years

SUTP	Population	Fleet	Replacement (10% of the Existing Fleet)	Additional Fleet Required (replacement surplus buses required based on population growth)
2022	735285	391	0	0
2027	792477	396	40	46
2032	849668	425	42	71
2042	964051	482	48	105

Creation of Supporting Infrastructure

For the new routes proposed, bus stops have been proposed at every 500 m interval to improve the accessibility for the commuters and, thus, encourage more public to use the bus service. It has also been observed that many of the bus stops in the city are located very close to the intersections which is not ideal for traffic flows. It is hence proposed to shift all such bus stops at least 100 m away from the intersection. Though the city corporation has renovated 60 bus stops within the corporation limits as a part of smart city, the CMP also proposes to provide additional bus stops to improve accessibility.

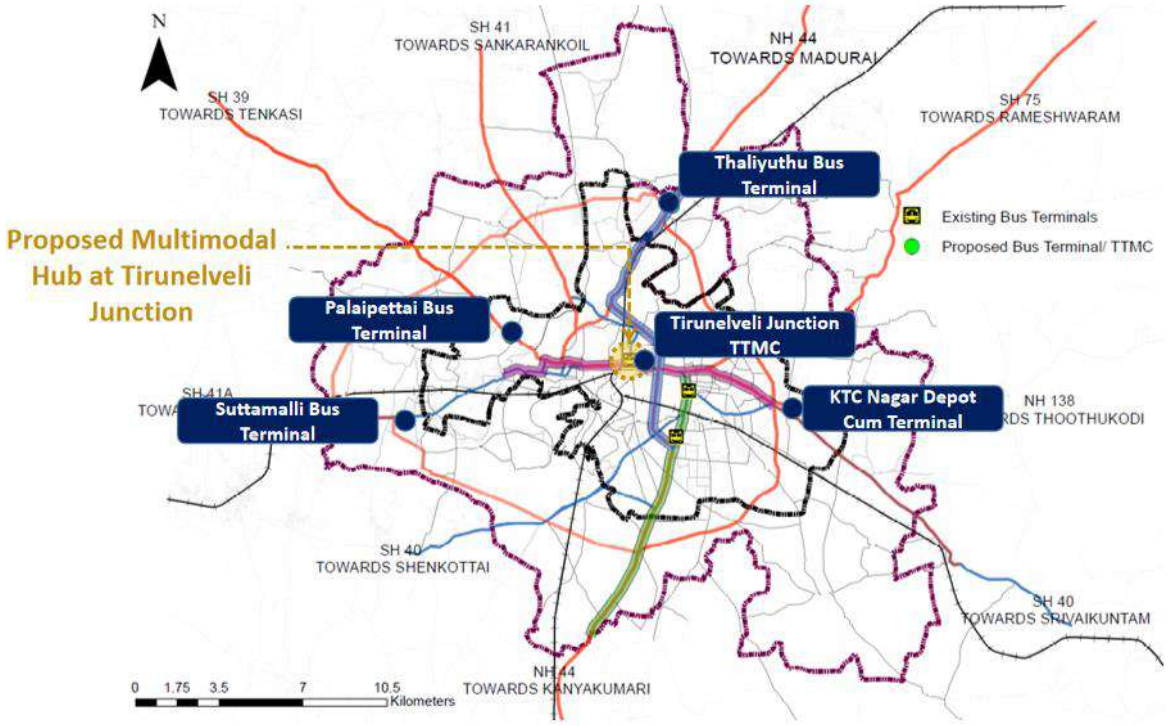
Table 0-4 Estimated number of Bus Stops required in Tirunelveli LPA

Existing Number of Bus Stops in Corporation Area	90
Number of Bus Shelters Required in the LPA area (both sides of the road)	470

Proposed Depots & Terminals

- **Periya Bus Stand should be redeveloped as a multi modal hub.**
- **Four proposed Regional Bus Terminals** should also serve as the depot/terminals for the city buses and regional transport service buses.

Figure 0-12: Locations of Supporting Transport Infrastructure



Urban Mass Transit Company Limited

Dedicated High Demand Public Transit Corridor

It is envisaged that buses will continue to be the major mode of public transport in Tirunelveli, and keeping in mind the increase in population and future growth of the city, **High Demand Public Transit Corridors have been identified for the study area covering a span of 39 km.**

Figure 0-13 Proposed High Demand Corridor

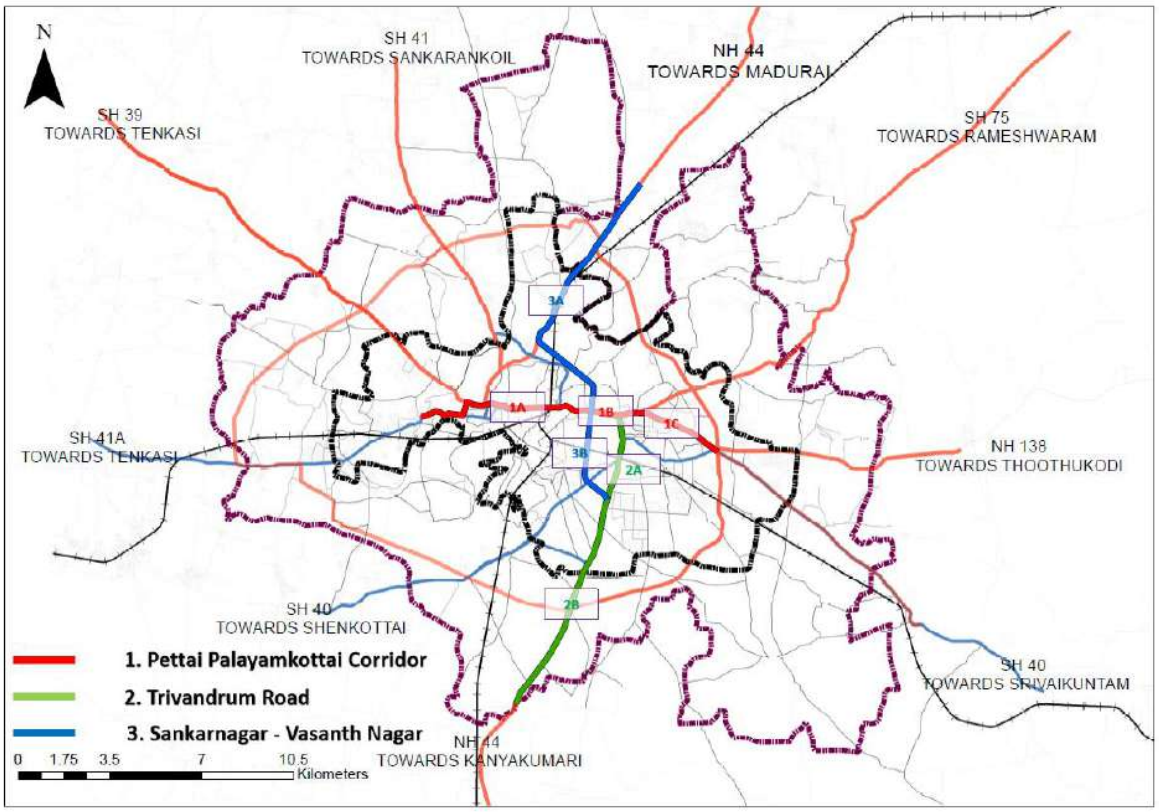


Table 0-5 Proposed High demand Mass Transit Corridors.

S No	Proposed High Demand Mass Transit Corridors		Length in km
1	Line 1	SN High Road (Pettai to Palayamkottai)	12.4
2	Line 2	Trivandrum Road (Murugankurichi to Punnakudi)	12
3	Line 3	Bypass (Sankarnagar to Vasanth Nagar)	14.6

A rule of thumb comparing different mass transit systems and their selection criteria at a macroscopic level is shown in the table given below. On the basis of this broader criteria for system selection, a bus based or rail based, light capacity mass transit system could perhaps be an ideal mass transit system on the identified mobility corridors in Tirunelveli. However, at this point of time, no particular system can be called out. The Alternative Analysis Study will evaluate dozens of parameters and recommend/name the most preferable transit system on the identified corridors.

Non-Motorized Transport Strategy

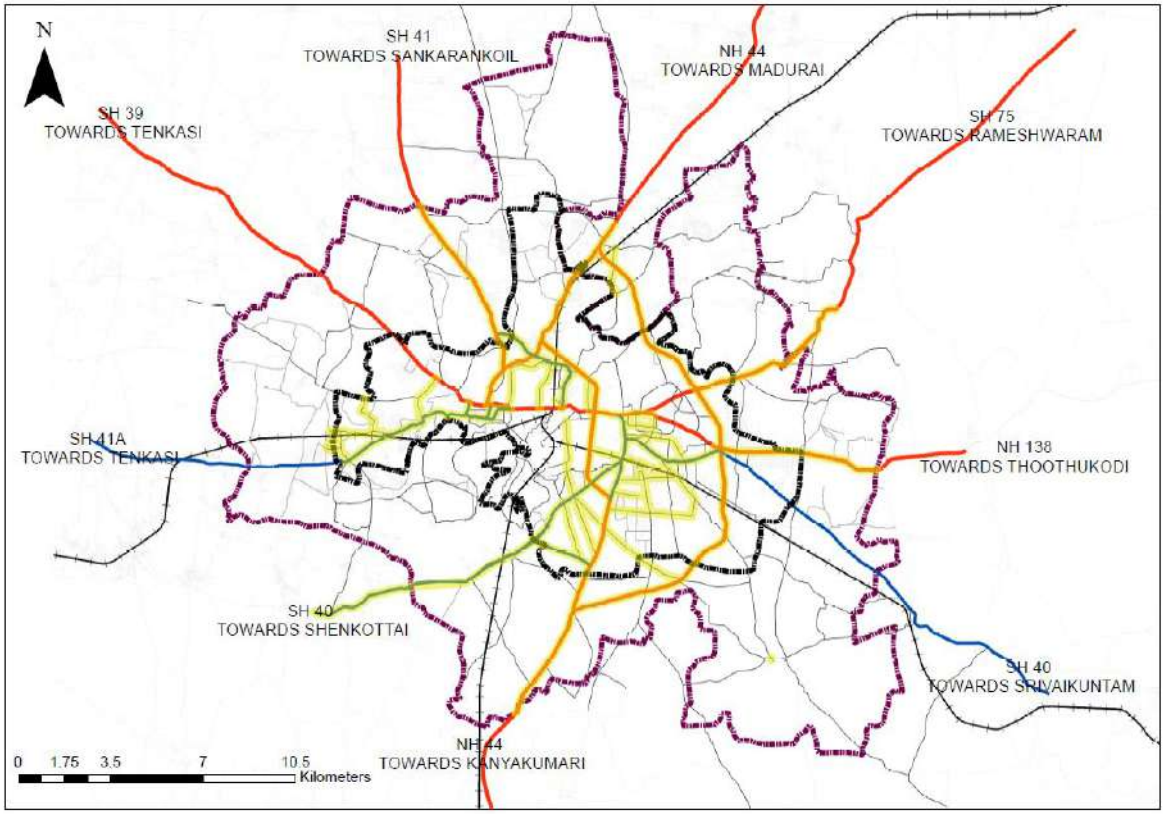
In Tirunelveli, currently, the city lacks adequate pedestrian infrastructure with a complete absence of cycle tracks. Some of the intersections are devoid of safe pedestrian and NMT crossings, which have an adverse impact on the safety of pedestrians. Keeping this in mind, the following NMT proposals are devised for Tirunelveli under this CMP:

- Development of footpath facilities
- Pedestrian friendly links
- Development of cycle track facilities

Footpath Network Development

As part of short-term measures, it is proposed to develop about 150 km of footpaths across the city. The proposal is as given in Figure 0-14.

Figure 0-14 Proposed Footpath



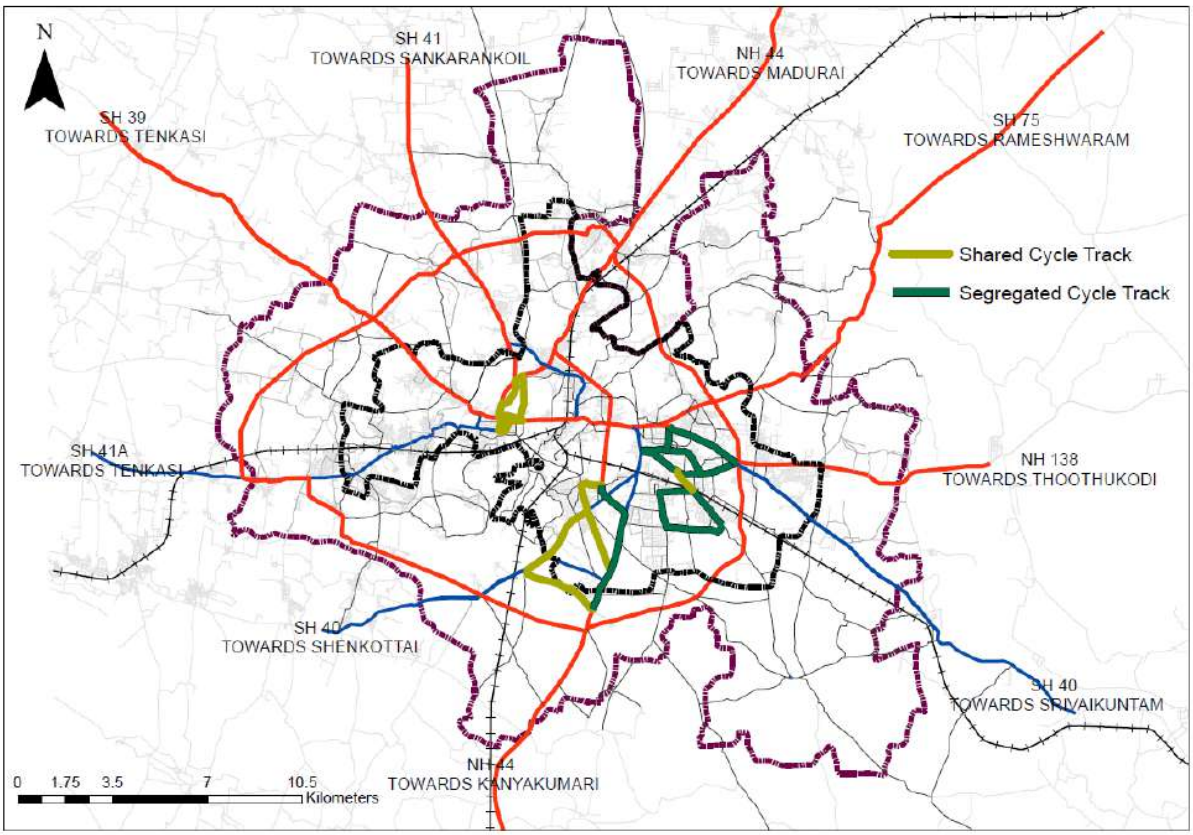
Development of Cycle Friendly Infrastructure

It is, thus, proposed to have a total of 40 km of cycle track network comprising dedicated and shared tracks, details of which can be seen in Figure 0-15.

1. **Shared cycle lanes** – 19 km of shared cycle tracks of which 7.8 km in the second phase and 10.5 km in the third phase

2. **Dedicated cycle tracks** – 21 km of segregated cycle tracks of which 18 km in the first phase covering areas other than the city core and 3 km in the second phase.[3]

Figure 0-15 Proposed cycle network



All Weatherproof Road

TM Road which is the link between Tirunelveli Junction railway station and Tirunelveli Junction bus stand (presently under construction) is another major link which needs to be considered for the pedestrian network improvement. The 120 m stretch of street is currently encroached with on street parking and shops jutting into the footpath.

Area Improvement Plans

Area Improvement Plan for Core City

Traffic issues in some of the areas in Tirunelveli are critical and require a mix of traffic proposals given above. These areas have been categorized under area specific traffic management proposals, and the selected areas are as follows:

- Car Street (Core City, Nellaiappar temple Complex)
- Vannarpettai Junction

[3] *In addition, all new major roads shall have the provision for dedicated cycle tracks and foot paths, subject to the availability of land*

- Roti Kadai Mukku

1. Improvement of existing cross-sections

- Reclaiming encroached spaces
- Marked and designated lanes
- Well-defined pedestrian walkways
- Speed Reduction Measures

2. Pedestrian-Friendly roads

3. Traffic Rerouting

4. Parking Facilities

5. Freight Management

Figure 0-16 Car Street Area Based Management Proposal

Freight Management Strategy

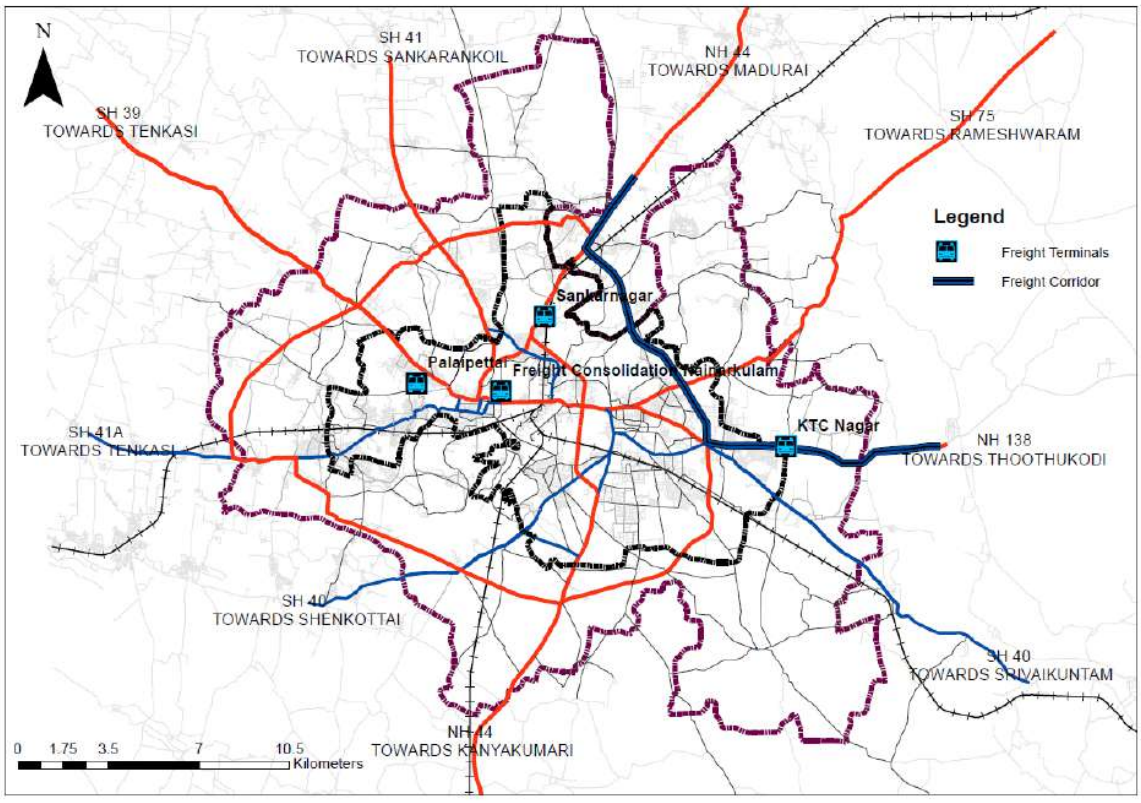
To ensure that the Tirunelveli road network allows **efficient and reliable handling and distribution of goods vehicles**, **minimize the impact of congestion** while strengthening the location advantage of the city under the freight management strategy, freight policy, truck terminals, and freight corridor are proposed in accordance with various other studies.

(i) Truck Terminal has been developed along Palai Pettai Link Road as a part of Smart city, to which the existing truck parking along the Tank Bund Road will be shifted soon,

(ii) The CMP also proposes freight consolidation centre in the market near Nainarkulam.

(iii) A freight corridor has been proposed along the link connecting Gangaikondan SIPCOT with Tuticorin Port, which currently experiences heavy freight traffic.

Figure 0-17 Existing and Proposed Freight Facilities



Traffic Management Strategy

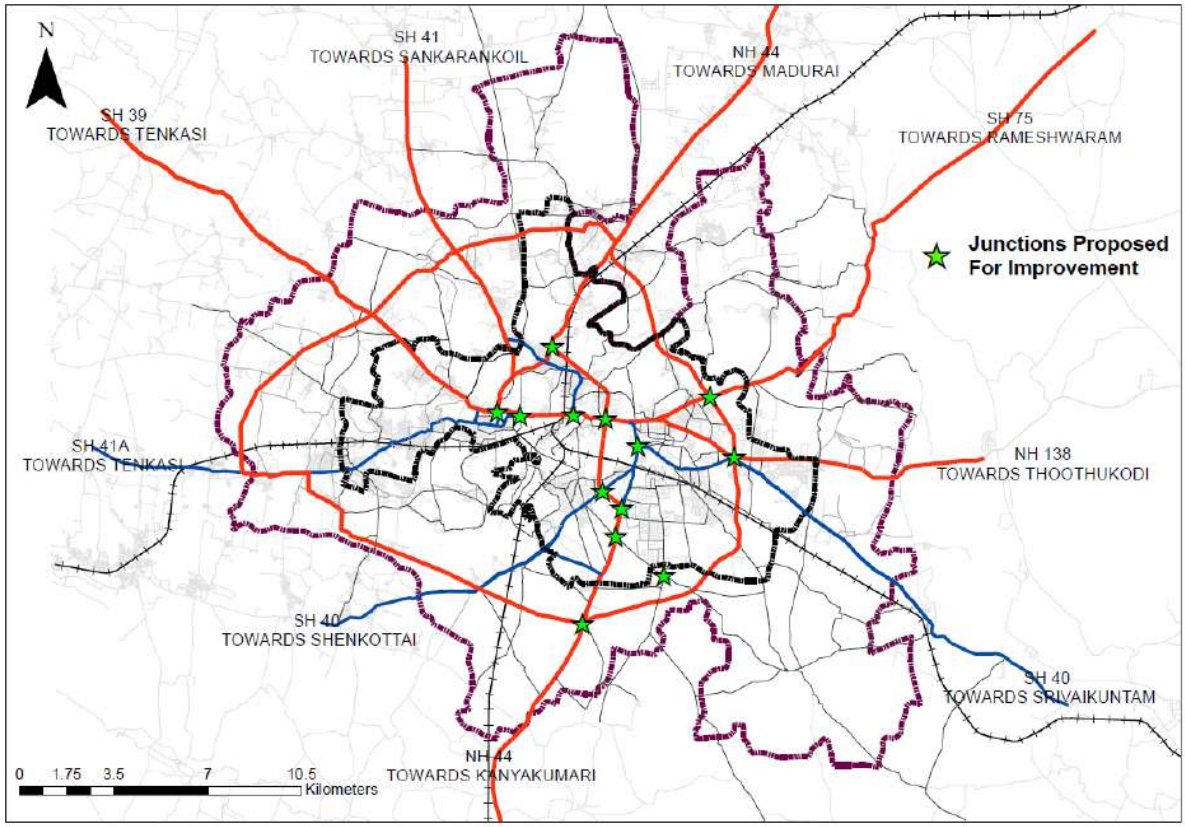
In Tirunelveli, the CMP proposes, a total of 13 junctions have been identified for junction improvement[4] as shown in Table 0-6 & Figure 0-18.

[4] *Further, it is suggested that all junctions on new roads or road being widened to be developed as per IRC guidelines or urban road codes*

Table 0-6 Short-term Junction Improvement

S.No.	Junction Locations
1	Vannarpettai Junction
2	Town Arch Junction
3	Katta Bomman Statue- SN High Road Junction
4	Reliance Junction
5	Tenkasi- Tirunelveli- Sankarankoil- Tirunelveli Road (S. Street) Junction
6	Trivandrum Road South Bypass Road Junction
7	Thachenellur Junction
8	V C Chatram Junction on NH-44
9	Palai Bus Stand Junction
10	Reddiyarpatti Junction
11	Govt College of Engineering Junction
12	IRT Polytechnic College Junction

Figure 0-18: Junctions Identified for Junction Improvement



As a part of the CMP SN High Road was selected for the corridor improvement proposal which involved measures like geometric corrections and beautification. Based on the high traffic numbers at the important junctions, 5 junctions have been identified for smart signals, all of which have been proposed for Phase I. The list of junctions identified for smart signals in the future years is given below.

Table 0-7 Smart Signal Locations

S.No.	Junction Locations
1	**Town Arch Junction**
2	**Vanarpettai Junction**
3	**RailwayStation Road- Irattai Paalam Junction**
4	**NH 44 Thrirchendur Road Junction**
5	**South Bypass Road Tivandrum Road Junction**

Parking Management Strategy

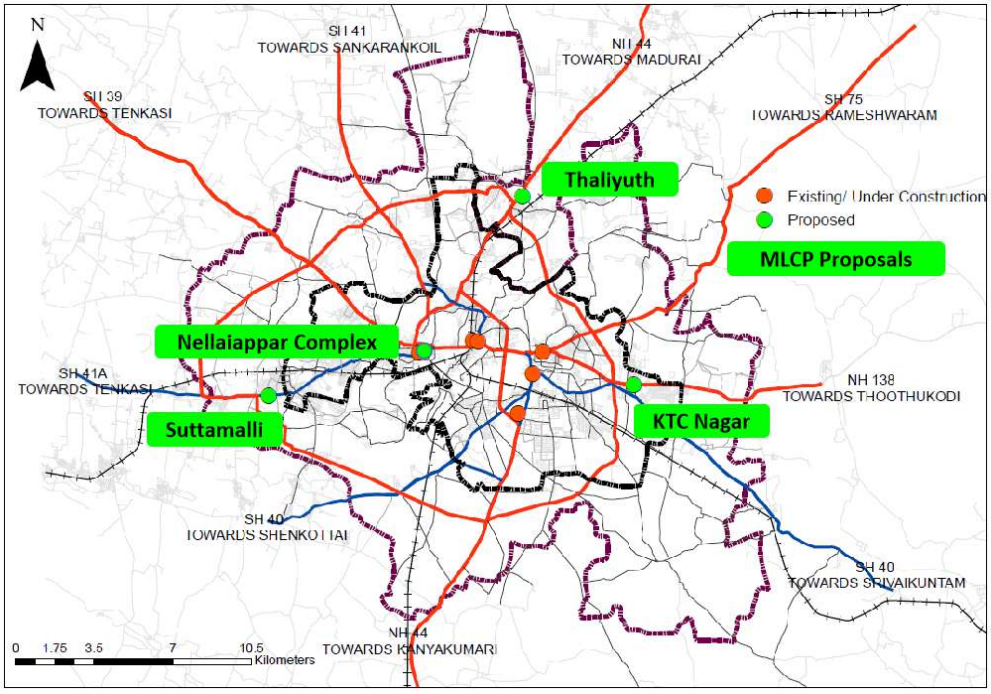
From the parking survey, it was observed that all the major roads of the city have high on-street parking. The maximum parking was observed near the Tirunelveli Junction Railway Station and new MGR bus stand.

Based on the parking demand assessed for the horizon year 2042, the following on-street and off-street parking locations are proposed for the city:

- On-street parking management is proposed on all major links in the city especially along: High Ground Road, Trivandrum Road
- Off Street parking is proposed at Suttamalli, Thalayoothu, KTC Nagar and near Nellaiappar Complex.

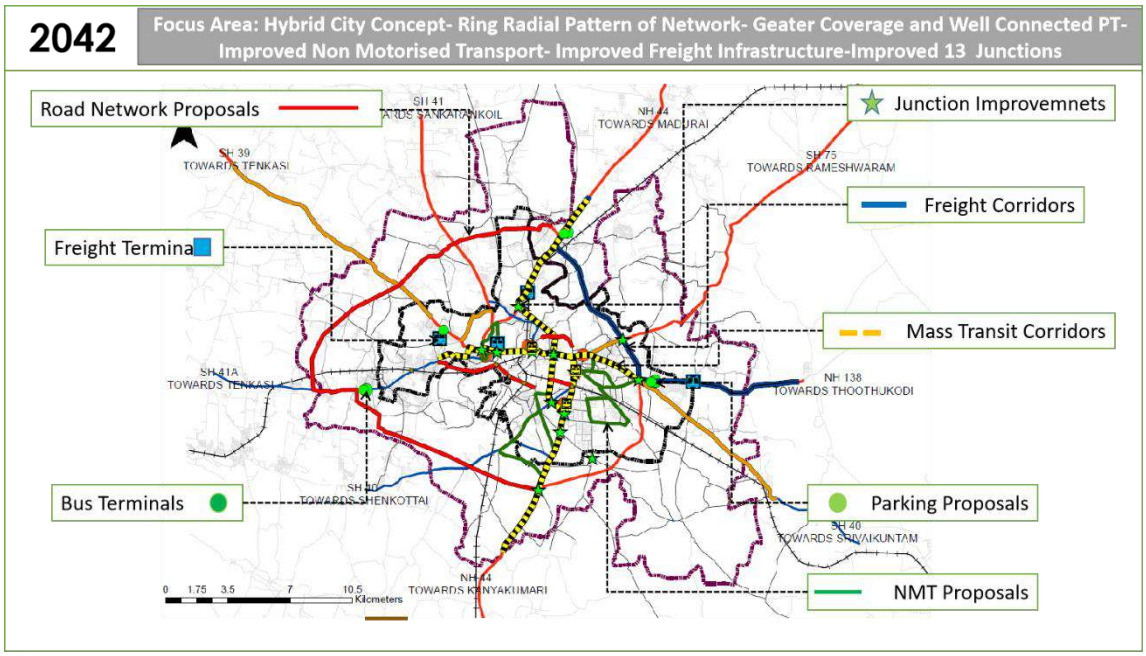
Also, for the effective utilization of the proposed parking spaces, measures like smart parking, parking pricing and enforcement are also proposed.

Figure 0-19 Proposed Off Street Parking Locations



The summary of all the proposals are given in Figure 0-20.

Figure 0-20: Summary of all proposals identified for Tirunelveli



ENVIRONMENTAL AND SOCIAL FRAMEWORK

A Rapid Assessment of the environmental and social framework of the proposed projects was carried out the projects were categorized and analyzed based on the potential impacts they shall have on the social and environmental setting on the study area, it has been summarized in the following table. The projects have been categorized in to E1, E2 and E3 (based on severe to low environmental impact) and S1, S2 and S3(based on severe to low social impact)

Table 0-8: Project Categorization Based on the Environmental and Social Impacts

Strategy	Proposal	as per ESMF		WB -ESF	
		Environmental Category	Social category	Environmental Risk	Social Risk
Land Use & Urban Transport Strategy	TOD Policy	E-1	S1	HR/SR	HR/SR
Road Network Strategy	Ring Road-Western Bypass	E-1	S2	HR/SR	SR/MR
	Missing Link	E-1	S1/S2	HR/SR	HR/SR
	Widening	E-1	S2	HR/SR	MR
	River/Rail Bridge	E-1	S1	HR/SR	HR/SR
Public Transport	Fleet Replacement	E-3	S3	LR	LR
	Bus Shelters	E-3	S3	LR	LR
	Bus Terminal/ Depot	E-2	S2/S3	MR	MR/LR
	Mass Transit System	E-3	S1/S2	LR	HR/SR
NMT Strategy	Footpath Proposal	E-3	S1	LR	HR/SR
	Pedestrian Crossing Infrastructure	E-3	S3	LR	LR

	Bicycle Tracks	E-3	S3	LR	LR
	Pedestrian Priority Streets/ All-weather walkway	E-3	S3	LR	LR
Freight Management Strategy	Freight Terminals	E-2	S2	MR	MR
	Freight Consolidation Center	E-2	S2	MR	MR
Traffic Management Strategy	Junction Improvement	E-3	S2	LR	MR
	Corridor Improvement	E-3	S2	LR	MR
	Smart Signals	E-3	S3	LR	LR
	Road Pavement Marking	E-3	S3	LR	LR
	Signage	E-3	S3	LR	LR
Parking Management Strategy	Off Street Parking Locations	E-2	S3	MR	LR
Note: H = High Risk, SR=Substantial Risk, MR= Moderate Risk, LR=Low Risk					

INSTITUTIONAL FRAMEWORK

To ensure sustainable urban mobility, it is imperative to ensure efficient coordination with all agencies, delineate clear jurisdiction and remove ambiguity on roles and responsibilities of various institutions. Tirunelveli is no exception to the above-mentioned problem in existing legal and institutional arrangement that persists in almost all Indian cities.

Planning and provision of sustainable urban mobility in Moradabad therefore would depend on effective coordination among these institutions and developing a “win-win” strategy for all stakeholders, which is quite an onerous task. Establishment of a supportive institutional environment will therefore hold the key. This can be facilitated through an umbrella level organization with regulatory powers to carry out planning, monitoring, funding, implementation, and coordination tasks. The National Urban Transport Policy (NUTP), 2006 has provided for setting up of Unified Metropolitan Transport Authority (UMTA) to serve this purpose.

The proposed institutional mechanism for setting up the UMTA in Tirunelveli may be any one of the following three:

- UMTA as a separate statutory authority; or
- Any State Appointed Agency undertaking transport related activities as UMTA at the state level; or
- UMTA is accountable to the municipal level of government

As per the National Urban Transport Policy (NUTP-2006), representation of agencies involved in the preparation of land use and transportation plan is required in UMTA. This body should also be staffed with transport experts and other experts. The main responsibility of UMTA shall be to plan and design mobility planning and management schemes. It will also coordinate with other agencies involved in urban transport infrastructure and its operation.

IMPLEMENTATION PLAN

The mobility plan components discussed in the previous sections were considered in the estimation of block cost (FY2022) estimate for implementing the elements in the future. The approximate capital cost, excluding land acquisition, for implementing the mobility plan is about Rs. 3443 crores. Mass Transit Project constitutes a major proportion of the total cost, followed by the road network improvement project.

The projects are phased into short-term, medium term and long term projects based on their impact and capital.

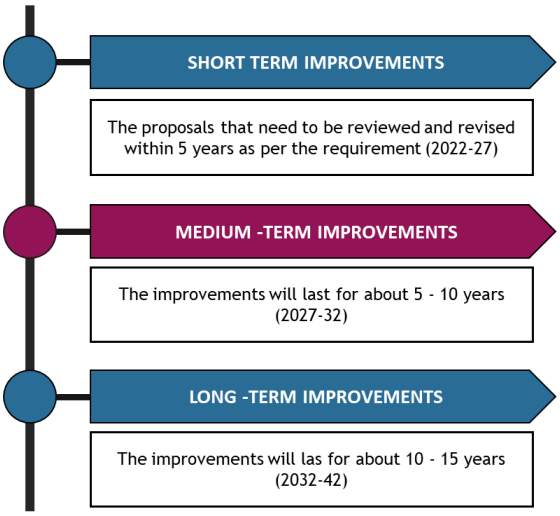


Table 0-9: Block Cost Summary

STRATEGY	Road Network Plan	Public Transport Plan	NMT Plan	Freight Management Plan	Traffic Eng. & Management	Parking Management Measures	Total
Immediate to short term 2022-2027	205.21	161	108	0	22	0.4	497
Medium term 2027-2032	274	754	4	5	0	2.2	1040
Long Term 2032-2042	114	1776	0	16	0	1.1	1907
Total Cost (in Rs. Crores)	593	2692	112	21	22	4	3443

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1. INTRODUCTION

1.1. BACKGROUND

Urbanization is one of the most glaring realities of the 21st Century. The 2011 Census of India has shown that urbanization in India is gaining momentum, where every third person is living in urban areas and this is expected to increase to 58% by 2050. The number of million-plus cities is presently at 42 and the urban economy accounts for roughly 60% of the GDP[5]. City efficiency largely depends upon the effectiveness of its transport systems, i.e., the efficacy with which people and goods are moved throughout the city. During the last decade, a rapid increase in population resulted in urban sprawl and heavy demand on urban transport infrastructure. Burgeoning cities need sustainable mobility systems now, and the opportunity to build infrastructure should not be at odds with the opportunity to guarantee continued prosperity. To ensure mobility for all, cities need to develop a comprehensive urban transport strategy that offers easy access to jobs, education, healthcare, and other necessities. Therefore, a long-term strategic plan focused on the mobility of people rather than vehicles, in line with the objectives of the National Urban Transport Policy (NUTP), should be prepared by all cities.

1.2 NEED FOR THE STUDY

Tirunelveli city, has seen a growth in population, increased urban sprawl, vehicle ownership, traffic volume and economy far greater than what was thought likely and it is fair, proper and reasonable to anticipate the concomitant transport problems such as congestion, pollution and environmental hazards. To solve the traffic and transportation issues, it is proposed to conduct a comprehensive transportation study to prepare long-term urban transport strategy for an improvement of people's mobility and to identify specific proposals for upgradation of transport infrastructure / facilities to ease the congestion level. The study is designed to provide the broad parameters for the long term development of transport infrastructure setting objectives for the next two decades.

In this context, **Tamil Nadu Urban Infrastructure Financial Services Limited (TNUIFSL)** has awarded the study of preparing the Comprehensive Mobility Plan (CMP) to **Urban Mass Transit Company Limited (UMTC)**. Transport proposals will be developed by integrating land use and transport and the Study shall come out with a plan for the safe and sustainable mobility needs of the people of Tirunelveli. This Study will develop a perspective plan for sustainable urban transport over a 20-year horizon period.

1.3 PROJECT OBJECTIVES

The objective of the current study is to prepare a comprehensive mobility plan for **Tirunelveli Local Planning Area for the period 2022–2042 in line with the NUTP, 2006, which focuses on the mobility of people and not vehicles** and on the need for **promoting safe pedestrian movement, bicycle movement and public transport, integration of land use and transport planning.**

[5] https://www.worldbank.org/en/news/feature/2011/09/23/india transportation#:~:text=Urban%20Transport.,roughly%2060%25%20of%20the%20GDP.

The broad objectives that such a document would fulfil for the city are:

- Integration: Integrate the mobility plan with urban growth, structure and urban form, and use this understanding in setting up the envelope of possibilities in travel decision-making.
- Equity: Provide accessibility and safety for different socio-economic groups and genders.
- Mode Shift: Prioritize sustainable modes of transport, i.e. public transport, and non-motorized transport.

Figure 1-1: Vision for Tirunelveli Mobility Plan

The CMP provides a vision for urban transport in the city with development (both technological and planning strategy) options and investment requirements to provide a desirable level of mobility and accessibility to all sections of the citizens while focusing on minimizing carbon emissions. It relies on the 'avoid, shift and improve' framework, i.e., avoid motorized trips, where possible or give options for using shared/public transport, encourage a shift to low-carbon modes, and improve the efficiency of motorized vehicles.

1.4 SCOPE OF WORK

The scope of work for the study is as per the Terms of Reference (ToR) and revised toolkit for Preparing Comprehensive Mobility Plans by the MoHUA. The **detailed scope of work,** as defined as part of this study, is to:

Figure 1-2: Vision for Tirunelveli Mobility Plan

1.5 STATUS OF THE PROJECT

The entire study has been divided into four stages where the Final CMP report is the third stage towards the preparation of the Comprehensive Mobility Plan for Tirunelveli. The previous deliverable of the Interim report was submitted in March 2022, which included the base year travel demand modelling that was developed to arrive at the traffic and transportation proposals for the study area. The deliverable also included the details of proposed City Bus System for the city of Tirunelveli along with the proposed Institutional Framework.

1.6 STRUCTURE OF THE REPORT

The report is divided into nine Chapters, each briefly outlining the study below:

Chapter 1: Introduction	Introduction to the project, the major study objectives, scope of work and status of the project
Chapter 2: Study Area Profile	Study area delineation, demography and socio-economic characteristics of the study area, land use and connectivity and regional linkages of Tirunelveli
Chapter 3: Existing Traffic and Travel Characteristics	Analysis and inferences of the primary and secondary surveys conducted for the identified study area.
Chapter 4: Travel Demand Modelling	The detailed Four-Stage modelling and the various scenarios built for the model are showcased in this chapter. A comparison of all scenarios and the selection of the most apt scenario for proposals and strategies are also dealt with in this chapter
Chapter 5: Urban Mobility Plan	Vision development and identification of objectives are included in this chapter. The proposals developed for each strategy is also detailed here.
Chapter 6: Service Level Benchmark	Service-level benchmark for the current year (2022) as well as the improved SLB for the horizon year (2042) assuming implementation of all proposals
Chapter 7: Funding Mechanism	Funding mechanisms for the implementation of the proposals identified
Chapter 8: Implementation Plan	Block cost estimated for the proposals as well as the categorization into short, medium and long term for implementation of projects.
Chapter 9: Institutional Framework	The current situation of Urban Transport and institutional framework, the need for formation of UMTA and the proposed roles and responsibilities are discussed in this chapter.

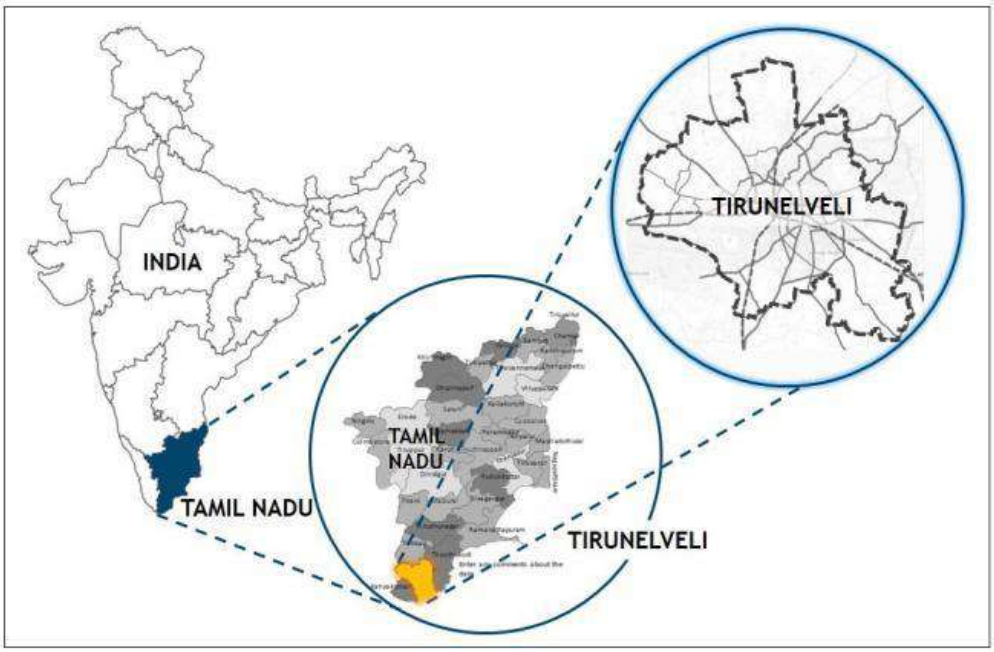
2. STUDY AREA PROFILE

2.1 INTRODUCTION OF THE CITY

The City of Tirunelveli is the sixth largest city (in terms of population) in Tamil Nadu located in the Tirunelveli district and functions as the administrative headquarters of the district. It is situated at a distance of 700 km south west from the State Capital Chennai. It is located in the southern-most tip of the Deccan plateau. Tirunelveli is an important junction in the National Highway No 44, connecting India from the North to South (Kashmir to Kanyakumari). Tirunelveli is a southern district of Tamil Nadu and is surrounded by Virudhunagar District in the north, Western Ghats and Tenkasi District in the West, Kanyakumari District in the south and Thoothukudi District in the East. The nearest pivotal towns are: Gangaikondan in the north, Thoothukudi in the east, Alangulam in the west, Kalakkad in the southwest and Nanguneri in the south. Tirunelveli Regional Setting is shown in Figure 2-1.

Tirunelveli is an ancient city, believed to be as old as 3000 years. The early settlement, known by the name Nellai, originated on the western banks of Thamarabarani River and is known for the ancient Nellaiappar temple constructed between 13th and 14th century, (Figure 2-1), shows the ancient Nellaiappar temple).

Figure 2-1 Location and Regional Setting of Tirunelveli



The present Tirunelveli Municipal Corporation Area consists of four zones namely Palayamkottai, Tirunelveli, Melapalayam, Thachenallur and 55 wards and the Local Planning area consists of 44 villages along with these wards. Thamarabarani River roughly divides the city into the Tirunelveli quarter and the Palayamkottai area. While Tirunelveli quarter remains as the culturally important focal point of the city, Palayamkottai is known as the oxford of the south India, because of the presence of a number of important educational institutions.

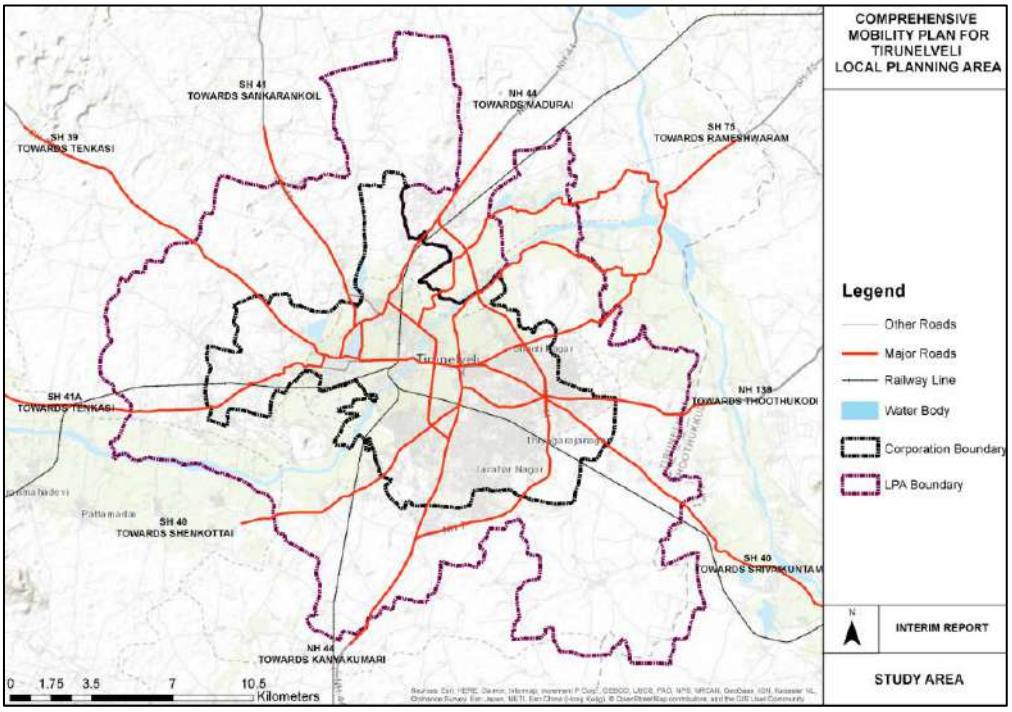
Figure 2-2 Nellaiappar Temple

2.2 STUDY AREA DELINEATION

The Master Plan, 2021 has identified **353.78 sq. km** as the developable area. In cognizance of that, the study area considered for the current study **is the developable area identified as per Master plan, 2021.**

The current Local Planning Area of Tirunelveli constitutes the Tirunelveli Municipal Corporation consisting of 55 wards and, 44 villages falling in Palayamkottai Panchayat Union and Manur Panchayat Union. The details of the same are as shown in (Figure 2-1) [6]. The Study Area is shown in Figure 2-3.

Figure 2-3 Study Area- Tirunelveli LPA



[6] Source: https://tirunelveli.nic.in/local-planning-authority/

Table 2-1 Study Area Details

S. No.	Composition of Tirunelveli LPA	Population as per Census -2011	Area
1	A. Tirunelveli (M Corp.)	473,637	108.65 sq km
2	B. Vicinity Area (44 Villages)[7]	135,827	245.13 sq km
3	Local Planning Area (A+B)	609,464	353.78 sq km

The corporation limits consist of 4 Zones namely Tirunelveli, Palayamkottai, Melapalayam and Thachenallur, which in total comprises 55 wards. Each zonal office is headed by the Assistant Commissioner.

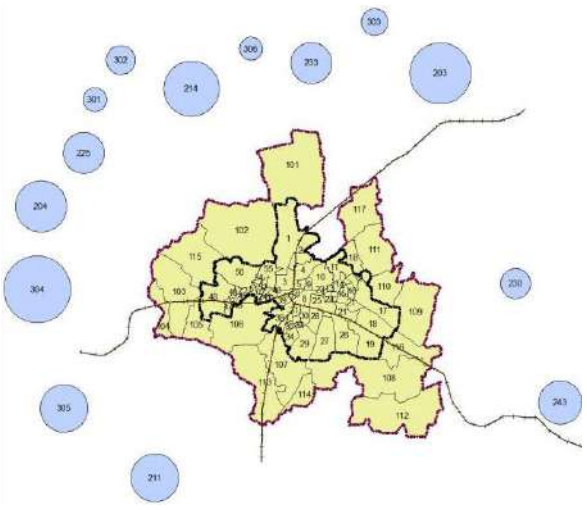
Tirunelveli and Palayamkottai are the important towns of the Tirunelveli Corporation limit. Tirunelveli is situated on the left bank of Thamarabarani River and Palayamkottai on the right bank. Palayamkottai as administrative headquarters and with the establishment of educational institutions, industries and government offices, exhibited remarkable development. The vicinity area is the area within the Tirunelveli LPA limits lying outside the corporation boundary, consisting of 44 villages spreading over an area of 245.13 sq km, as listed in the Tirunelveli Master Plan for 2021. As per the census of 2011, the LPA area excluding limits, had a population of 135,827.

2.2.1 Traffic Analysis Zones

Each of the areas within the study area has different socio-economic patterns, administrative boundaries and a different set of travel needs and transport infrastructure. To facilitate independent demand–supply analysis and planning for each of these areas, the study area has been divided into Traffic Analysis Zones (TAZs).

For analysis, the study area has been divided into **73 Internal Zones and 14 External Zones**.

Figure 2-4 Tirunelveli Traffic Analysis Zones



[7] Source: DTCP Tirunelveli

Traffic analysis zones adopted will be utilized to establish the travel pattern, within the city. The delineated TAZs for the study area in the city are as shown in Figure 2-4.

The list of TAZs identified for the study area along with their respective population and number of households as per Census 2011 is available in Volume 2.

2.3 DEMOGRAPHY AND SOCIO-ECONOMIC CHARACTERISTICS

2.3.1 Demographic Profile

As of 2011 Census of India, Tirunelveli Municipal Corporation had a total population of 473,637 and a vicinity population of 135,827. With the corporation area remaining constant, the gross population density has increased from 3790 to 4370 per Sq. km. between 2001 and 2011. (Figure 2-5, Table 2-2). There had been considerable fluctuations in population growth, during the past decades. The corporation area had registered a steep variation during the decades of 1971-1981 and 1991-2001 at 20.78% and 28.12% respectively. This may be attributed to various aspects like the formation of the Corporation and inclusion of other public and private offices and Institutions etc.

The steep negative trend was observed between 1981 to 2001, and is considered to be so due to the shift of residential development outside the three Municipal limits at that period.

For the current study, **the estimated population for the considered study area for the base year (2022) is 7.3 lakhs.**

The decadal growth rate has been calculated at 18% and the population density of the study area is about 43.6 persons per hectare (ppha) for corporation area and 3.4 persons per hectare (ppha) for the vicinity area.

Figure 2-5 Population Growth Trend in Tirunelveli LPA

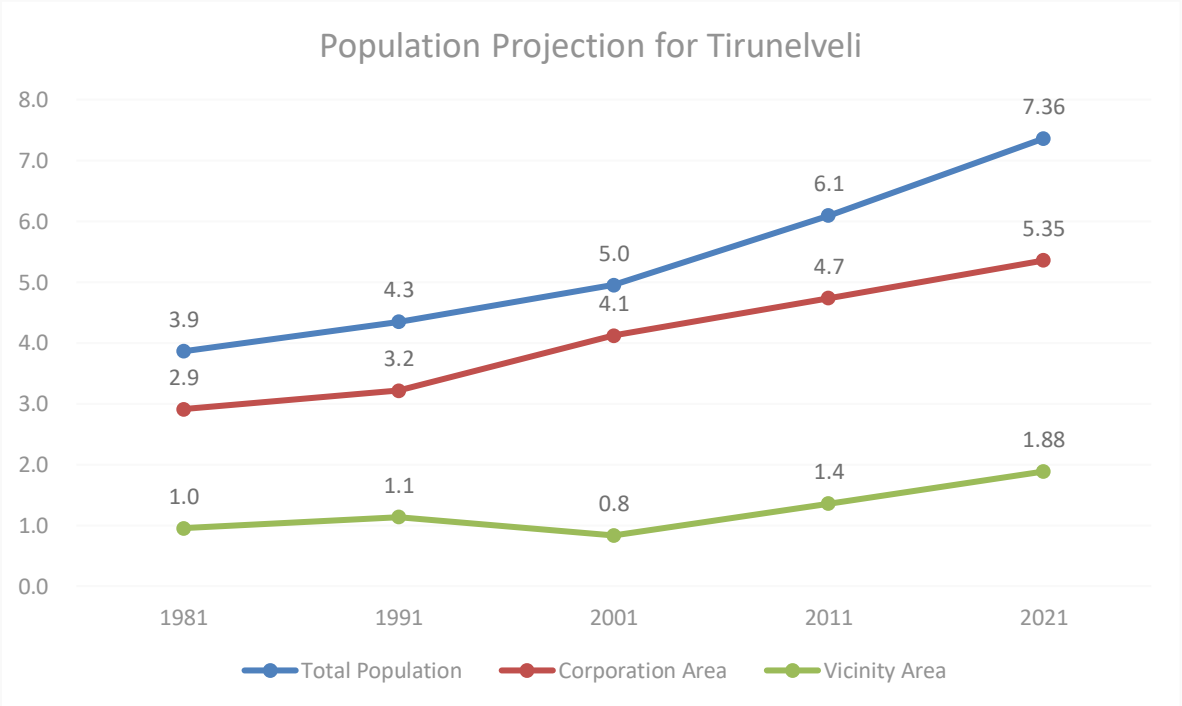


Table 2-2 Population, Tirunelveli LPA

Area	Corporation Area				Vicinity Area (LPA Area excluding the corporation limits)		
Year	Population	Increase	% Variation	Gross Pop Density	Population	Increase	% Variation
1971	241013			2218	82145		
1981	291104	50091	20.8%	2679	95038	12893	16%
1991	321454	30350	10.4%	2958	113250	38212	40%
2001	411831	90377	28.1%	3790	82830	-49370	-44%
2011	473637	61806	15.0%	4370	135827	52997	64%

Increase in population in the vicinity area during the decade 1971-81 and 1981-1991 can be seen to be 15.70% and 40.21% respectively but it decreased in 1991-2001, due to the migration from rural to within the Corporation area. The Increase in Population in the following decade outside the corporation limits is because of the revision in the LPA boundary after 2012.

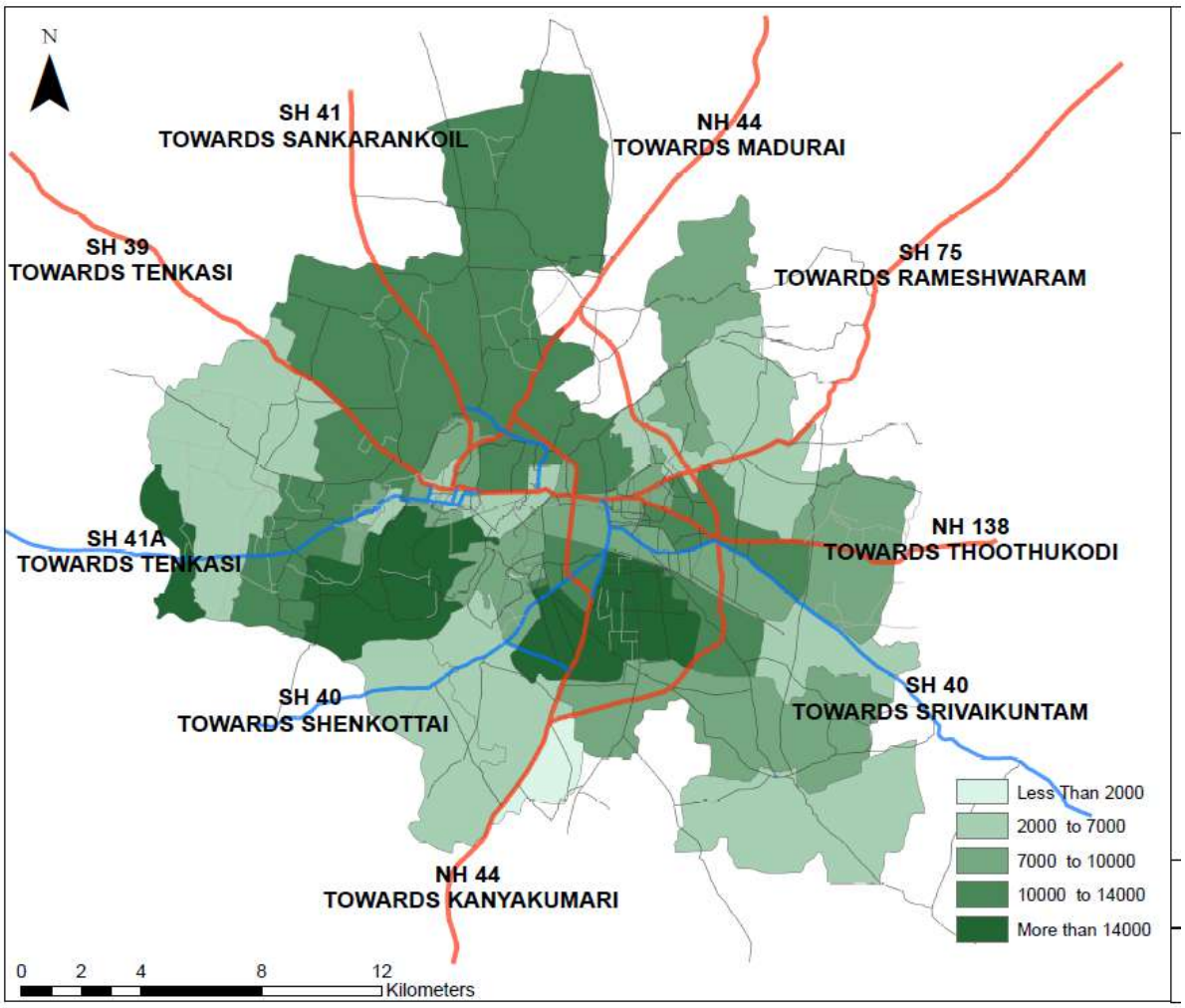
2.3.2 Population Density & Distribution

The population density distribution in the LPA area for the year 2011 is as given in Table 2-3 and Figure 2-6.

Table 2-3 Population Density, Tirunelveli LPA

Limits	Corporation				Vicinity			
Year	Population	Area (Sq. Km)	Population Density		Population	Area (Sq. Km)	Population Density	
			Persons per Sq.km	Persons per hectare			Persons per Sq.km	Persons per hectare
1991	321454	-				-		
2001	411831	108.65	3,790	37.9		unknown		
2011	473637	108.65	4,359	43.6	82830	245.13	338	3.4

Figure 2-6 Population Distribution in Tirunelveli LPA



2.3.3 Economic Characteristics

The economic base of Tirunelveli LPA mainly constitutes of the service sector activities like administrative services (district headquarters) many educational institutions, agricultural marketing and service, tourism, banking, technical training, agro machinery repairs and educational services etc., followed by the contribution of small scale industrial activities.

The tertiary activities flourished as there has been a continuous growth in arrivals of pilgrims and tourists. The vast hinder land comprising mostly the agricultural lands has been contributing to the growth of Tirunelveli town as a commercial centre, while the number of educational institutions established at Palayamkottai, which has been responsible to make it as a popular educational centre. Beedi manufacturing has once been an important economic activity at Melapalayam. Production of Handloom cloths and other household industries have made their contribution to the economic growth of the city as a whole. The mat weaving at Palamadai, a close by settlement, has also lent its share to the growth. The beedi manufacturing at Melapalayam is waning away from the scene of economic activities due to increase in individual income and increased health awareness about the dangers

associated with smoking. The mat weaving activity is also on the decline due to changing habits in the usage of materials.

Tirunelveli is a major area for wind-power generation. In 2005 it contributed 2036.9 MW to the state power-generation capacity. Tirunelveli also has two Special Economic Zones in the outskirts of the city, one located in Gangaikondan in the North along NH 44 and another one located in Nanguneri in South along NH 44. They house many MNCs.

2.3.4 Occupational Structure and Work Force Participation Rate

A good proportion of population in Tirunelveli city are employed in the service sector. Work force participation rate in Tirunelveli was 38.5% (corporation) for the year 2011. The sector wise occupational pattern for the year 2021 in the existing Master Plan is as given in Table 2-4 a high percentage in the secondary sector is estimated based on the influence of the Industrial growth of Thoothukudi on Tirunelveli. The Work Force participation rate is provided in Table 2-5.

Table 2-4 Sector Wise Occupational Contribution, Tirunelveli LPA

Economic Sector	Sector Wise Occupational contribution as proposed in the Master Plan for 2021, for Tirunelveli	
	Corporation Area	Vicinity Area
Primary	5%	30%
Secondary	40%	35%
Tertiary	55%	35%

Table 2-5 Worker Population, Tirunelveli LPA

S. No.	Details	Details	2001	% of total population	2011	% of total population	Decadal Growth (%)	CAGR (%)
Corporation Area	Population		4,11,831		4,73,637			
	1	Total workers (Main + Marginal)	153841	37%	182471	39%	7%	2%
	2	Total Non-Workers	257990	63%	291166	61%	8%	1%
	Work Force Participation Rate **(WFPR)**		37.4%		38.5%			
	Population		82,830		1,35,827			

S. No.	Details	Details	2001	% of total population	2011	% of total population	Decadal Growth (%)	CAGR (%)
Vicinity Area (LPA excluding corporation limits)	1	Total workers (Main + Marginal)	44520	54%	59394	44%	18%	3%
	2	Total Non-Workers	38310	46%	76433	56%	46%	7%
	Work Force Participation Rate (WFPR)		54%		44%			

Workforce participation rate as computed for the study area for the year 2022 is 39.75%[8] and the working population estimated from the WfPR is about 292,268.

2.4 LAND USE AND GROWTH PATTERN

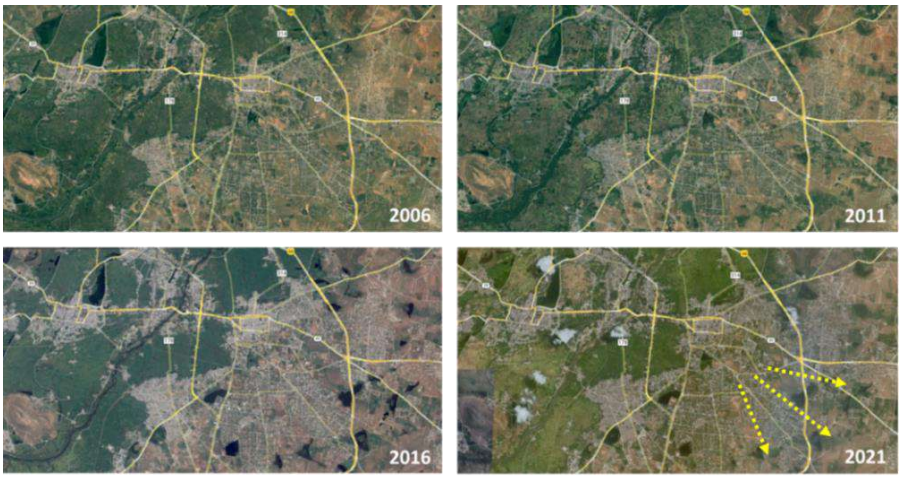
The city has a unique background of spatial development. The existing structure is a result of urbanization from four different urban centers which have experienced an organic growth around each of them. Such a growth pattern has resulted in creation of various large vacant plots around the present geometric center of the city (refer Figure 2-7). Such huge disparity in urban spatial development which is rarely observed in other Indian cities acts as a potential for the city's development as the vacant plots provide plenty of spaces for retrofitting the missing urban infrastructure in the city. However, the confluence of the road networks of these urban centers might not merge to a structure which would efficiently address the city's present urban travel demand pattern.

Therefore, unlike other cities, several chunks of saturated land parcels separated by large vacant spaces is the unique characteristics of this city. Nevertheless, city can be seen growing towards east towards the side of Srinagar Kanyakumari National Highway and Thoothukudi. (Refer Figure 2-8)

Figure 2-7 Zones in Tirunelveli corporation, Existing Vacant Spaces in the corporation and road network pattern

[8] *UMTC projections*

Figure 2-8 Growth of Settlement (From Satellite Imagery)

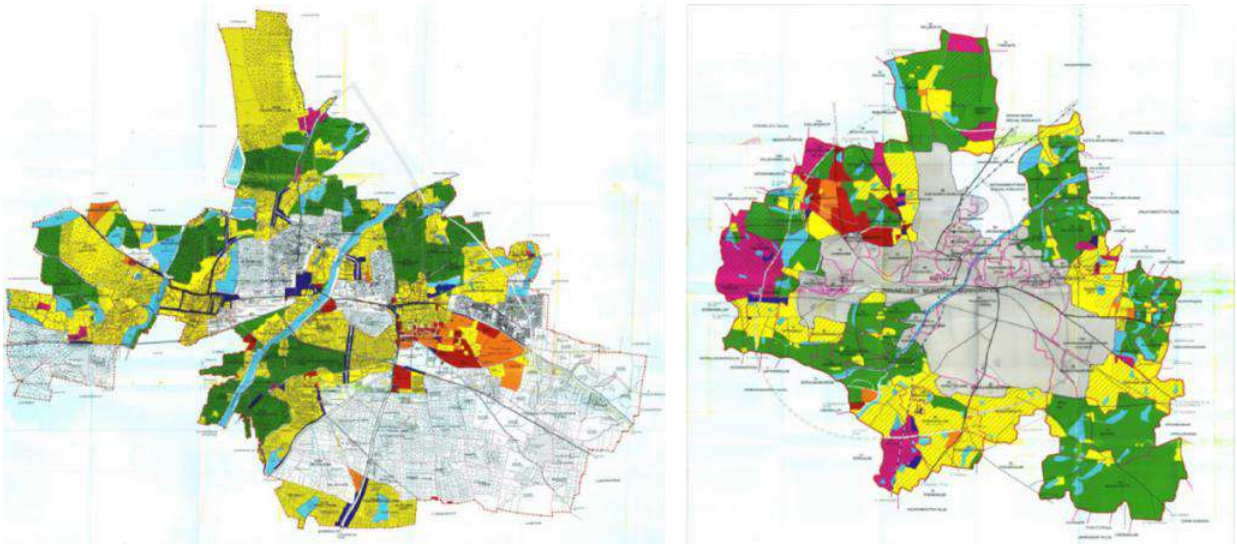


2.4.1 Land Use Analysis

The existing master Plan for the Local Planning Area was taken up to a plan period till 2021. The existing Tirunelveli L.P.A. includes three municipalities, one town panchayat and sixty-seven revenue villages. The L.P.A. extends over an area of 35377.80 hectares[9]. (Refer **Figure 2-9**)

With a population of 4,40,000 for the base year of 2005, the overall population density estimated was 216 persons per hectare. The population projected for the year 2021 was 6 lakhs and the estimated area to be developed for this growth was 3429 hectares after adopting a population density of 175 persons per hectare. The existing land-use in Tirunelveli and rest of LPA as per the Master Plan prepared for the year 2021 is shown in **Figure 2-9**. and its percentile distribution is shown in **Figure 2-10** and Table 2-6 About 59% is currently under Agricultural land use under the entire LPA. The Land use for the LPA area for the year 2042 is under preparation.

Figure 2-9 Land Use Map - Tirunelveli LPA, Master Plan, 2021

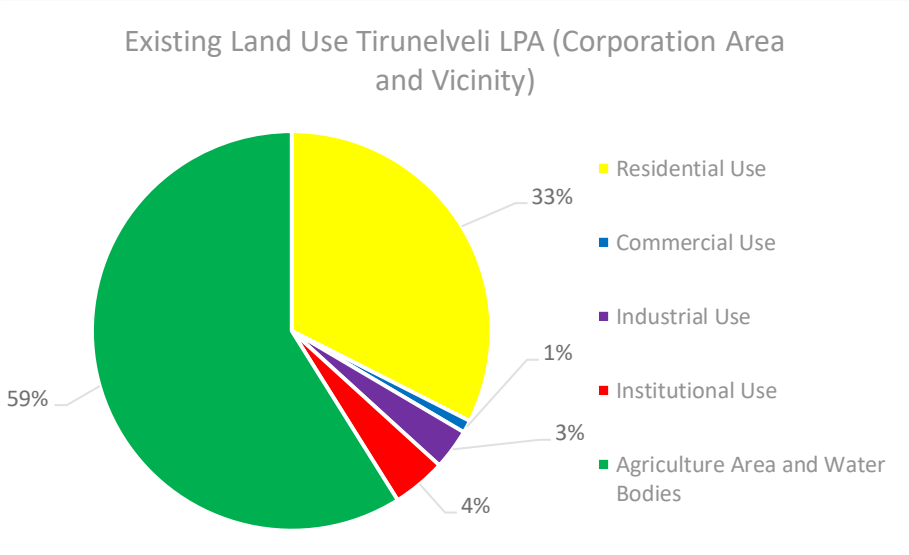


[9] Master Plan for 2021

Table 2-6 Existing Land Use, Tirunelveli LPA

Sl No	Land Use	Existing land Use within Corporation Area (within LPA)	Existing land Use in the Vicinity Area (within LPA, excluding corporation limits)	Existing Land Use in Tirunelveli - LPA
1	Residential Use	35%	31%	33%
2	Commercial Use	2%	0%	1%
3	Industrial Use	3%	4%	3%
4	Institutional Use	5%	4%	4%
5	Agriculture Area and Water Bodies	55%	61%	59%
6	Total Developed Area in Hectares	a. 10865 hectares	b. 24292 hectares	(a+b) 35157 hectares

Figure 2-10 Existing Land Use- Tirunelveli LPA, Master Plan, 2021

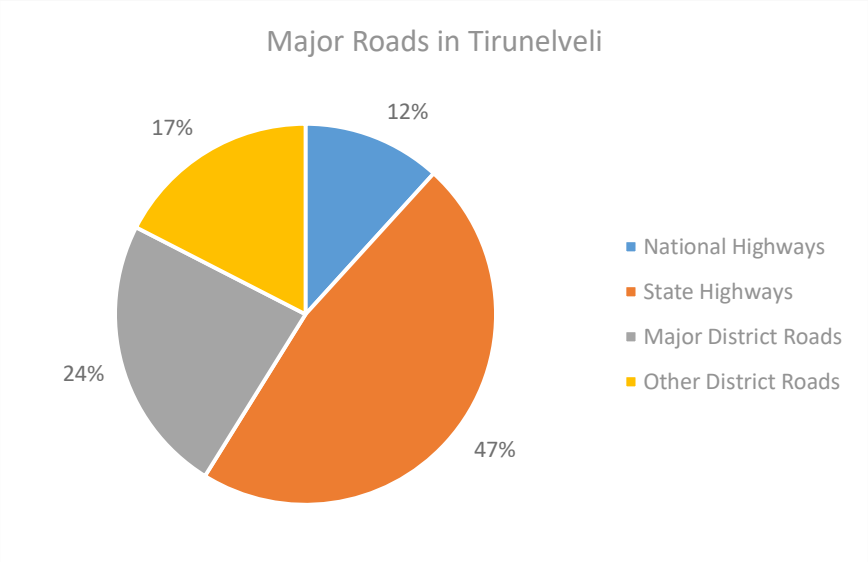


2.5 CONNECTIVITY AND REGIONAL LINKAGES

2.5.1 Road Connectivity

Road network in Tirunelveli with 9 radials emerging from the heart of the city provides good connectivity to all major urban canters situated around the city. Out of these, two are National Highways - NH 44 and NH 138 and six are state highways, SH 75A, SH 75, SH 41, SH 40, SH 41A and SH 39. The Roads under different classification within the corporation limit are shown in **Figure 2-11.**

Figure 2-11 Composition of Roads



The road network forms a clear radial, suffers from lack of circumferential road to provide the orbital links to the bye passable traffic. Locations where two or more radials meet within the city are major points of traffic congestion in the city. The city has an irregular road network comprising major roads, which are almost single lane, intermediate lane, two lanes and four lanes wide. A conspicuous feature of the layout of arteries is that all of them are linked with the main transport artery, the Grand Trunk Road (SN High Road via Town Arch, Irattai Paalam and Kokkirakulam Bridge) which passes through the heart of the area and hence interlinked with each other. Out of these roads, 91 percent of the roads are maintained by Tirunelveli Corporation, and the remaining 9 percent of the road is maintained by the Highway department.

The major roads in Tirunelveli are listed below (refer **Figure 2-12**)

National highways

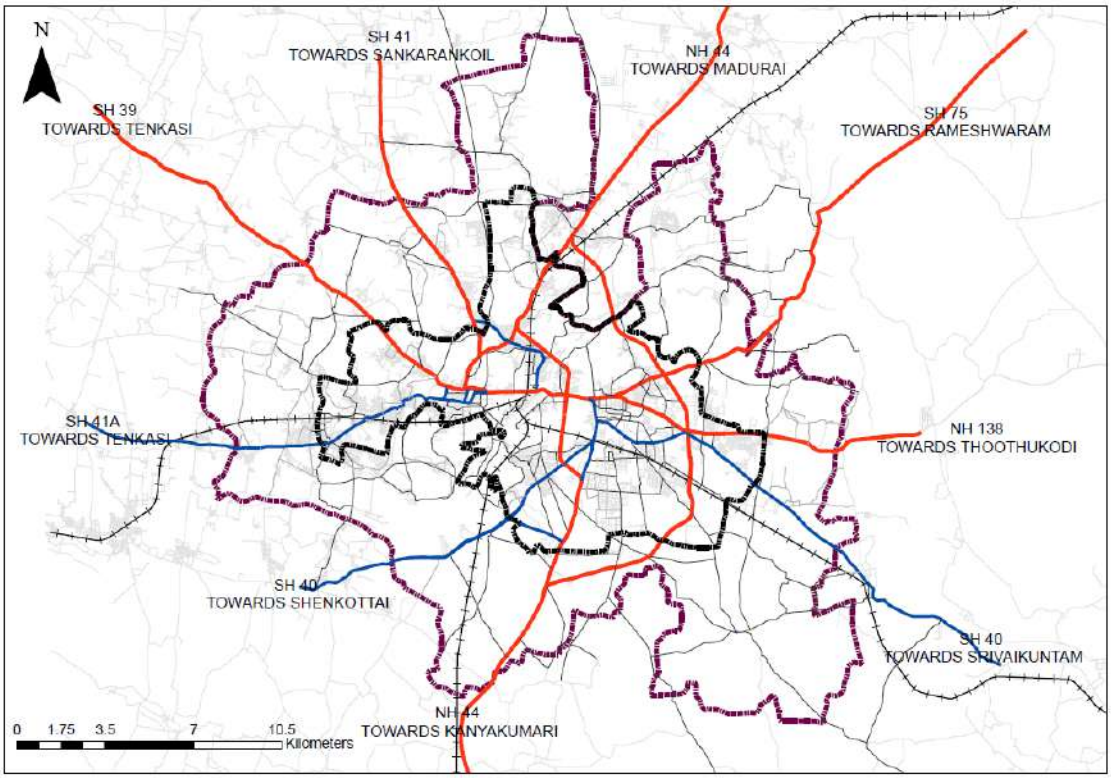
- The NH - No.44 (Srinagar to Kanyakumari Highway),
- NH 138 (Tirunelveli-Thoothukudi Highway)

State Highways

- SH - No. 39 (Tenkasi Tirunelveli Road)
- SH - No. 40 (Tirunelveli Shenkottai Road)

- SH - No. 41 (Sankarankoil Tirunelveli Road)
- SH - No. 41A (Tirunelveli Pottalpudur Road)
- SH - No. 75 (North and South by Pass Road)

Figure 2-12 Major Roads



2.5.2 Rail Connectivity

Almost 10 railway Stations can be found in and around Tirunelveli Urban Area, out of which Tirunelveli Junction acts as the most important one. It is also an important node in the railway routes of Southern Railway, where the Tenkasi line and Tiruchendur line meet with Kanyakumari Maniachi line. The Tirunelveli Junction railway station (**Figure 2-13**) comes under the administrative range of Madurai Railway division - Southern Railway and serves as the main railway station for the districts of Tirunelveli, Thoothukudi and Kanyakumari. Tirunelveli Railway Station is favorably located close to the Tirunelveli junction bus stand. Some of the important trains originating from the Tirunelveli junction railway station include Nellai Express, Tirunelveli - Dadar Express, Tirunelveli - Bilaspur Super-Fast Express, Tirunelveli - Dadar Chalukya Express, Hapa Tirunelveli Superfast Express and Tirunelveli - Tiruchirappalli Intercity Express. Apart from the originating trains, Tirunelveli junction serves as an important transiting point with a lot of express and passenger trains making a stopover. Tirunelveli Town Railway Station and Palayamkottai Railway Station and other stations listed below are the sub-urban railway stations of the City.[10]

Other Railway Stations in the vicinity are:

[10] Master Plan for Tirunelveli LPA-2021

- Tirunelveli Town Railway Station - Within LPA limits
- Tirunelveli Junction Cabin Railway Station- Within LPA limits currently not operational
- Palayamkottai Railway Station - Within LPA limits
- Pettai Railway Station - Within LPA limits
- Melapalayam Railway Station - Within LPA limits
- Thalayoothu - Outside LPA limits

Figure 2-13 Tirunelveli Junction Railway Station

2.5.3 Air Connectivity

The nearest airport to Tirunelveli is Thoothukudi Airport (TCR **Figure 2-14**) at Vaagaikulam in Thoothukudi District, 22 km east of the city, which offers daily flights to Chennai and Bangalore. The nearest international airports are Madurai International Airport, 150 km away and Thiruvananthapuram International Airport ,about 130 km away.

Figure 2-14 Tuticorin Airport

2.6 PUBLIC TRANSPORT CHARACTERISTICS

City bus Transport service and IPT services are the main public transport service providers in Tirunelveli. Tirunelveli does not have a suburban rail network, nevertheless, 30 daily trains start/run from Tirunelveli. Though it is well connected to the nearby urban areas via rail along all the four cardinal directions, bus is the most preferred mode in the city. Figure 2-15 shows bus and rail connectivity in Tirunelveli. Existing Public Transport Fleet Registered Under the RTO is given in Table 2-7.

2.6.1 City Bus Services Run by TNSTC

Tirunelveli has a well-established bus route network with four bus stands within the corporation boundary. Tirunelveli Junction bus terminal, located close to the Tirunelveli junction railway station is the most important bus stand of the city, which is at present undergoing renovation. The bus stand used to cater to the town bus services for several routes in and around the city. The bus stand has been temporarily relocated partly to the western side of the city near SN Road and partly near the Vannarpattai Chellapandyan Statue Junction. Other Bus Stands in the city are the Palayamkottai new bus stand and MGR New Bus Stand along the south bypass road which is an intercity terminal. Mofussil buses operate from the MGR new bus stand as well as Vannarpattai Junction Flyover. There are both private and Public Sector run services available in the city round the clock. The main Public Bus service providers are TNSTC- Tamil Nadu State Transport Corporation, operating a string of local and mofussil bus services, SECT- Tamil Nadu's State Express Bus Corporation, operating express services to urban centers around the city. There are also Omnibus Intercity and Interstate stops available in the city.

Table 2-7 Existing Public Transport Fleet Registered Under the RTO (district data)

	Mofussil	Town Bus	Total
Private Stage Carriage	23	69	92
State Transport Undertaking	154	145	299

The Corporation and the local planning area are well connected by the city bus services either through TNSTC or private operators. However, it is widely observed that bus stops are not placed ideally at many locations within the study area.

Figure 2-15 Regional Connectivity, Tirunelveli

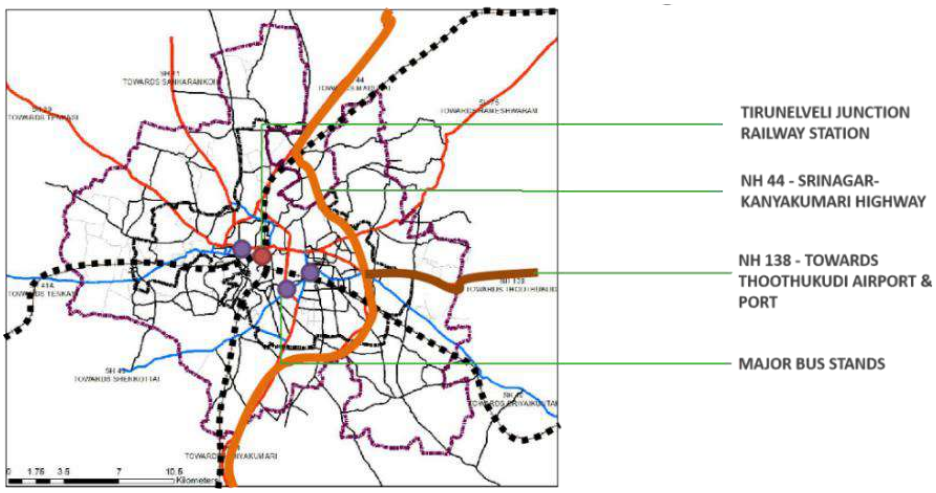


Figure 2-16 New MGR Bus Stand and Palai Bus Stand

2.6.2 Private Bus Services

Private Buses in Tirunelveli run on all major Roads, the major destinations being, Kovilpatti, Sankarankoil, Tenkasi, Ambasamudram, Thoothukudi, Tiruchendur, Nagarcoil, High ground and Sivalapperi. There are approximately 63 town buses and 31 mofussil operational buses undertaken by Private Bus Operators. Town buses cover an average daily kilometer of 275km, whereas, Mofussil buses cover a daily kilometer of 375km. Average daily earning per private bus per day is Rs 1300[11]. Total Fleet registered under Tirunelveli Private Stage Carriage is given in Table 2-8 and Major Private Bus Routes of Tirunelveli are given in Table 2-9.

Table 2-8 Total fleet under Tirunelveli Private Stage Carriage

	Mofussil	Town Bus	Total
Private Stage Carriage	23	69	92

Table 2-9 Major Private Bus Routes in Tirunelveli

	Major Routes of Private Buses
1	Tirunelveli town to High ground via Market, Samadhanapauram
2	Tirunelveli town to High ground via Palayamkottai bus stand
3	Tirunelveli Town to NGO B Colony
4	Tirunelveli Town to Shantinagar
5	Tirunelveli Town to Sarada college
6	Tirunelveli Town to Arockianathapuram
7	Tirunelveli Town to Melapalayam
8	Tirunelveli Junction to Thalayoothu
9	Tirunelveli Town to Tuckerammalpuram
10	Tirunelveli Town to Rastha

[11] Source: Private Bus operator's association, Tirunelveli

	Major Routes of Private Buses
11	Tirunelveli Town to Pettai
12	Tirunelveli Town to Rani Anna College

2.6.3 TNSTC Bus Services

TNSTC Tirunelveli caters bus services for Tirunelveli District. Some of the routes are dedicated entirely to the corporation and LPA limits but most of the routes ply outside the LPA limits. There are approximately 3882 staff employed under TNSTC Tirunelveli Region, as for the year 2021. There are seven depots in total under TNSTC Tirunelveli region, two of which- By Pass depot and Kattabomman Depot, cater to most of the services within the Tirunelveli LPA limits. Approximate distance between two stages is 2km.

2.6.4 Intermediate Public Transport

Tirunelveli has a well-established IPT system in place, category wise vehicular position of which is given in Table 2-10. The permits of all contract carriage vehicles are valid only for five years from the date of issue of the permit.

Table 2-10 Vehicular Position of different Classes of IPT[12]

Sl No	Category	Total Number Registered
1	Tourist Taxi	1098
2	Share Auto	49
3	Auto Rickshaw	4062

Auto Rickshaws

Auto rickshaws are one of the most popular modes of para-transit in Tirunelveli. They provide door-to-door transportation and last mile connectivity to a major chunk of city population. Despite the existence of buses, last mile connectivity remains an unresolved issue in Tirunelveli like in most Indian cities, due to the underdeveloped feeder system. Auto rickshaws in Tirunelveli can be seen parked around all major transport nodes, hospitals, schools etc. in the city. They are only allowed to ply within a distance of 30km from the city limits with a maximum capacity of 4. The permit details of the Auto Rickshaw and their Challenges are discussed in the following sections(refer Table 2-11, Figure 2-17).

Most of the Auto Rickshaw operators do not stick the permitted fare structure inside the vehicle. Average charge for a minimum distance trip (1.8 km) is Rs 70 at present.

[12] Source: RTO Tirunelveli

Table 2-11 Auto Rickshaw Permit Details in Tirunelveli[13]

IPT Mode	Total No	Fares	Auto Rickshaw Route	Detention Charge	Allowed Seating Capacity
Auto Rickshaw	4062	1st 1.8 km- Rs 25, Rs 12 for every additional KM	30 KM Radius From Parking Area	Rs 3.5 for every 5 mins	4

Figure 2-17 Auto rickshaws and Share Autos in Tirunelveli

Shared Auto Rickshaw

Share Autos is the preferred mode of transportation for short distances. There are 49 shared autos registered under Tirunelveli RTO and each has an allowed capacity of 5 people including the driver. This system in Tirunelveli is frequently available on most of the bus routes. They are mostly seen to be parked near the Tirunelveli Junction and Periya Bus Stand during the non-Peak Hours. Overcrowding is the main challenge in Shared Auto system, all shared autos are loaded beyond their capacities The auto permit details are shown in Table 2-12.

Table 2-12 Share Auto Rickshaw Permit Details in Tirunelveli

IPT Mode	Total No	Fares	Share Auto Route	Allowed Seating Capacity
Share Auto	49	Rs 1 for 1 KM	30 KM Radius From Parking Area	5

2.7 GOODS TRANSPORT CHARACTERISTICS

Tirunelveli is one of the major nodal points in Tami Nadu acting as a regional marketing center for distribution of agricultural products and a few textiles. At present, there is only truck terminal in the LPA developed under the Smart City Mission, (Figure 2-18). It is currently not operational, due to the construction activities on the Palai Pettai link road. Therefore, trucks coming to Tirunelveli are found to be parked on the Tank Bund Road (road along the Nainar Lake) which is also a bus route. There are also many booking offices on this stretch of road which creates lot of congestion on this road. Light commercial vehicles which are used to distribute the goods, are found to be parked in large numbers on the railway

[13] Source: RTO Tirunelveli

station feeder road near the flyover. The open ground near the Palayamkottai market is being used as parking area by trucks coming to Palayamkottai. Major developments have not yet taken place in Melapalayam town which is still depending on cottage industries like weaving and beedi manufacturing. Hence, movement of vehicles is less in Melapalayam.

Figure 2-18 Tirunelveli Truck Terminal developed under Smart City Mission

3. EXISTING TRAFFIC AND TRAVEL CHARACTRSITICS

Chapter 2 described the study area in terms of its demographic and socioeconomic characteristics, which are important to understand its transport profile. This chapter will discuss and identify the transport and traffic scenarios in the study area, by assessing the regional connectivity and existing public transport options. Tirunelveli is connected with its neighboring cities, states and other parts of the country by rail and National/State/District roads.

To understand traffic and travel characteristics and highlight city-specific problems, UMTC conducted 21 primary surveys on ground as shown in Table 3-1.

Table 3-1 List of Primary Surveys

S.No.	Particulars of Survey	Unit	Tirunelveli
1	Classified Volume count at cordon locations (24 hours)	Location (No.)	9
2	RSI at Cordon locations (10% sample size)	Location (No.)	9
3	Classified Volume counts surveys at Screen Line locations (16 hours)	Location (No.)	7
4	RSI at Screen Line location (10% sample size; 16 hours)	Location (No.)	7
5	Classified Volume counts at Mid-Block locations (16 hours)	Location (No.)	6
6	Turning Volume Counts at Junctions (16 hours)	Location (No.)	17
7	Pedestrian Volume Counts at critical junctions (16 hours)	Location (No.)	6
8	Terminal survey OD & Volume	Location (No.)	6
9	Bus Stop Waiting, boarding and alighting survey (16 hours)	Location (No.)	6
10	Bus stop OD Surveys (12 hours)	Location	6
11	IPT OD Survey (12 hours)	Location	6
12	Operator Survey (Auto rickshaw/Taxi) @50/stand	Sample	300
13	Willingness to Shift Survey	Sample	250
14	Road Network Inventory	Km	Major links
15	Speed and Delay Study at peak and off peak hours	Km	Major Links
16	Parking Survey (12 Hrs) (Off street & On-street)	Location (On-Street)	5
		Location (Off-Street)	2

17	House Hold Interview (@ 1.5% total House Holds in LPA)	Sample	2007
18	Goods Terminal Survey (16 Hrs)	Location	1
19	Establishment survey (@10% of HH)	Sample	200
20	Lux Meter survey	Km	Major links
21	Topographic Survey	2Km, 2 Junction	

All the aforementioned traffic surveys were carried out during the weekdays, i.e., Monday through Friday. Surveys on public holidays were not considered. The details of the data collected through the surveys have been presented in Deliverable 1 (Interim Report) and major observations from the surveys conducted have been summarized in the sections below.

Figure 3-1 Outer Cordon Survey at NH-44

3.1 VEHICULAR REGISTRATION AND CHARACTERISTICS

3.1.1 Vehicular Registration Trends

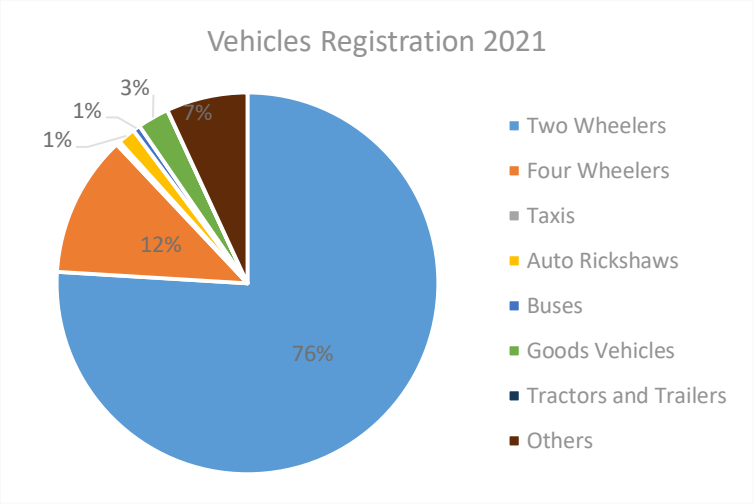
The vehicle population growth of Tirunelveli is not as rapid as compared to other cities in Tamil Nadu. Nevertheless, it can be observed that a good portion of the newly registered vehicles are two wheelers which shows a growing dependency on the private modes for transportation – as shown in Table 3-2. As of 2021, 16603 vehicles were registered under Tirunelveli RTO, out of which 76% were two wheelers (refer Figure 3-2).

Table 3-2 Vehicle registration in Tirunelveli from 2017 to 2021

Year	2017	2018	2019	2020	2021
Two Wheelers	15960	15617	17484	16813	12612
Four Wheelers	2420	2809	2692	2397	1995

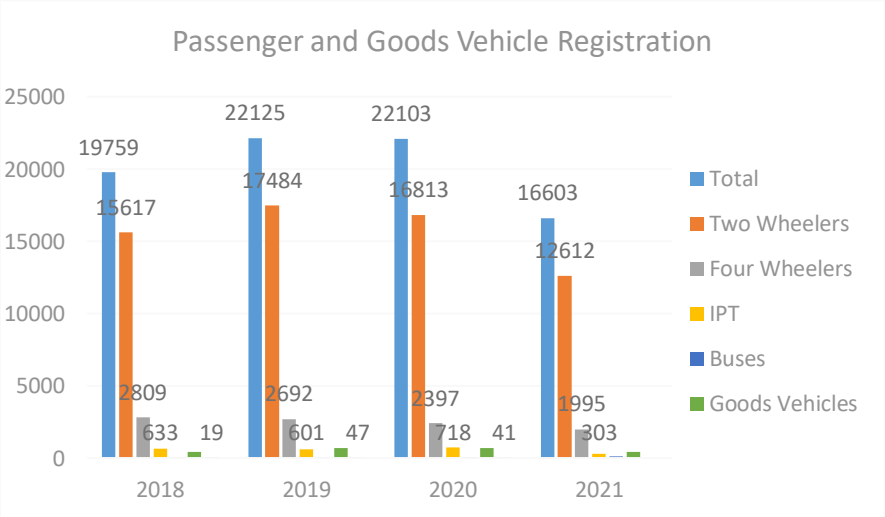
Year	2017	2018	2019	2020	2021
Taxis	187	211	221	223	55
Auto Rickshaws	533	422	380	495	248
Buses	88	30	43	58	102
Goods Vehicles	363	406	696	673	444
Tractors and Trailers	19	20	5	1	4
Others	226	244	604	1443	1143
Total	**19796**	**19759**	**22125**	**22103**	**16603**

Figure 3-2 Vehicle Registration- 2021



As seen in the sections above, the city has not been experiencing a rapid growth, vehicular growth can also be seen to follow this pace of development. There has been a sharp decline in the number of vehicular registrations in the year 2020, this is believed to be as a result of the impact of Covid on the economy. The past few years has also seen a slight growth in electric two wheeler registrations in the city. The comparison of passenger and goods vehicles registered over the past few years is shown in Figure 3-3.

Figure 3-3 Passenger and Goods vehicles registered from 2018 to 2021[14]



[14] Vehicle registration Data from RTO, Tirunelveli

3.2 ROAD NETWORK AND CHARACTERISTICS

The road inventory survey was carried out on all major arterials, sub-arterials and collectors in Tirunelveli and further extended to the entire study area. The hierarchy of the road network in the study area is shown in Table 3-3.

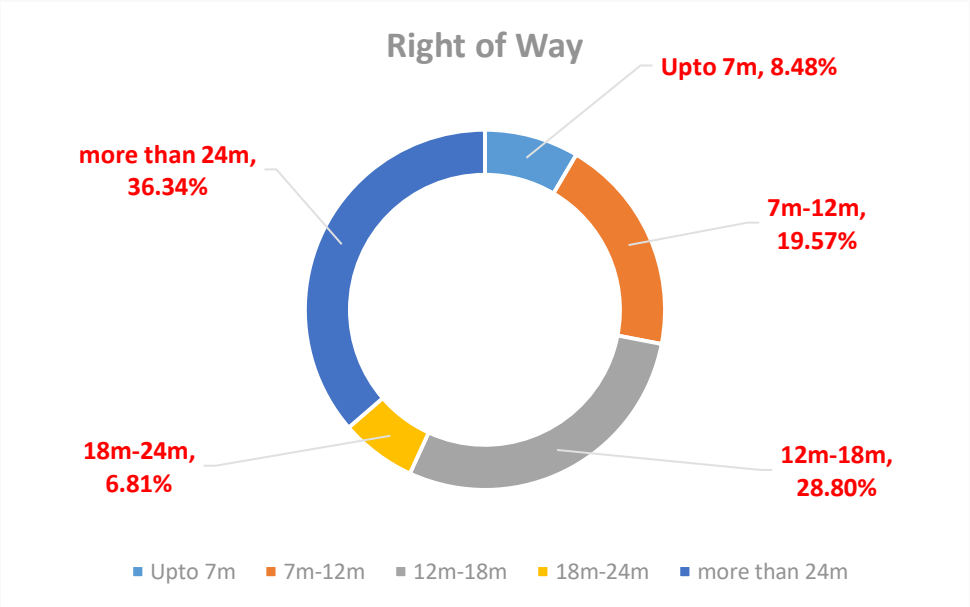
Table 3-3: Road Network Hierarchy in the Study Area

S. No.	Road Type	Length (km)[15]
1.	Arterial Roads	99
2.	Sub-Arterial Roads	58
3.	Collector Roads	377

3.2.1 Right of Way

The RoW of every surveyed road was measured and it is observed that 28% of the roads have RoW less than 12 m followed by 28% having RoW of 12–18 m.

Figure 3-4: ROW Distribution of Surveyed Roads



3.2.2 Carriageway Type

About 81% of the surveyed roads (refer Figure 3-6) fall under the undivided category of roads. Medians were observed to be present on the major arterial and sub-arterial networks of the city. Only 23% of the roads have good lane marking (Refer Figure 3-7).

[15] *As per the digitized road network of UMTC*

Figure 3-5 Distribution of Surveyed Roads by Carriageway

3.2.3 Pavement Conditions

As represented in Figure 3-6, only about 1% of the roads within the study area are unpaved, whereas 98% of the surveyed roads are flexible paved, and only 1% accounts for rigid paved roads.

Figure 3-6: Type of Road Pavement Surface

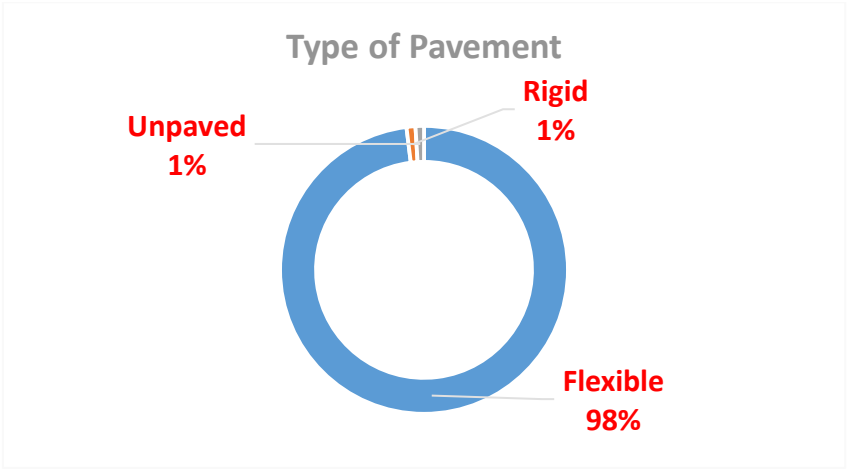
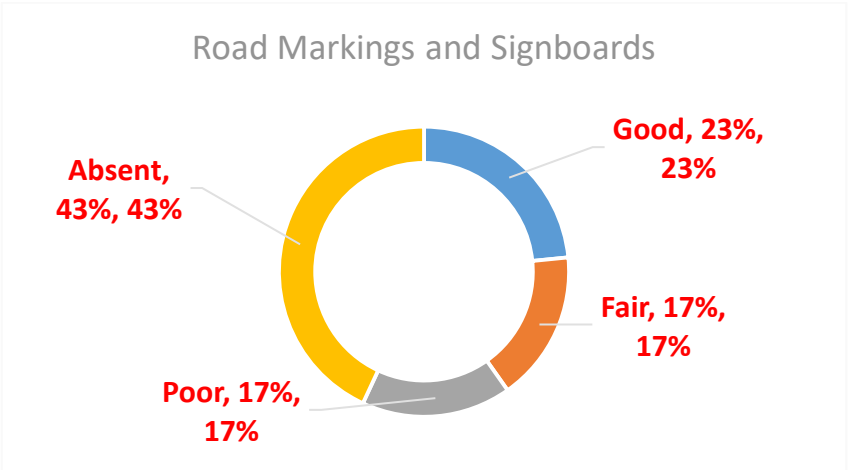


Figure 3-7: Availability of Lane Markings



3.2.4 Footpath Conditions and Availability

Availability of footpath in the study area is presented in Table 3-4. The inventory showed that majority of roads do not have footpath. About 70% of surveyed road do not have footpaths.

Table 3-4 Footpath Availability

S.No	Footpath Width (Mtrs) - Paved	% Road Length
1	No Footpath	70
2	Up to 1.2m	28
3	1.2 to 1.8	2
5	More than 1.8m	0

3.3 TRAFFIC SAFETY IN STUDY AREA

3.3.1 Accident Pattern

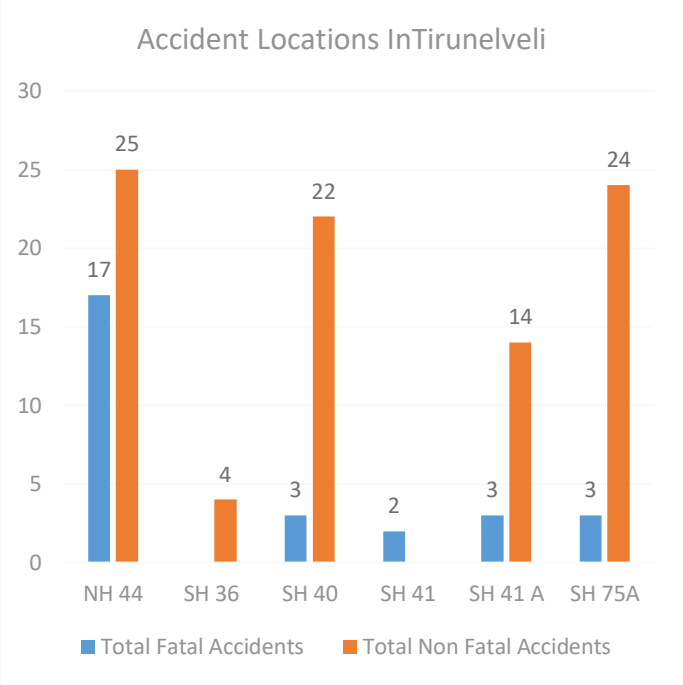
Road Safety is a crucial factor in evaluating the efficiency of the transportation infrastructure. On analyzing the five-year accident data, it can be observed that the city has high number of accidents, especially grievous ones, whose number has remained more or less the same over these years. A drop in the total accident cases in 2020 is due to the lockdown related to Covid (Ref Table 3-5).

Table 3-5 Five Year Accident Data

Year	Fatal		Grievous Injury (need hospitalization)		Minor Injury (not needing hospitalization)		Non Injury	Total (no of Accidents)	Total (injuries and fatalities)
	NA	NPK	NA	NPI	NA	NPI	NA	NA	NPK+NPI
2017	78	85	132	205	116	153	28	354	443
2018	118	124	183	276	65	90	13	379	490
2019	91	95	203	283	46	66	17	357	444
2020	72	72	132	162	75	91	1	280	325
2021	66	66	132	160	136	188	17	351	414
NA- Number of Accidents	NPK- Number of People Killed		NPI- Number of People Injured						

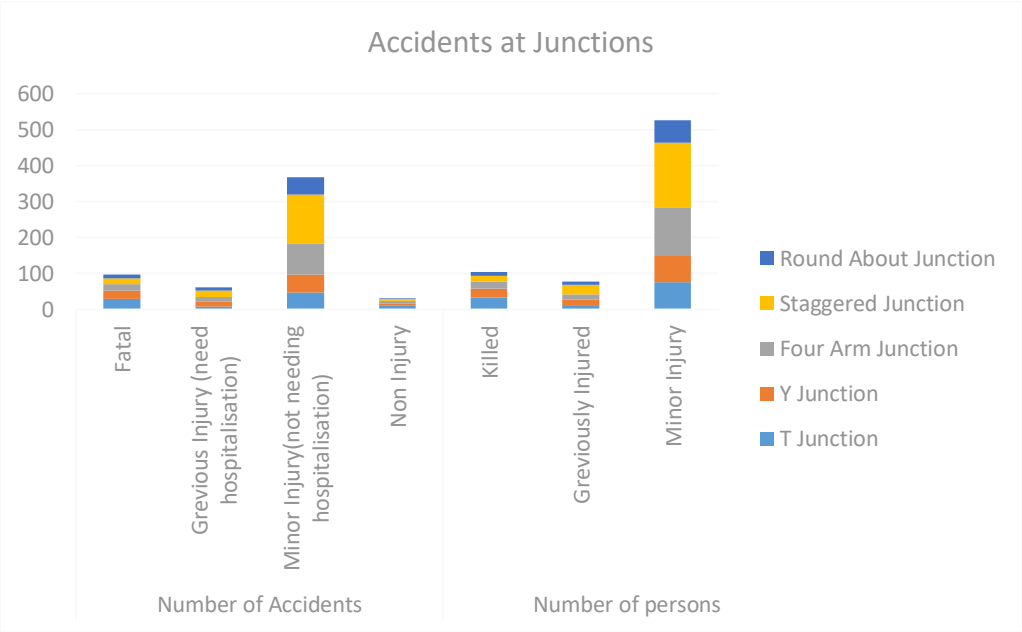
It was also seen that the road where the highest number of accidents have happened is NH 44. North and South Bypass road SH 75A is the second highest in terms of number of accidents. Refer Figure 3-8 for accident details in Tirunelveli.

Figure 3-8 Accidents in Tirunelveli[16]



Blind Spots at junctions and road visibility related issues were the main reported reasons for the accidents. The Figure 3-9 shows the number of accidents that took place at junctions, highest number of accidents took place at staggered junctions.

Figure 3-9 Analysis of Accidents at Junctions



[16] Tirunelveli RTO

3.3.2 Accident Black spots

There are a total of **seven blackspots within the study area**.

Table 3-6: Accident Blackspots Identified by Traffic Police, Tirunelveli

Place	2021		
	Fatal	Non-Fatal	Total
Pottal Villakku		3	3
Keelathanam Villakku	1	1	2
Peddiyarpatti Hills		3	3
IRT Palam	1	1	2
Rajagopalnagar		1	1
Relaince Junction	1	4	5
Thachanallur Railway Station		4	4

3.4 TRAFFIC CONDITIONS IN STUDY AREA

3.4.1 Speed & Delay

A total of 100 kms of roads were surveyed to find out the running speed, journey speed, and types of delay, such as stopped delay and operational delay, to evaluate the level of service and quality of traffic flow of a road for the entire road network system.

Journey Speed Analysis

Journey speeds are used for validation of the urban transport model and to develop speed and volume functions for different categories of road network in the study area. The data will be used in developing the speed flow relationships which will be used in building the Transport Model and to validate journey speeds predicted by the transport model. The average speeds surveyed have been discussed in Table 3-7, Table 3-8 and Table 3-9.

Table 3-7 Average Journey Speed and Average Running Speed in Tirunelveli

Average Journey Speed	Average Running Speed	Major Reason for Delay
27.5	33.3	Traffic Congestion at Junctions

It is observed from the analysis that **average journey speed in the city is 27.5 kmph and average running speed is 33.3 kmph.**

Table 3-8 Reasons for delay in Tirunelveli

Sl No	Reasons For Delay	%
1	Row Constraints & Bottle necks	96%

Sl No	Reasons For Delay	%
2	Signal	1%
3	Traffic Congestion	2%

Table 3-9 Average Journey Speed and Average Running Speed on major corridors

S.No	Road Name	Journey Speed	Running Speed	Reasons for Delay
1	Pettai Road	15.7	26.2	RoW Constrains/ Sharp turns
2	Tenkasi Tirunelveli Road	34.9	36.0	RoW Constrains/ Sharp turns
3	Koolakkadai Street	41.4	42.7	Bottleneck/ Row Constrains
4	S Mount Road	37.6	38.8	Traffic Congestion
5	Nainar Kulam Road	21.6	36.0	Traffic Congestion
6	Car Street	15.4	25.7	RoW Constrains/ Bottle Necks
7	Sankarankovil Tirunelveli Road	26.4	27.2	No major delay
8	Trivandrum Road	24.3	27.0	Signal
9	Palayamkottai Market Parallel Road	21.6	36.0	Traffic Congetsion
10	60 ft road Kamaraj Nagar	36.1	37.2	No major delay

The journey speed was observed to be in a range between 15 kmph and 22 kmph towards Tirunelveli Town (east) and between 22 kmph and 27 kmph towards Palayamkottai (west).

3.4.2 On Street & Off-Street Parking

On-street Parking Survey

On-street parking surveys were conducted near all major commercial establishments and activity nodes for a total road stretch of 2.56 km. A summary of the parking characteristics of the city is presented in Table 3-10. Highest total parking accumulation was found in Car Street, Palayamkottai market & Vannarpettai Junction.

Table 3-10 Summary of On-Street Parking Survey

On-Street Parking Stretches	Total Stretch (m)	Type of Parking	Peak Accumulation (ECS)	Peak Time	Parking Load (ECS hours)	Total Accumulation
Chellapandyan Flyover	400	Perpendicular / parallel	96	9.00-10.00	24	1532
Car Street	1440	Perpendicular	272	9.00-10.00	68	3032
Palayamkottai Market	375	perpendicular/ angular	184	13.00-14.00	46	1944
Tirunelveli Junction Railway Station	344	Angular	148	11.00-12.00	37	1764

Off-Street Parking Survey

Off-Street parking was conducted at two designated off-street parking locations as mentioned in Table 3-11.

Table 3-11: Summary for Off-Street Parking Locations

Off-Street Parking Locations	Capacity (Parking Bays)	Peak Accumulation (ECS)	Peak Time	Parking Load (ECS hours)	Capacity Utilization
Tirunelveli new Smart City Bus Stand	68	292	16.00-17.00	73	107%
Palayamkottai New Bus Stand	62	44	9.00-10.00	11	18%

Tirunelveli new Smart City Bus Stand parking exhibits its peak during the day between 16:00 pm and 17:00 pm and the Palayamkottai New Bus Stand sees the peak between 9:00 am and 10:00 am but has a continuous parking demand throughout the day.

3.5 TRAFFIC VOLUME IN STUDY AREA

To understand the existing traffic volumes within the city and to understand the vehicular volumes between the study area and outside, the surveys conducted and the analysis thereof has been presented in the following sections.

3.5.1 Outer Cordon Survey

Outer Cordon volume counts were carried out at ten cordon locations to understand the interaction of vehicles coming in and going out from the city. The name of the cordon locations, considered as part of this survey, is shown in Table 3-12.

Table 3-12: Outer Cordon Survey Locations

S. No.	Cordon Location Name
OC 1	SH 41A(Near HP Petrol Pump - Hayagriva Agency)
OC2	Tenkasi road
OC3	Puliangudi-Tirunelveli Road (Supreme Home Goods Store)
OC4	NH 44 (Pandarakulam Esaki Amman Temple)
OC5	SH 75 (Near CSI Christ Church Sivalaperi)
OC6	Vasavappapuram police check post
OC 7	Indian Oil Petrol Pump Vitthalapuram
OC8	Essar Petrol Pump Perinbapuram
OC9	SH 40 (Near Indian Oil Petrol Pump)

Total inbound and outbound traffic at cordon locations is presented in Table 3-13 .

Daily Volume Counts at Cordon Locations

As per the primary survey, the maximum traffic coming in and going outside Tirunelveli was observed along NH 44 (Pandarakulam Esaki Amman Temple), at OC 4. Temporal variation of the traffic at outer cordon locations is shown in Figure 3-10.

Table 3-13: Traffic Volume Counts at Cordon Locations

S. No.	Locations		Direction	Vehicle	PCUs	Total Vehicle	Total PCU
1	OC 1	SH 41A(Near HP Petrol Pump - Hayagriva Agency)	Towards Tirunelveli	6060	5456	11918	10751
			Outside Tirunelveli	5858	5294		
2	OC2	Tenkasi road	Towards Tirunelveli	4165	4933	8205	9486
			Outside Tirunelveli	4040	4553		
3	OC3	Puliangudi-Tirunelveli Road (Supreme Home Goods Store)	Towards Tirunelveli	5515	5590	11226	11403
			Outside Tirunelveli	5711	5814		
4	OC4	NH 44 (Pandarakulam Esaki Amman Temple)	Towards Tirunelveli	9796	11475	20383	23743
			Outside Tirunelveli	10587	12268		
5	OC5	SH 75 (Near CSI Christ Church Sivalaperi)	Towards Tirunelveli	2004	2256	4015	4472
			Outside Tirunelveli	2011	2217		
6	OC6	Vasavappapuram police check post	Towards Tirunelveli	9049	9506	18256	19869
			Outside Tirunelveli	9207	10362		
7	OC 7	Indian Oil Petrol Pump Vitthalapuram	Towards Tirunelveli	9523	9355	18343	17768
			Outside Tirunelveli	8820	8413		

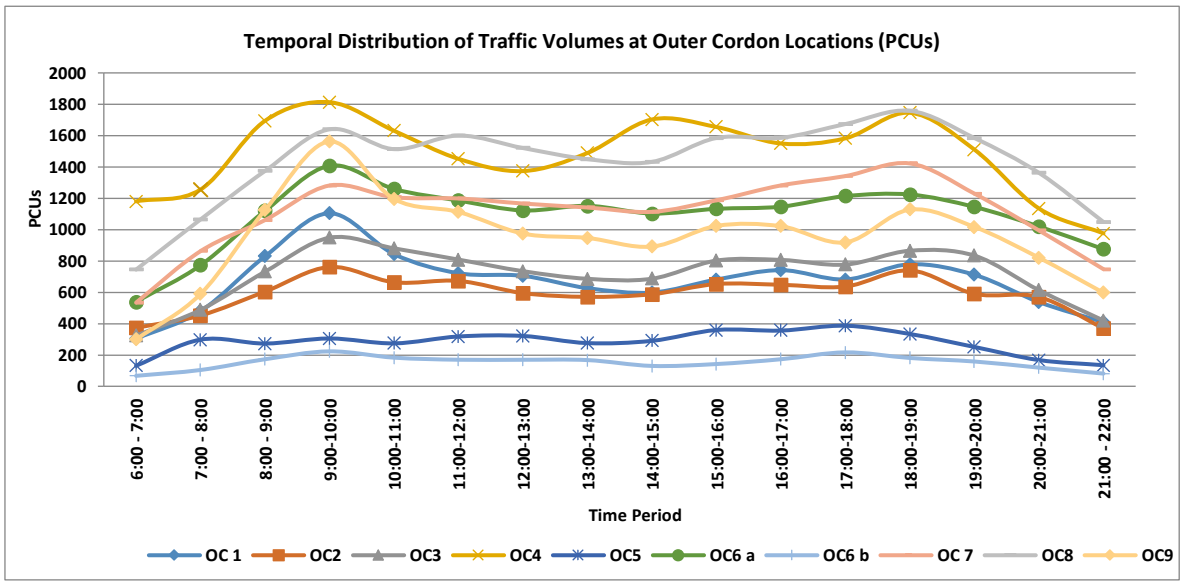
S. No.	Locations		Direction	Vehicle	PCUs	Total Vehicle	Total PCU
8	OC8	Essar Petrol Pump Perinbapuram	Towards Tirunelveli	10021	12029	19390	22937
			Outside Tirunelveli	9369	10908		
9	OC9	SH 40 (Near Indian Oil Petrol Pump)	Towards Tirunelveli	8389	7830	16311	15221
			Outside Tirunelveli	7922	7391		
TOTAL						**128047**	**135650**

Major flow observed on **NH 44** destined towards Nagercoil & Kanyakumari. **23,473 PCU per day** traffic observed near **Pandarakulam Essaki Amman Temple**, which is a gateway to Tirunelveli for vehicles coming from the North.

The average daily traffic entering the city is 6843

The average daily traffic leaving the city is 6722

Figure 3-10: Temporal Variation of PCUs on all Cordon Locations



Peak Hour Traffic Volume At Cordon Locations

Considering all cordon locations as shown in Figure 3-10, the general peak period for Outer Cordon locations in Tirunelveli is observed to be between 8:00 hours and 10:00 hours in the morning and 17:00-19:00 in the evening for the traffic moving in and out of Tirunelveli. The individual peak hours, peak hour volumes, and PCUs observed for all the Outer Cordons are as shown in Table 3-14. The maximum peak hour volume is observed at NH 44 (Pandarakulam Esaki Amman Temple) between 8:45 and 9:45 followed by Essar Petrol Pump Perinbapuram and SH 40 (Near Indian Oil Petrol Pump), while the minimum peak hour volume is observed at OC 6b (Vasavappapuram Police Check Post).

The general peak period for **Outer Cordon locations is between 8:00 hours and 10:00 hours** and **17:00-19:00 hours** in the evening for the traffic moving in and out of Tirunelveli.

Table 3-14: Peak Hour Traffic at Cordon Locations

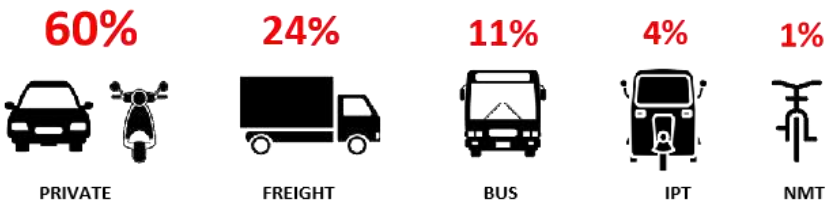
Locations		Peak Hour	Vehicles both Direction	PCUs both Direction
OC 1	SH 41A(Near HP Petrol Pump - Hayagriva Agency)	9:00-10:00	1303	1104
OC2	Tenkasi road	17:45-18:45	637	763
OC3	Puliangudi-Tirunelveli Road (Supreme Home Goods Store)	9:00-10:00	1020	948
OC4	NH 44 (Pandarakulam Esaki Amman Temple)	8:45-9:45	1737	1845
OC5	SH 75 (Near CSI Christ Church Sivalaperi)	17:00-18:00	338	386
OC6 a	Vasavappapuram police check post	9:00-10:00	1376	1407
OC6 b	Vasavappapuram Police Check Post	9:15-10:15	282	228
OC 7	Indian Oil Petrol Pump Vitthalapuram	17:45-18:45	1480	1440
OC8	Essar Petrol Pump Perinbapuram	18:15-19:15	1626	1783
OC9	SH 40 (Near Indian Oil Petrol Pump)	8:45-9:45	1830	1572

Classified Volume Counts At Cordon Locations

It can be observed that, 76% of traffic consists of passenger vehicles. Share of two wheelers is the highest in all locations, varying between 50% and 83%. Share of Goods vehicles is about 24%, while, slow moving traffic is about 1%.

The vehicle composition, as observed at each of the cordon locations, has been shown in Figure 3-11.

Figure 3-11: Traffic Composition at Cordon Points



Private vehicles account for **60%** of the total traffic. A substantial share of **Goods vehicles (24%) was** observed, **primarily attributed to the high fright movement to the Tuticorin port and other industrial areas of the city.**

3.5.2 Screen Line Volume Count

Screen line volume counts were carried out at seven locations to estimate the classified vehicular volumes crossing screen lines. Temporal variation of traffic at screen-lines is shown in Figure 3-12.

Table 3-15: Screen Line Survey Locations

S. No.	Screen Line Locations
Scr-CVC 1	Thamarabarani River Bridge (Srinagar-Kanyakumari Highway)
Scr-CVC 2	Thamarabarani River Bridge (N Bypass Road)
Scr-CVC 3	Railway Crossing Near Pettai Railway Station
Scr-CVC 4	NH 44 (Near Sundara Vinayakar Temple)
Scr-CVC 5	N Bypass Road (Railway Over Bridge)
Scr-CVC 6	Madurai Road Railway Over Bridge
Scr-CVC 7	Kokkirakulam Bridge Over Tamarabarani River

Daily Traffic Volume Counts at Screen Line Locations

Daily Traffic volume at screen-lines is given in Table 3-16 and the temporal variation is given in Figure 3-12.

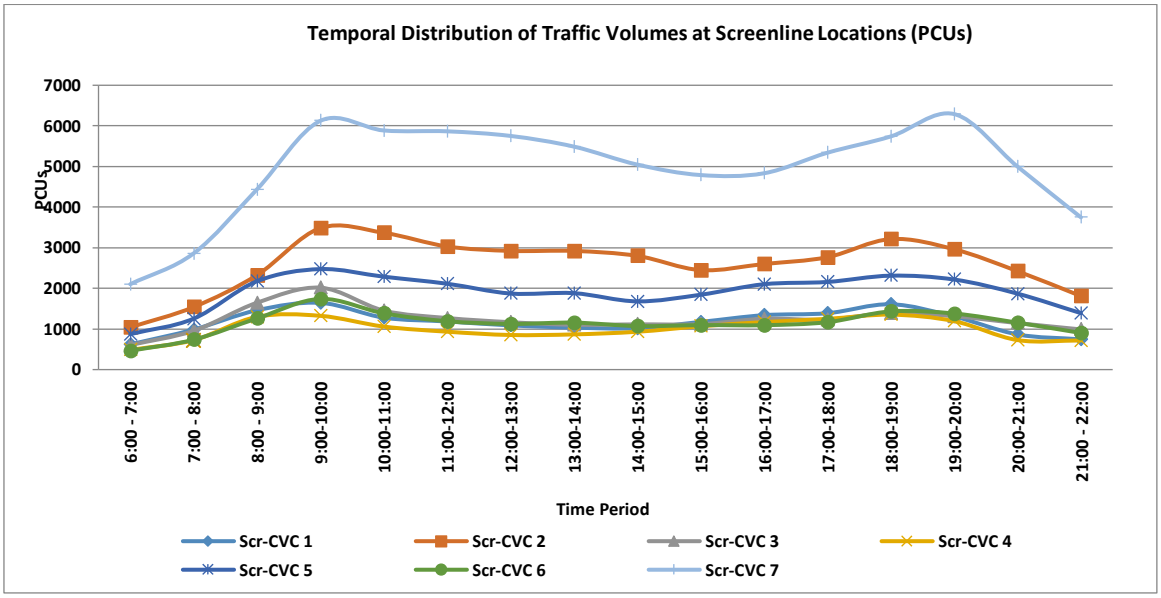
Table 3-16: Screen Line Survey Locations and observed Traffic

Locations		Direction	Veh	PCUs	Total Vehicle	Total PCU
Scr-CVC 1	Thamarabarani River Bridge (Srinagar-Kanyakumari Highway)	Towards Tirunelveli	8,674	9,474	16,981	18,737
		Outside Tirunelveli	8,307	9,263		
Scr-CVC 2	Thamarabarani River Bridge (N Bypass Road)	Towards Tirunelveli	21,537	20,665	43,690	41,654
		Outside Tirunelveli	22,153	20,988		
Scr-CVC 3	Railway Crossing Near Pettai Railway Station	Towards Tirunelveli	10,916	9,784	22,105	19,769
		Outside Tirunelveli	11,189	9,986		
Scr-CVC 4	NH 44 (Near Sundara Vinayakar Temple)	Towards Tirunelveli	6,925	8,334	13,598	15,947
		Outside Tirunelveli	6,673	7,613		
Scr-CVC 5	N Bypass Road (Railway Over Bridge)	Towards Tirunelveli	14,860	15,541	29,420	30,499
		Outside Tirunelveli	14,560	14,958		
Scr-CVC 6	Madurai Road Railway Over Bridge	Towards Tirunelveli	10,229	9,206	20,439	18,350
		Outside Tirunelveli	10,210	9,143		
Scr-CVC 7	Kokkirakulam Bridge Over Tamarabarani River	Towards Tirunelveli	42,677	39,381	85,592	79,299
		Outside Tirunelveli	42,915	39,918		

Locations	Direction	Veh	PCUs	Total Vehicle	Total PCU
Total				2,31,825	2,24,255

Maximum traffic was observed on the Kokkirakulam Bridge at Scr-CVC 7, wherein the major flow is observed towards VOC Stadium

Figure 3-12: Temporal Distribution of Traffic Volume at Screen Line Locations



Peak Hour Traffic Volume at Screen Line Locations

Details of observed peak hour traffic at screen lines have been given in Table 3-17.

The maximum peak hour volume is observed **at Scr-CVC 7 (on Kokkirakulam Bridge Over Tamarabarani River) between 09:15 and 10:15** followed by **Scr-CVC 2 (Thamarabarani river bridge on North Bypass Road)**, while the minimum peak hour volume is observed at **Scr-CVC 4 (NH 44 north, near sundara vinayaka temple)**.

Table 3-17: Peak Hour Traffic Volume at Screen Line Locations

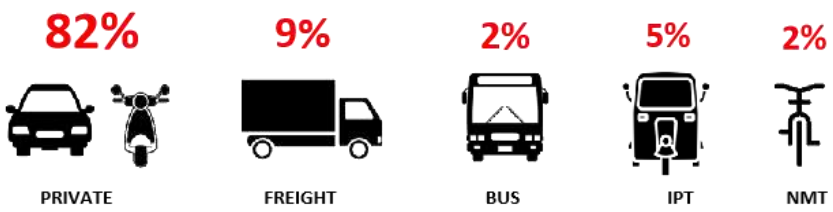
Locations		Peak Hour	Vehicles Both Directions	PCUs Both Directions
Scr-CVC 1	Thamarabarani River Bridge (Srinagar-Kanyakumari Highway)	8:45-9:45	1708	1674
Scr-CVC 2	Thamarabarani River Bridge (N Bypass Road)	9:15-10:15	4013	3581
Scr-CVC 3	Railway Crossing Near Pettai Railway Station	8:45-9:45	2581	2178
Scr-CVC 4	NH 44 (Near Sundara	8:30-9:30	1455	1467

Locations		Peak Hour	Vehicles Both Directions	PCUs Both Directions
	Vinayakar Temple)			
Scr-CVC 5	N Bypass Road (Railway Over Bridge)	8:45-9:45	2740	2568
Scr-CVC 6	Madurai Road Railway Over Bridge	9:00-10:00	2027	1740
Scr-CVC 7	Kokkirakulam Bridge Over Tamarabarani River	9:15-10:15	7063	6354

Classified Volume Counts at Screen Line Locations

Traffic composition observed at Screen-lines is shown in Figure 3-13.

Figure 3-13: Traffic Composition at Screen Line Points



Private and IPT vehicles account for 72% and 5% while **NMT vehicles** in city is around **2% and Public Transport vehicles is 2%**

1% share of public transport is attributed to the inter-city bus services operated by TNSTC and private operators

3.5.3 Traffic Volume Count At Intersections

Intersection Turning/Traffic Volume Counts (CVC) were carried out at 17 critical locations, names of which are given in Table 3-18.

Table 3-18 : Survey Locations of CVC at Intersections

S. No.	Junction Name
JN 1	Chellapandyan Flyover Junction
JN 2	NH 44 and Madurai Road Intersection
JN 3	Veerapandiya Kattabomman Statue Junction
JN 4	Pettai Roti Kadai Junction
JN 5	Trivandrum Road-South By Pass Road Junction
JN 6	NH 44 - Trivandrum Road Junction

S. No.	Junction Name
JN 7	Samadhanapuram Juction
JN 8	NH 44- NH 138 Junction
JN 9	Trivandrum Road - Ambai Road Junction
JN 10	Relaince Petrol Pump Junction
JN 11	Town Arch Junction
JN 12	Tyagaraja Nagar Railway Gate Junction
JN 13	West Car Street- South Car Street Junction
JN 14	Madurai Road North By Pass Road Junction
JN 15	Nainarkulam Road Nainarkulam Road, Tirunelveli Sankarankovil Road Junction
JN 16	NH 44 Sivalaperi Road Junction
JN 17	Swami Nellaiappar Highroad- Tirunelveli Old Bus Stand Road Junction

Daily and Peak Hour Traffic Volume at Intersections

The daily and peak hour volume of vehicles at intersections are given in Table 3-19.

Table 3-19: Daily and Peak Hour Traffic at Intersections

S. No.	Name of the Junction	Daily Vehicles	Peak Hour	Peak Hour Vehicles
1	Chellapandyan Flyover Junction	104857	10:00-11:00	8011
2	NH 44 and Madurai Road Intersection	29884	9:00-10:00	2515
3	Veerapandiya Kattabomman Statue Junction	64619	9:30-10:30	5470
4	Pettai Roti Kadai Junction	35256	9:00-10:00	3314
5	Trivandrum Road-South By Pass Road Junction	61747	18:00-19:00	5405
6	NH 44 - Trivandrum Road Junction	21144	9:00-10:00	1997
7	Samadhanapuram Juction	42977	9:15-10:15	3370
8	NH 44- NH 138 Junction	63017	18:15-19:15	5054
9	Trivandrum Road - Ambai Road Junction	56658	9:15-10:15	5002
10	Relaince Petrol Pump Junction	85843	9:15-10:15	7658
11	Town Arch Junction	73431	9:15-10:15	6447
12	Tyagaraja Nagar Railway Gate Junction	48797	9:15-10:15	4590
13	West Car Street- South Car Street Junction	51558	9:00-10:00	3913
14	Madurai Road North By Pass Road Junction	46729	9:30-10:30	3954
15	Nainarkulam Road Saliyar Street Junction	37197	9:15-10:15	3449
16	NH 44 Sivalaperi Road Junction	24548	9:00-10:00	2734

S. No.	Name of the Junction	Daily Vehicles	Peak Hour	Peak Hour Vehicles
17	Swami Nellaiappar Highroad- Tirunelveli Old Bus Stand Road Junction	86842	18:45-19:45	7160

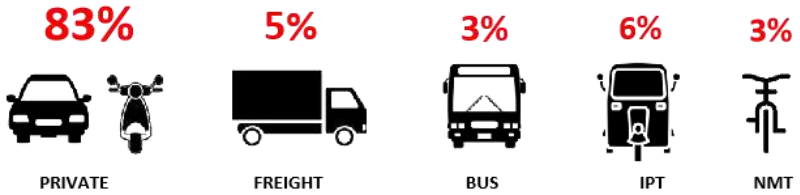
Chellapandyan Flyover Junction, Reliance Petrol Pump Junction, Tirunelveli Old Bus Stand Road Junction and GIC Chowk carry more than **85,000 vehicles (80,000 PCUs)** per day and more than **7,000 vehicles during peak hour**.

Town Arch Junction, Veerapandiya Kattabomman Statue Junction and Trivandrum Road-South By Pass Road Junction serve more than **60,000** vehicles every day.

Traffic Composition at Intersections Locations

The traffic composition at junctions are as shown in Figure 3-14. It was observed that 83% of the vehicles were private vehicles and a mere 3% of the vehicles composed of buses.

Figure 3-14: Vehicular Composition at Junctions



On average, the **composition of private vehicles on all these junctions ranges from 77% to 87%.**

At junctions such as West Car Street- South Car Street Junction and Nainarkulam Road Saliyar Street Junction, it was observed that non-motorized transport constituted more than 10% of the total traffic.

3.5.4 Traffic Volume Count at Mid-Block

Mid-block surveys were done at four locations within the city for 16 hours a day at the locations given in Table 3-20.

Table 3-20: Mid-block Survey Locations

S. No.	Mid-Block Locations
MB 1	NH 44
MB 2	Tirunelveli Sankarankoil Rajapalayam Road
MB 3	SH 39
MB 4	South Bypass Road
MB 5	Tirunelveli Moolaikkaraipatti
MB 6	Town Road

Daily and Peak Hour Traffic Volume

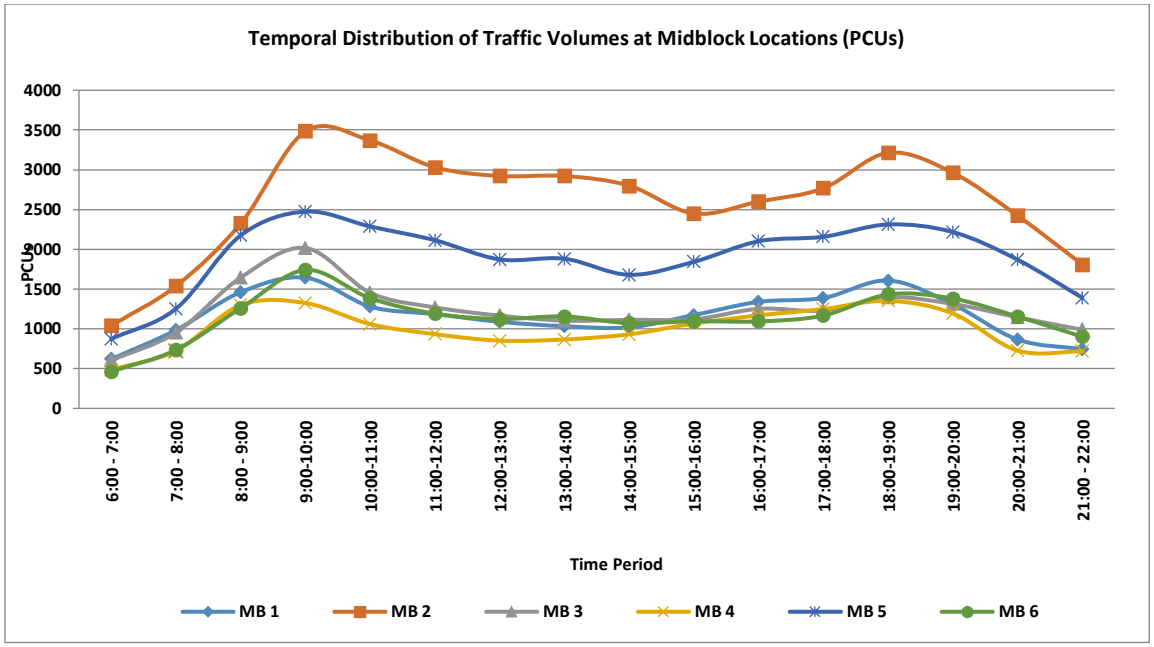
The daily and peak hour traffic volumes observed at Mid-blocks are as given in Table 3-21 and the temporal variation of traffic observed through the day is shown in Figure 3-15.

Table 3-21: Observed Traffic Volume At Mid-blocks

Location		Direction	Veh.	PCU	Total Veh	Total PCU
MB1	NH 44	Ponnakudi to V.M.Chatram	6,154	8,231	11,812	15,719
		V.M.Chatram to Ponnakudi	5,658	7,488		
MB 2	Tirunelveli Sankarankoil Rajapalayam Road	Thachanallur to Ramayanpatti	8,603	8,602	17,508	17,356
		Ramayanpatti to Thachanallur	8,905	8,754		
MB 3	SH 39	Vannarpettai to Valaiyapettai	10,418	9,391	21,632	19,652
		Valaiyapettai to Vannarpettai	11,214	10,261		
MB 4	South Bypass Road	Melapalayam to Vannarpettai	25,432	25,035	50,796	50,034
		Vannarpettai to Melapalayam	25,364	24,998		
MB 5	Tirunelveli Moolaikkaraipatti	Itteri to Vasantha Nagar	7,708	6,315	14,989	12,278
		Vasantha Nagar to Itteri	7,281	5,963		
MB 6	Town Road	Tirunelveli Town to Thachanallur	6,757	5,919	12,477	10,833
		Thachanallur to Tirunelveli Town	5,720	4,914		
Total					**1,29,214**	**1,25,872**

Max traffic is observed along **South Bypass Road** at **MB 4,** wherein the **major flow is towards Vannarpettai, followed by MB 3 (SH 39).**

Figure 3-15: Temporal Variation of Traffic Volume at Mid-Blocks

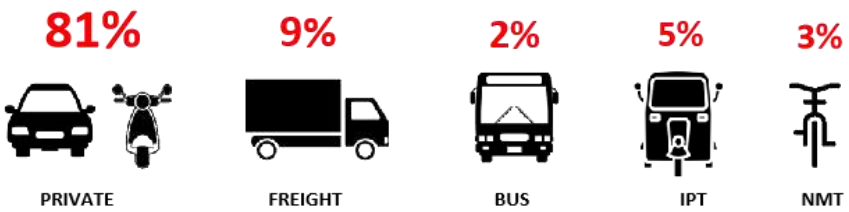


All the six mid-block locations show **less variation throughout the day**. As most of these mid-block locations are around heavily congested junctions in the city, traffic flow is moderate to high throughout the day.

Maximum peak hour volume is observed on **South Bypass Road** at **MB 4 between 18:00 and 19:00**, followed by **MB 3 (SH 39)**

The modal share at Mid-Block Locations is represented in Figure 3-16.

Figure 3-16: Traffic Composition at Mid-Block Points



- Private and IPT vehicles account for 81% and 5%
- Goods vehicles in the city is around 9%

3.6 PEDESTRIAN COUNT SURVEY

Pedestrian count data will be used frequently in planning applications. The data collected will be used to evaluate sidewalk and crosswalk needs, to justify pedestrian signals, and to time traffic signals.

Pedestrian counts will be carried out for a period of 16 hours in the 7 identified critical locations (ref Table 3-22) in Tirunelveli. The analysis shall enable identification of the High Risk Pedestrian Zones in the study area and will enable in improvement options for pedestrian facilities in the study area.

Table 3-22 Pedestrian Count Survey Locations

Code	Pedestrian Counts
Ped 1	Palayamkottai Market
Ped 2	Car Street Entrance
Ped 3	Chellapandyan Flyover Junction
Ped 4	Thachenellur Junction
Ped 5	Tirunelveli New Bus Stand/ Smart City Park
Ped 6	Railway Station/ Old Periya Bus Stand

The summary of pedestrian flow characteristics is presented in Table 3-23 and Figure 3-17.

Figure 3-17 Tirunelveli Pedestrian Survey- Morning and Evening Peak

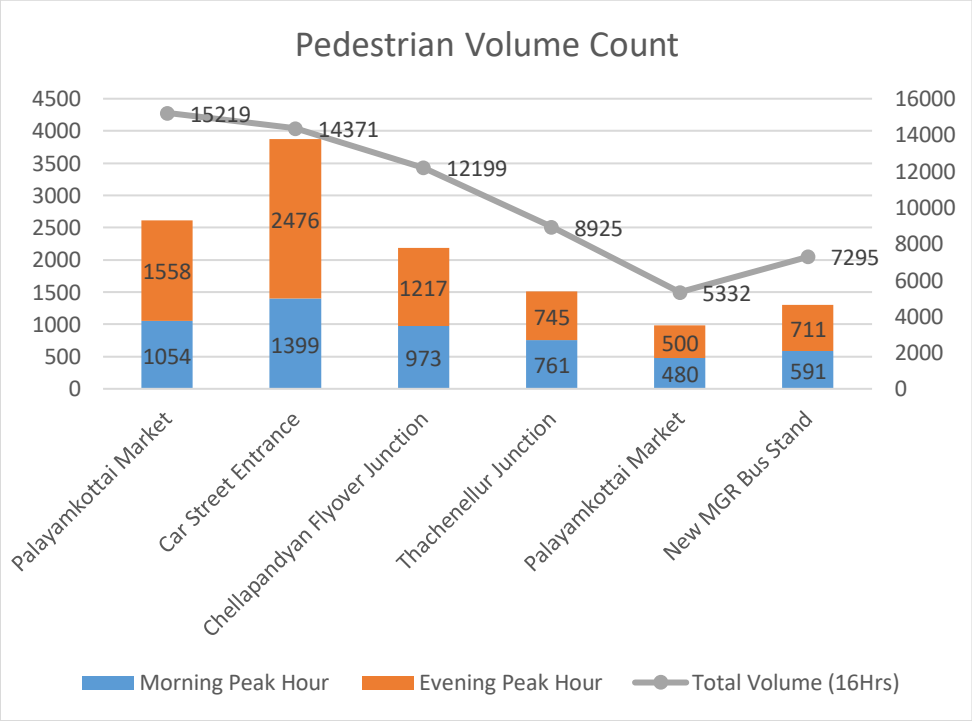


Table 3-23 Summary of Pedestrian flow characteristics

S. No	Location Name	Morning Peak Hour		Evening Peak Hour		Total Volume (16Hrs)
		Volume	Time	Volume	Time	
1	Palayamkottai Market	1054	09:00 - 10:00	1558	19:00 - 20:00	15219
2	Car Street Entrance	1399	12:00 - 13:00	2476	18:00 - 19:00	14371
3	Chellapandyan Flyover Junction	973	09:00 - 10:00	1217	16:00 - 17:00	12199
4	Thachenellur Junction	761	11:00 - 12:00	745	20:00 - 21:00	8925
5	Palayamkottai Market	480	09:00 - 10:00	500	18:00 - 19:00	5332
6	New MGR Bus Stand	591	12:00 - 13:00	711	19:00 - 20:00	7295

Pedestrian Survey Observation

Sixteen hour count has been conducted at 7 locations in the study area. Some of the major observations are given below.

- Heavy pedestrian crossings are observed in CBD/ commercial areas compared to other locations.
- Pedestrian crossings at junctions/roads in the City ranged from 5332 to 15219 for sixteen hours duration.
- Among all the locations within the study area, heavy pedestrian crossing was observed at Palayamkottai Market followed by Car Street Entrance and Chellapandyan Flyover Junction

3.7 PUBLIC/ INTERMEDIATE PUBLIC TRANSPORT FACILITIES

To assess the regional public transport facilities as well as the travel pattern of the commuters of Tirunelveli, traffic volume analysis and travel characteristics surveys of commuters were evaluated through terminal surveys at bus terminals and railway stations.

3.7.1 Regional Transport Facilities- Bus & Rail Terminal Surveys

Passenger Count

Terminal Pedestrian Volume count survey was conducted at all major terminal points in the city. Maximum footfall was observed at Vannarpettai bus stop (30334), under flyovers followed by Tirunelveli new bus stand along the Trivandrum Road (22140). The observed pedestrian flow has been shown in Table 3-24.

Table 3-24 Terminal Pedestrian Volume Counts

Location Name	Morning Peak Hour		Evening Peak Hour		Total Volume (16Hrs)
	Volume	Time	Volume	Time	Total
Tirunelveli Junction Temporary Bus Stand	287	09:00 - 10:00	336	17:00 - 18:00	3401
Palayamkottai Bus Stand	1387	08:00 - 09:00	1961	16:00 - 17:00	9515
Vannarpettai Bus stop	3373	09:00 - 10:00	2563	17:00 - 18:00	30334
Tirunelveli MGR Bus Stand	1732	09:00 - 10:00	2265	18:00 - 19:00	22140
Palayamkottai Railway Station	114	07:00 - 08:00	291	19:00 - 20:00	1458
Tirunelveli Junction Railway Station	865	06:00 - 07:00	1061	18:00 - 19:00	9705

The peak hour associated with railway station pedestrian counts are based on the intercity train timings.

Vehicular Count

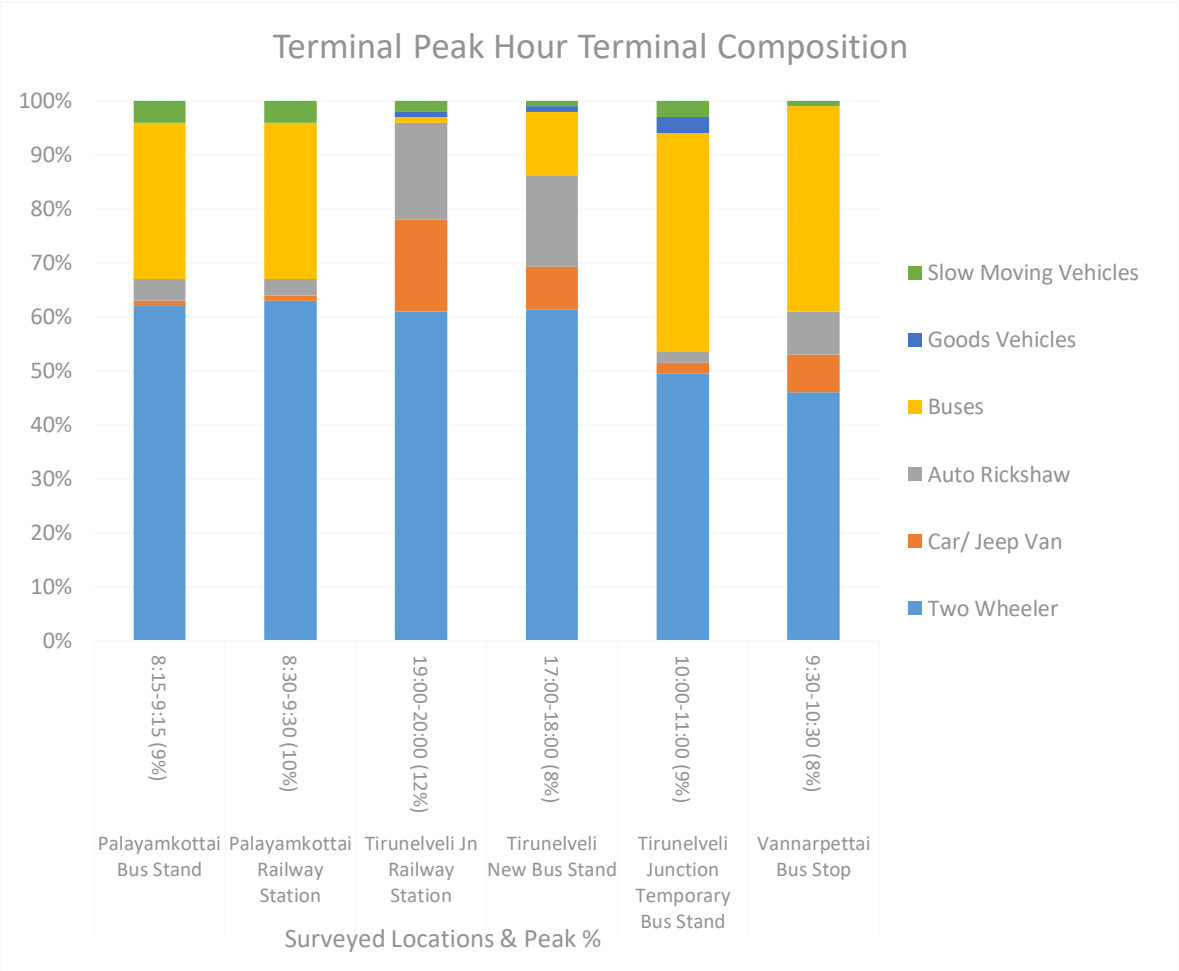
As given in Table 3-25, Out of all the surveyed locations, Tirunelveli New MGR bus stand since it caters for different categories of Bus Services, had the highest count of terminal vehicular access followed by the Vannarpettai Bus boarding points under the flyover. Tirunelveli Junction Railway Station comes third with respect to the total vehicular volume.

Figure 3-18 shows the composition of access & egress modes of the railway and bus terminal passengers.

Table 3-25 Terminal Vehicular Volume Count

Location Name	ENTRY		EXIT		Total Vehicles	Total PCUs
	Vehicles	PCUs	Vehicles	PCUs		
Tirunelveli Junction Temporary Bus Stand	2314	3488	2321	3503	4635	6990
Palayamkottai Bus Stand	313	324	317	322	630	645
Vannarpettai Bus stop Under Flyover	10410	10245	10426	10351	20836	20596
Tirunelveli MGR Bus Stand	15044	19193	15164	19531	30208	38724
Palayamkottai Railway Station	1316	2871	1300	2843	2616	5714
Tirunelveli Junction Railway Station	7132	11556	6801	11217	13933	22773

Figure 3-18: Traffic Composition during peak hour at terminals



Trip Purpose

24% of the commuters at the railway station are travelling for Religious/Recreation purposes, whereas 19% of the passengers are travelling for social purposes and 16% of the passengers are travelling for work-related activities. **18% of the commuters at the bus terminals are travelling for Religious/Recreation purposes**, whereas **17% of the passengers for Work related activities** and **15% of the passengers** are travelling for **social activities.**

1. Access/ Egress Modes

Access/Egress Mode: most preferred access, as well as egress mode at the terminal, is **the two-wheeler, with a very high share of 32%.** The most preferred **access and egress modes at the bus terminals is City Bus** followed by two-wheelers.

2. Access/ Egress Distances

The data for access/egress distance for both the railway stations shows that **most trips are >20 kms** and 33% are between 10-20 Kms. The most number of **access and egress trips are in the range of 5 to 10 km with 29% and between 10-20 Kms at 24% and 2-5 Kms at 23%.** The most number of **access and egress trips among bus terminal passengers are in the range of 5 to 10 km with 29% and between 10-20 Kms at 24% and 2-5 Kms at 23%.**

3.7.2 Intermediate Public Transport - Operator & Commuter Survey

Due to the absence of a formalized bus network in the city, IPT modes serve the public transport needs. The IPT demand in the city is being catered to primarily by auto rickshaws, and shared and hired auto-rickshaws.

Ownership and Hiring Basis

From the survey, it is observed that for most of the IPT modes operating in Tirunelveli the ownership lies with the drivers. About 60% of the auto-rickshaws are self-owned.

Cost of IPT Operations

Cost of IPT Operations recorded during the survey is given in Table 3-26.

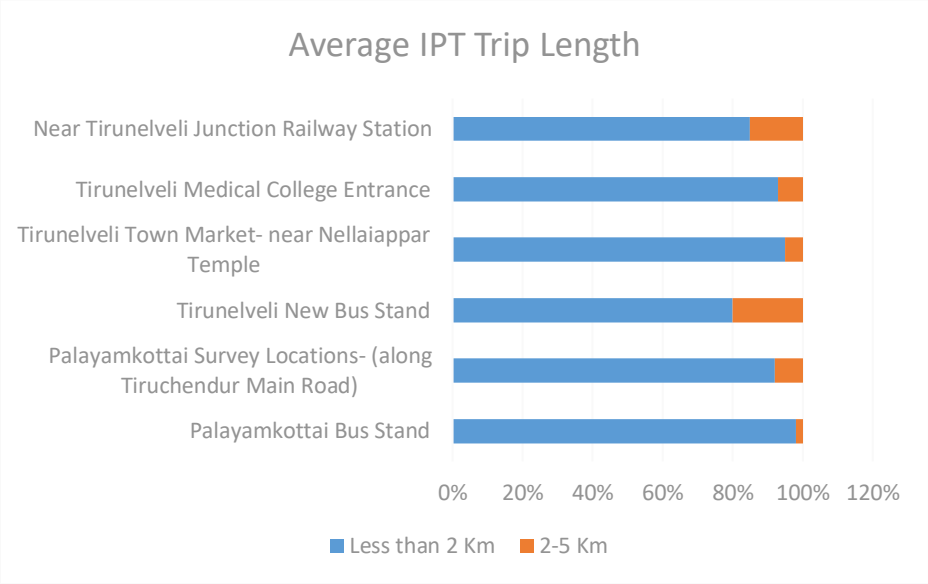
Table 3-26 IPT Operator Survey Analysis- Overall expenditure for rented vehicle

Type	Fuel cost (Rs.)	Maintenance Cost (Rs.)	Revenue (Rs.)	Earnings/ Savings (Rs.)	Rent (Rs.)
Auto Rickshaw (3 Seater)	333	148	1148	531	136
Rickshaw	267	220	767	167	113
Taxi (Car)	1000	171	2276	613	492

Average IPT Trip Length of Commuters

It can be understood from the figure that in Tirunelveli, IPT is being used for short distances only (refer Figure 3-19)

Figure 3-19 Average IPT Trip Length of Commuters



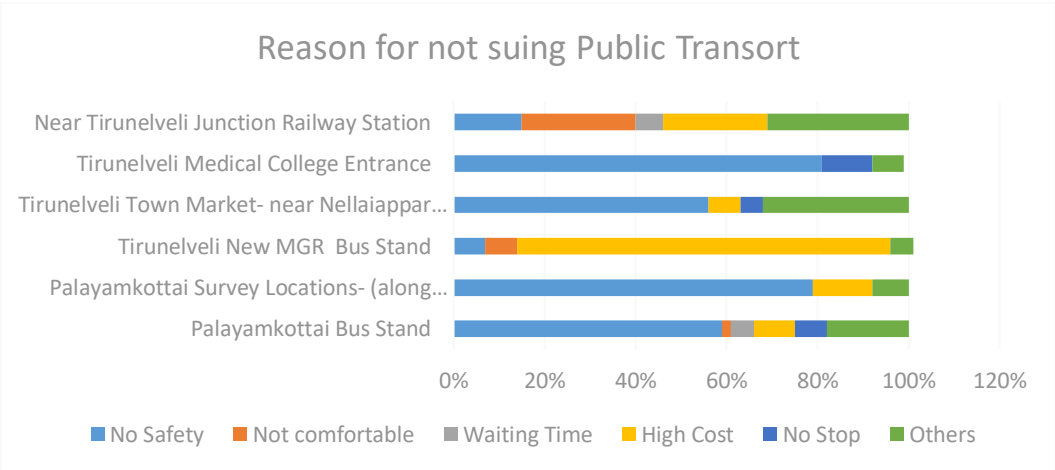
Number of Trips Served

Per day 10–15 trips are made by 38% and 33% of the auto-rickshaws and shared rickshaws, respectively in the city.

Reasons For Not Using Public Transport

On analysing the response about the reason for not using public transport, (Figure 3-20), Safety issues related to Public Transport was the major reason conveyed by the IPT users for not using Public Transport services.

Figure 3-20 Opinion on PT by IPT Users



3.8 SOCIO-ECONOMIC CHARACTERISTICS OF COMMUTERS AND EXISTING TRAVEL PATTERN

To assess the socio-economic characteristics, travel patterns, mode choice, the willingness of commuters to shift to other modes etc., an extensive primary survey was done covering the following types of surveys:

1. Household Survey with Travel Diary
2. Origin Destination Survey at Outer Cordon Locations
3. Origin Destination Survey at Screen Line locations
4. Willingness to Shift Surveys at Terminals
5. Establishment Survey

The distribution of trips observed during the above mentioned surveys are as shown in Table 3-27 and Figure 3-21.

3.8.1 House Hold Survey

The survey was carried out with a sample size of 2% of the total population, distributed within the study area. The major observations are summarized below.

Household Size

58% of the households have 3-4 members and. 25% of the house-holds have 1-2 members per household. The average household size of Tirunelveli is 3.9.

Socio-Economic Characteristics

About **36%** of the people are in **Low Income Group** and **25%** of the people fall under **Higher Income Group** and **35%** of the people are coming under **Middle Income Group**. The average income is **16,768/--** and average earner per house is **1.1**. The socio-economic characteristics of the study area have been assessed and provided in Table 3-27.

Figure 3-21: Distribution of Trips

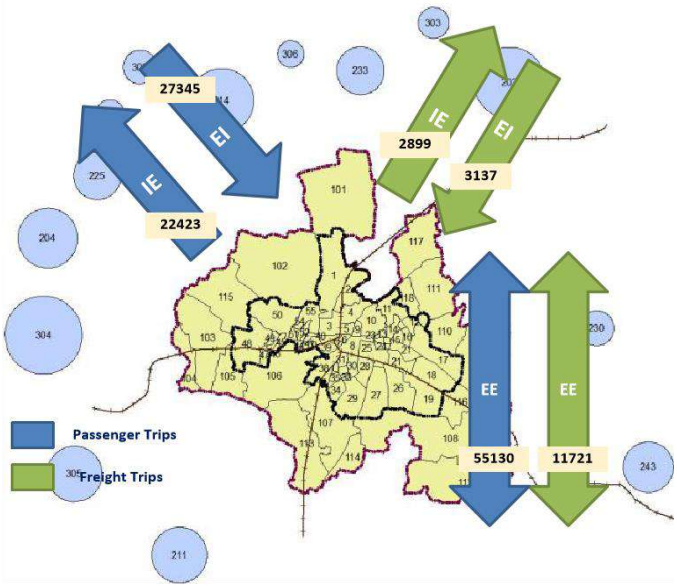


Table 3-27: Major Socio-economic Characteristics of Surveyed Households

Number of Members in HH		Vehicle Ownership		Main Activity		Education Qualification		Monthly Income		Number of Earning Members per HH	
No	%	Number	%	Activity	%	Education Level	%	Monthly Income	%	No	%
<5	89 %	No Vehicle	14 %	Business	9%	No School Education	17%	<5000	7%	1	6%
5	7%	Two Wheeler	78 %	Retired/ unemployed	25 %	Up to High School (8th Grade)	12%	5001-10000	36 %		
		Car	7%	Service	18 %	High School (up to 10th)	37%	10001-15000	26 %	02-03	63%
>5	4%	Others	1%	Student	14 %	Graduate	27%				
				Worker/ Labour / Farmer	34 %	Post Graduate	7%	> 15000	31 %	>3	31%

Travel Characteristics

1. Trip Rate

The trip rate with walk trips is **1.24** and without walk trips, it is **1.11** for the study area.

2. Trip Length

Average motorized trip length observed was 5.8 km and average non-motorized trip length was 1.6 km

3. Modal Share

The motorised and non-motorised mode share has been given in Figure 3-22 and Figure 3-23

The highest mode share in terms of day-to-day travel is by **two-wheelers, which accounts for 41%. Cycle trips** account for **2%** of the mode share.

Figure 3-22 Non-Motorized Mode Share in Tirunelveli

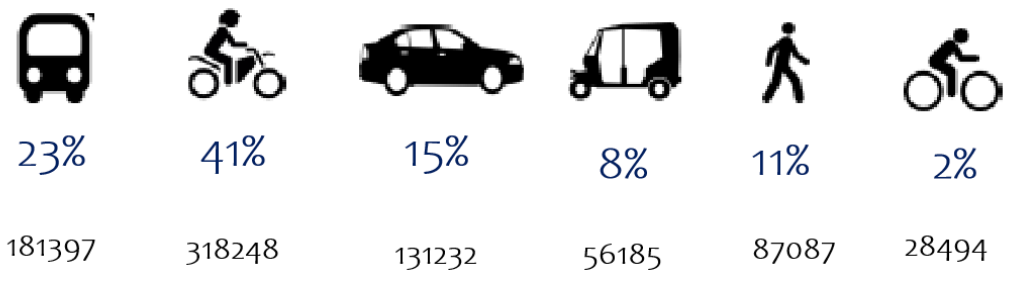
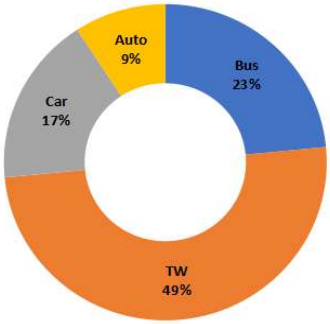


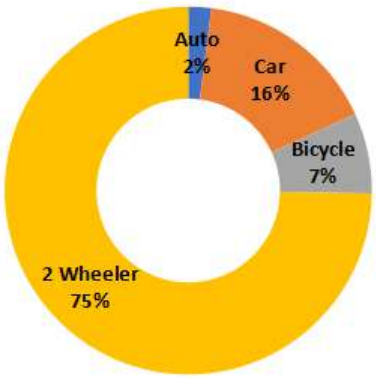
Figure 3-23 Mode Share in Tirunelveli



4. Vehicle Ownership

Vehicle ownership recorded during the House Hold Survey is represented in Figure 3-24

Figure 3-24 Vehicle Ownership



74% of households surveyed owned 2 wheelers whereas only 16% of households owned 4 wheelers. The ownership of bicycles was found out to be 7%.

5. Mode-wise Travel Cost

The average monthly HH expenditure on transportation is 9% of the household income for the city.

Mode-wise cost of travel analysis shows that the highest cost per km in the city is of four-wheelers, i.e., Rs 17.2 per km, followed by, IPT modes, two-wheelers and cycle rickshaws. (Refer Table 3-28)

Table 3-28: Mode-wise Cost of Travel

Mode-wise Cost of Travel	
Mode	**Cost/km**
Two-wheeler	6.9
Four-wheeler	17.2
Auto-Rickshaw/E-Rickshaw	13.4
Cycle Rickshaw	8
Inter-city Bus/Inter-state Bus	4.5

3.8.2 Origin Destination Survey at Outer Cordon Locations

OD Survey was conducted at nine outer cordon locations. At each identified location, the origin and destination along with other trip characteristics of the passengers by vehicle type were recorded. Trip pattern of Passenger Vehicles in the Study Area has been shown in Figure 3-25 and Figure 3-26. The same has been given in Table 3-29.

Passenger Vehicle Trip Characteristics

1. Vehicular Flow

The highest vehicular flow share is **external to external flow at 53%,** followed by **external to internal flow at 24%**. About **20% of the total flow is Internal to external flow**.

Figure 3-25: Cordon-wise Private Vehicle Trip Distribution

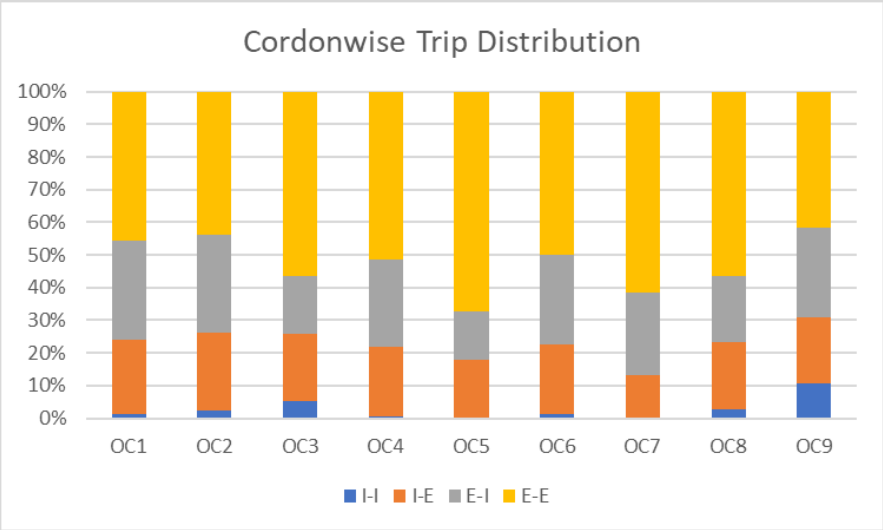


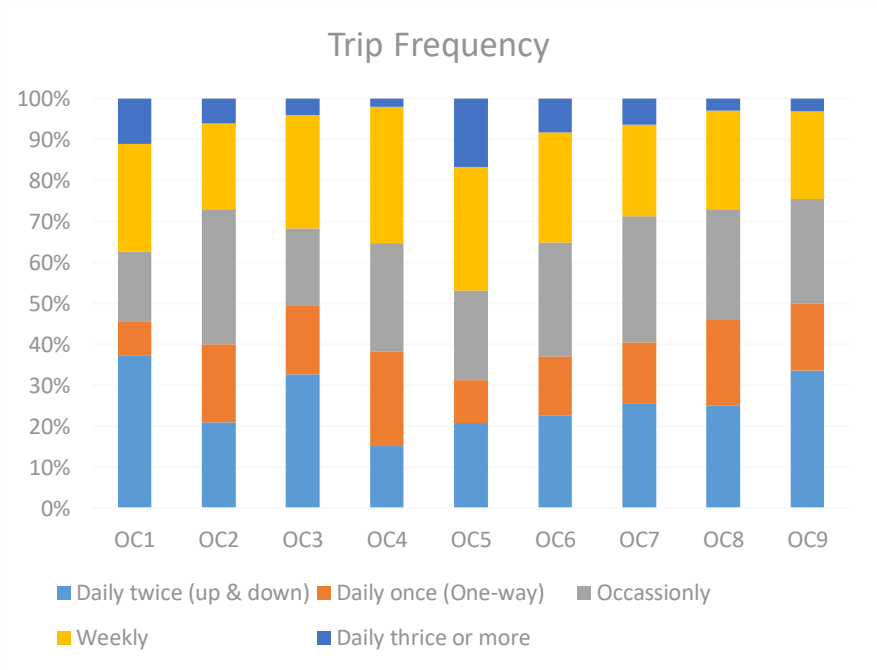
Table 3-29: Passenger Trip Details

Passenger Vehicle				
Mode	**I-E**	**E-I**	**E-E**	**TOTAL**
Car/Jeep/Van (White Board)	**6433**	**7721**	**17736**	**31890**
2-Wheeler	**15381**	**18489**	**35496**	**69366**
Car/Jeep/Van (Yellow Board)	**469**	**589**	**1669**	**2727**
Auto-Rickshaw-3 Searter	**62**	**166**	**60**	**288**
Auto-Rickshaw-7 Searter	**79**	**380**	**169**	**628**

2. Trip Frequency

Almost **48% of the trips were observed to be daily trips**. While these daily trips can be broadly attributed to the institutional nature of the city, which attracts a sizeable workforce working in various institutions. Other trip frequencies with a substantial share include occasional and weekly trips.

Figure 3-26: Trip Frequency of Passenger Trips at Outer Cordons

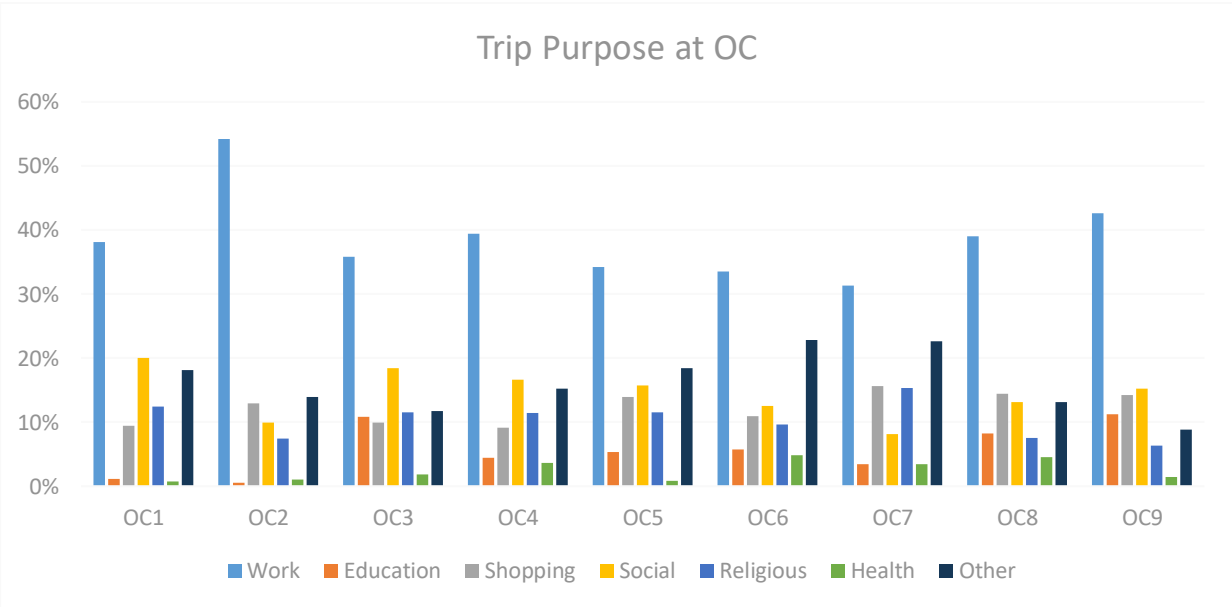


3. Trip Purpose

Trip Purpose recorded at the Cordon Locations asre as represented in Figure 3-27.

Work trips account for 39%, followed by 16% of other trips. 14% of Social Trips and 12% of Shopping trips, which make up the larger share of the total trips.

Figure 3-27: Trip Purpose of Passenger Trips at Outer Cordons



Goods Vehicles Travel Characteristics

Trip pattern of Freight Vehicles in the Study Area has been shown in Table 3-27.

Figure 3-21. The same has been given in Table 3-30.

Table 3-30: Goods Trip Details

Goods Vehicle				
Mode	I-E	E-I	E-E	TOTAL
LCV	1529	2007	5965	9502
Goods Auto	74	86	236	396
Truck (2 - Axle)	419	440	2229	3088
Truck (3 - Axle)	373	369	1439	2182
MAV	502	197	1789	2488
Agricultural Tractor Trailer	1	38	63	102

Goods vehicles were also interviewed during RSI (Figure 3-28: goods survey at Tirunelveli), the results are as follows:

Figure 3-28 Goods Survey at OC4

MODE SHARE: Modes of goods vehicles are given in the table, LCV was the most common mode used by goods transport (ref Table 3-31, Figure 3-29).

Table 3-31 Goods vehicle composition at Outer Cordon

S No	Cordon Locations	LCV	Goods Auto	Truck (2-Axle)	Truck (3-Axle)	MAV	Agricultural Tractor Trailer
1	SH 41A - Tirunelveli-Pottalpudur Road	43%	16%	12%	16%	13%	0%
2	SH 39 - Tenkasi-Tirunelveli Road	24%	1%	16%	54%	0%	4%

S No	Cordon Locations	LCV	Goods Auto	Truck (2-Axle)	Truck (3-Axle)	MAV	Agricultural Tractor Trailer
3	SH 41 Sankarankoil Tirunelveli Road	50%	1%	25%	12%	12%	0%
4	NH 44 Srinagar-Kanyakumari Highway	29%	4%	22%	26%	13%	6%
5	SH 75 Sivalaperi Road	21%	29%	20%	18%	6%	6%
6	NH 138 Tirunelveli Thoothukudi Highway	8%	19%	26%	23%	19%	5%
7	SH 40 Tirunelveli Tiruchendur Main Road	12%	34%	22%	15%	13%	5%
8	NH 44 Srinagar-Kanyakumari Highway	24%	0%	26%	39%	8%	3%
9	SH 40 Tirunelveli Shenkottai Road	15%	1%	23%	57%	1%	4%

GOODS COMMODITY: On analyzing the commodity types (refer Figure 3-29), highest (32%) were vegetables/commodities, followed by sand bricks and cement, as Tirunelveli couple of cement manufacturing units.

Figure 3-29 Goods Vehicle Mode Share

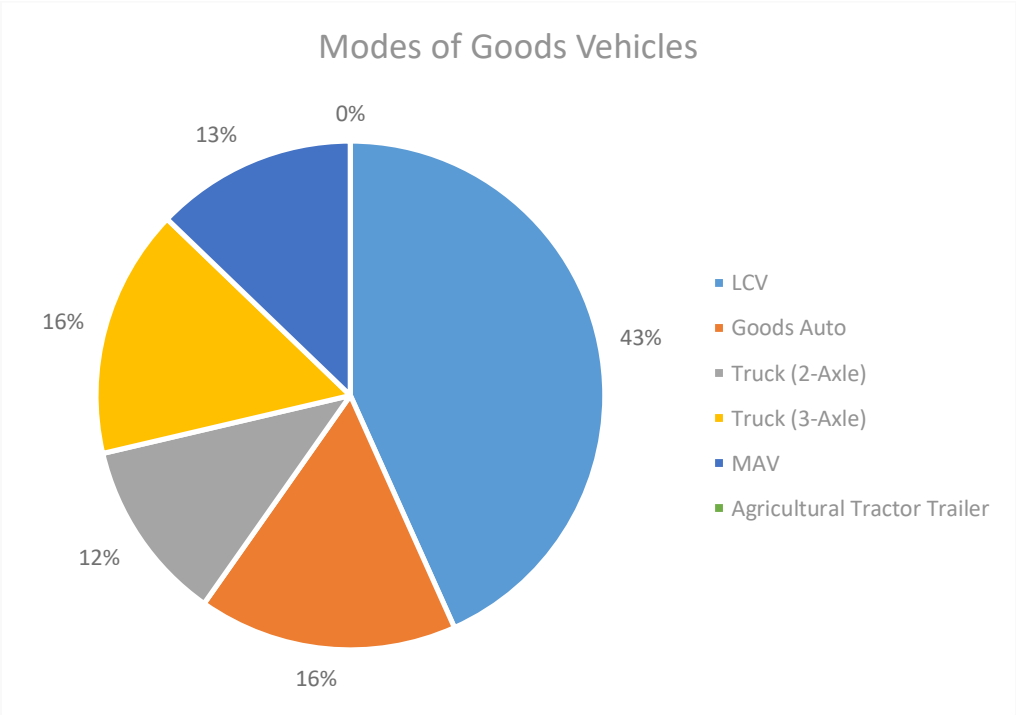
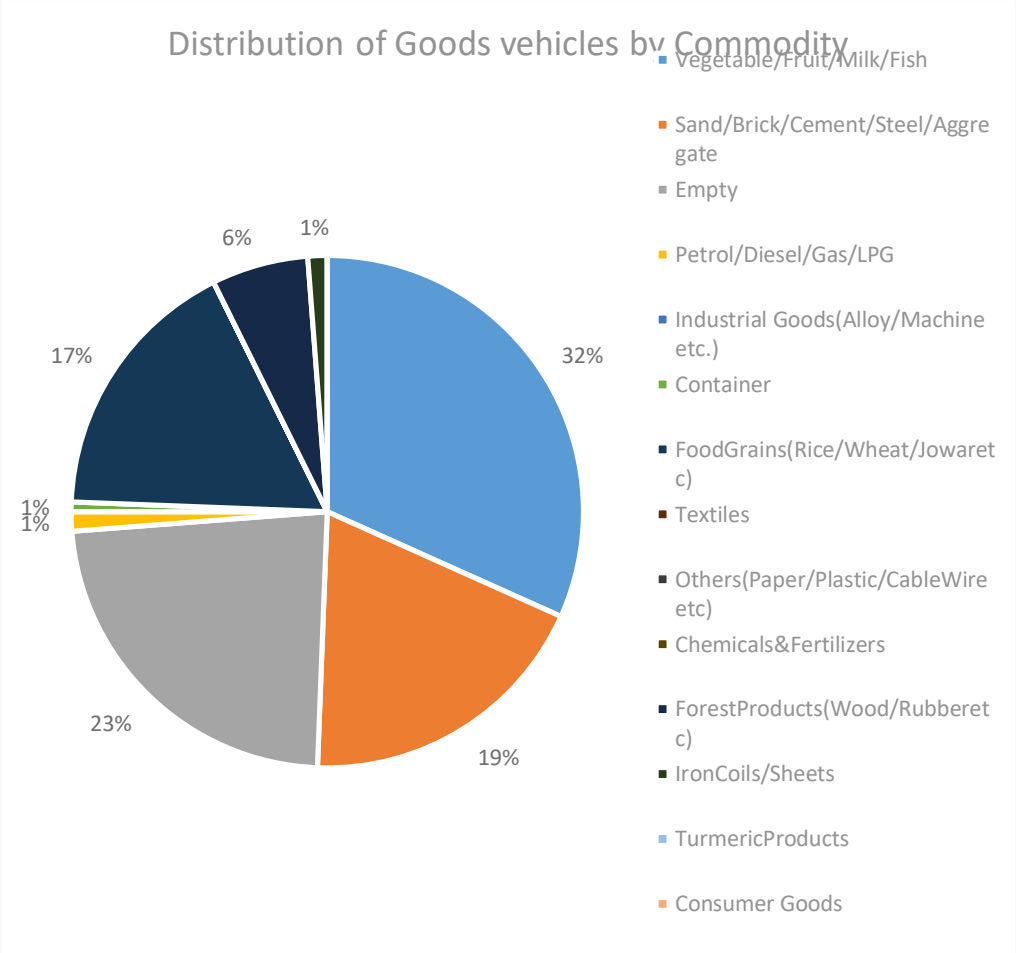
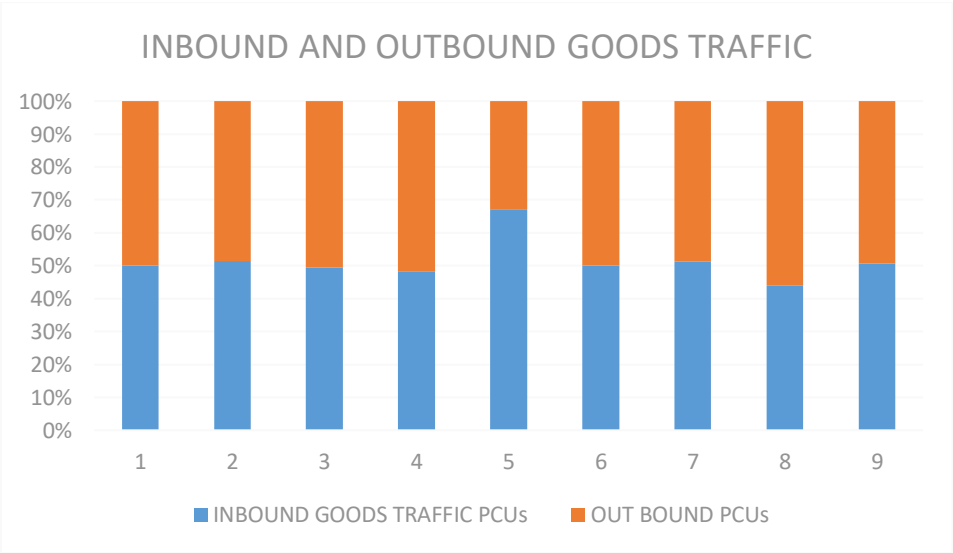


Figure 3-30 Distribution of Goods vehicles by Commodity



GOODS VEHICLES BY DIRECTION: It is seen that over 50% of the vehicles surveyed at the outer cordon locations are in-bound. The Figure 3-31 shows the direction of vehicles surveyed at each outer cordon location.

Figure 3-31 Goods Vehicle by direction



3.8.3 Origin Destination Survey at Screen Line Locations

OD Survey was conducted at seven screen line locations. At each identified location, the origin and destination along with other trip characteristics of the passengers by vehicle type were recorded.

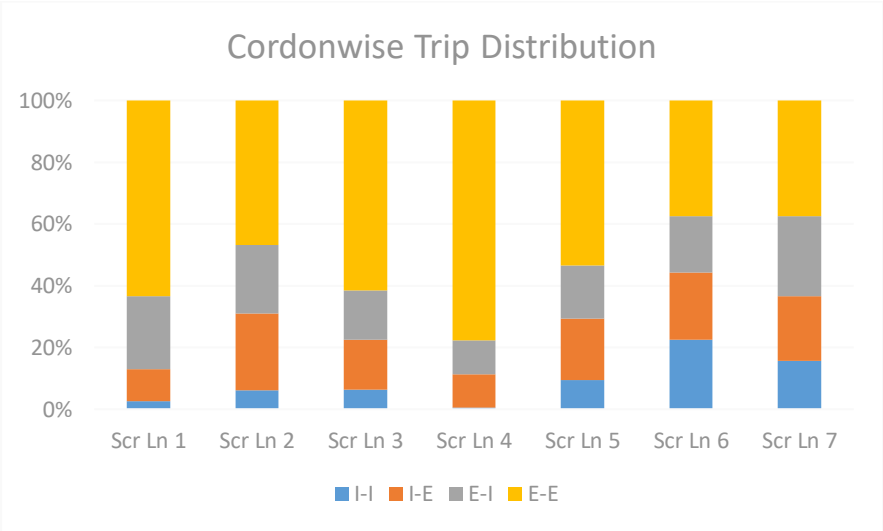
Passenger Vehicle Trip Characteristics

1. Vehicular Flow

Trip distribution at screen line is shown in Figure 3-32

The highest vehicular flow share is **external to external flow at 39%,** followed by **14% external to internal flow,** and 13**% internal to external flow**. Internal to internal **or local traffic constitute 7% of the total flow.**

Figure 3-32: Screen Line-wise Private Vehicle Trip Distribution



2. Trip Frequency

Almost **61% of the trips were observed to be daily trips including one-way, twice and more**. About 29% are weekly and 7% are occasional trips.

Table 3-32: Passenger Vehicles Trip Frequency Distribution at Screen Line Locations

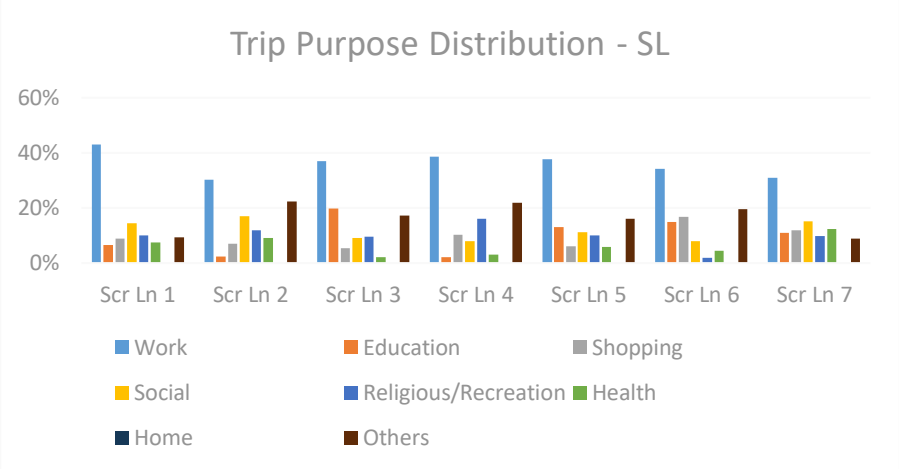
Screen line Locations	Daily twice (up & down)	Daily once (One-way)	Occasional	Weekly	Daily thrice or more
SC 1	27%	22%	5%	35%	10%
SC 2	33%	15%	7%	31%	14%
SC 3	31%	33%	3%	20%	11%
SC 4	21%	24%	16%	36%	3%
SC 5	50%	16%	9%	19%	7%
SC 6	27%	29%	5%	21%	8%
SC 7	**25%**	**17%**	**5%**	**44%**	**8%**

2. Trip Purpose

Trip purpose of the commutes, recorded at screen line locations has been represented in Figure 3-33.

Work trips account for 36%, followed by other **trips at 17% and social trips at 12%. Religious / Recreational trips and educational trips accounted for 10%** of the total share.

Figure 3-33: Screen Line-wise Trip Purpose Distribution[17]



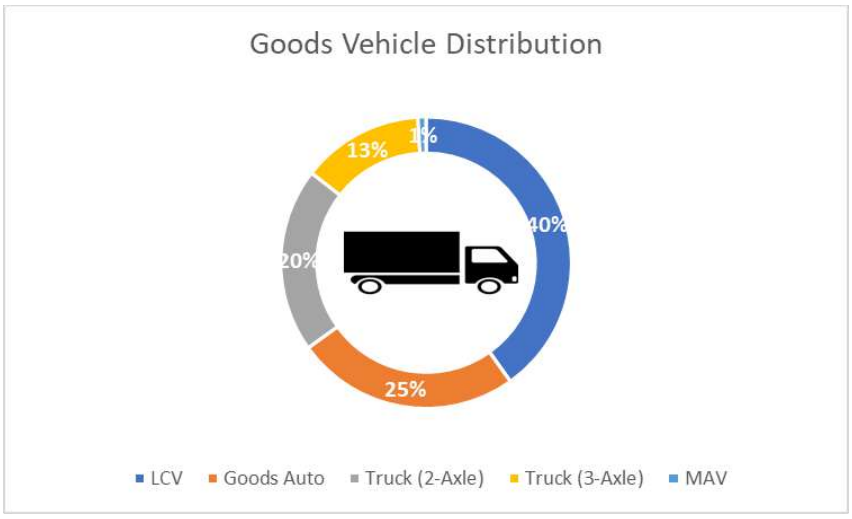
Goods Vehicles Travel Characteristics

1. Vehicular Flow

Vehicular Flow at Screenline is represented in Figure 3-34, the trip distibution of goods vehicles at screenlines is as represented in Figure 3-35.

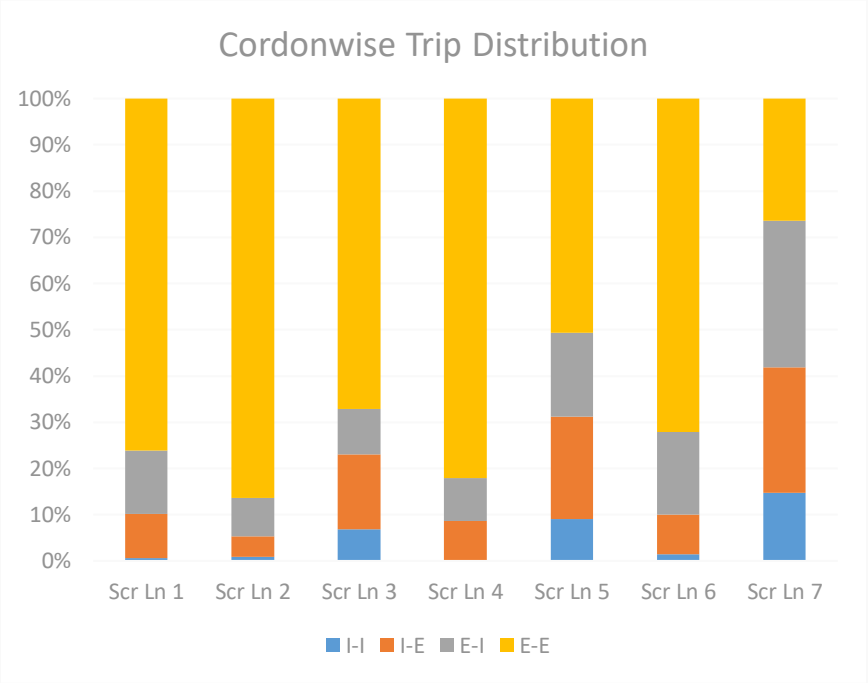
The highest share of vehicle is external to external flow or through traffic, at 66%, followed by external to internal flow at 16%.

Figure 3-34: Type of Goods Vehicle at Screen Line Locations



[17] *The low share of educational trips can be attributed to restrictions on educational institutes due to COVID-19*

Figure 3-35: Screen Line-wise Goods Vehicle Trip Distribution



2. Trip Frequency

Daily trips constituted 43% of the trips, including once, twice, thrice, and more daily trips.

While 14% of the trips are weekly trips and 14% are occasional trips (Refer Table 3-33).

Table 3-33: Goods Vehicle Trip Frequency Distribution at Outer Cordon Locations

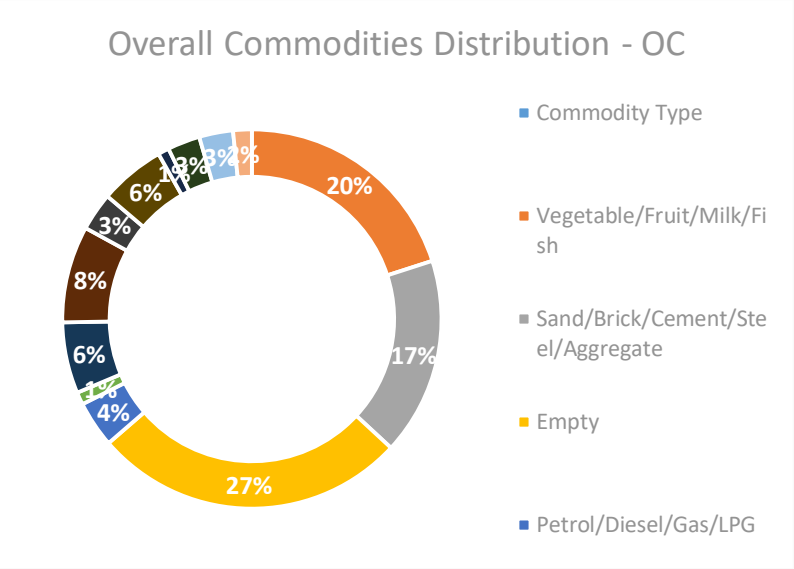
Trip Frequency	Daily twice (up & down)	Daily once (One-way)	Occasional	Weekly	Daily thrice or more
SC 1	24%	9%	1%	8%	27%
SC 2	23%	30%	8%	10%	27%
SC 3	16%	17%	8%	7%	22%
SC 4	9%	9%	47%	41%	3%
SC 5	6%	11%	0%	8%	1%
SC 6	14%	14%	6%	8%	19%
SC 7	**8%**	**9%**	**29%**	**19%**	**1%**

2. Commodity Type

The commodity type captures at screen-lines are represented in Figure 3-36.

Of the total commodities captured at the screen line locations **35%** include **perishable goods** such as Vegetables, Fruits, Milk/Fish and **18% are construction aggregates (sand, cement)**. Similarly, **food grains constitute 16% and 21% are of the total share are empty**.

Figure 3-36: Commodities Captured at Screen Line Locations

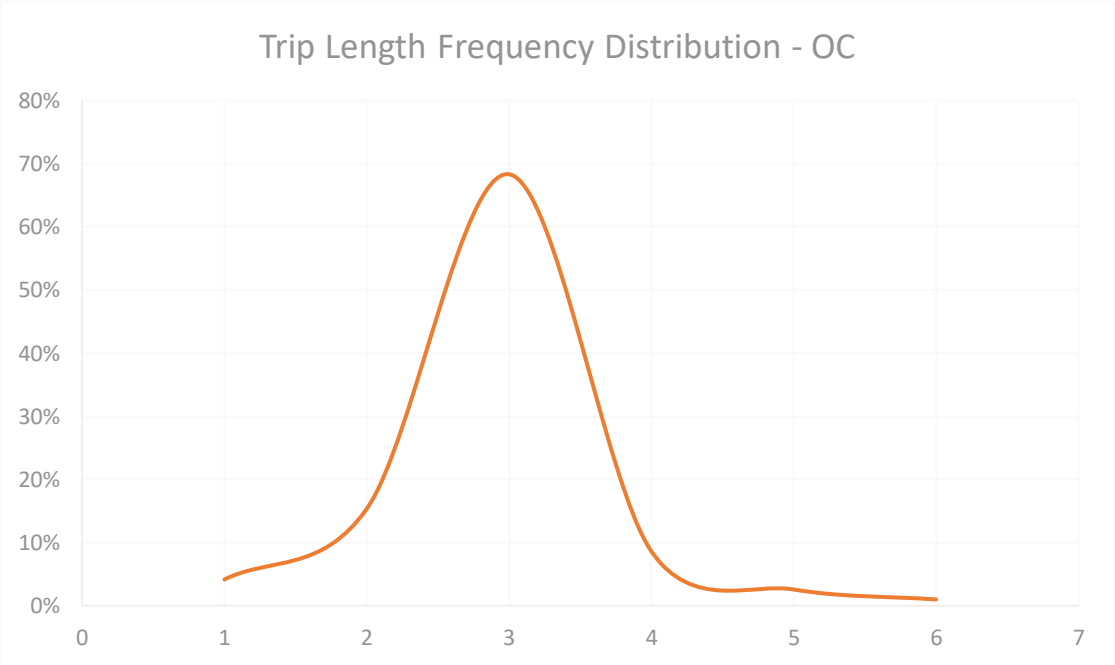


4. Trip Length Distribution

72 per cent of the trips (majority of the trips) are in the **range of 30-150 km** followed by **20% of the trips** within **10–30 km**.

The Trip length distribution in Figure 3-37, shows that a large number of regional freight movement takes place in Tirunelveli from adjoining towns/cities.

Figure 3-37: TLFD for Goods Vehicle at Screen Line Locations



3.8.4 Stated Preference Survey & Willingness Survey

To assess the current trip characteristics and understand the willingness to shift to the proposed PT system, a stated preference survey was done at major transit hubs within the study area.

Of the surveyed **commuters, 65%**are **very likely to shift** to a **public transport system** if the same is provisioned in the city.

Of the surveyed commuters, 42% are likely to shift if the public transport system provides them with a comfortable, safe, and economical journey experience.

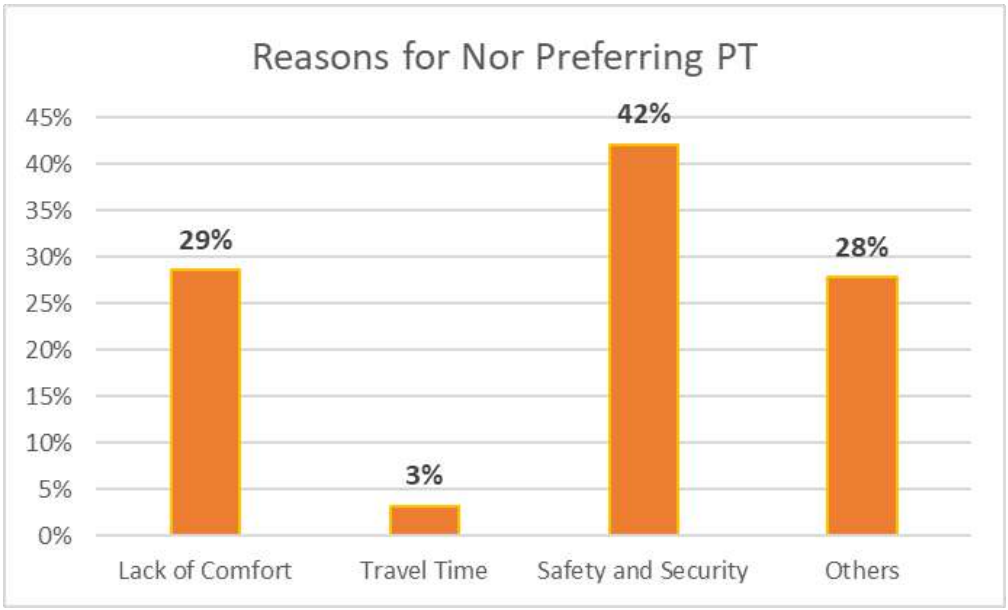
Of the surveyed commuters, 5% are **not likely to shift** to the proposed system.

Upon further analysing the response of the 3% of respondents who did not wish to shift to sustainable transport modes, it was understood that comfort, travel time, and lack of first- and last-mile connectivity were the major deterring factors for the commuters.

Of the surveyed commuters **29%** felt that the proposed system will be **less comfortable than their existing mode**.

Figure 3-38 shows the reasons commuters are not willing to shift to a PT service.

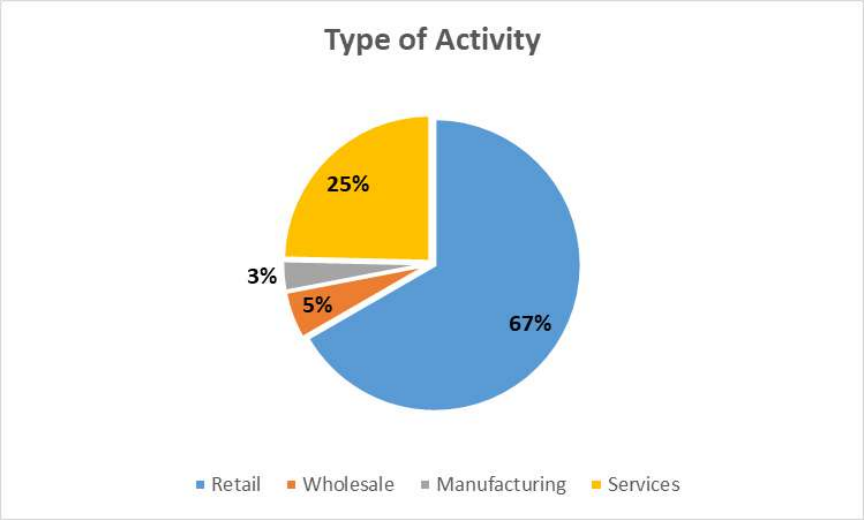
Figure 3-38: Reasons for Not Willing to Shift to a PT Service



3.8.5 Establishment Survey

Establishment survey was conducted throughout the study area to understand the type of activity in the place along with employment, the average inflow and outflow of goods, the area under establishment, etc. Figure 3-39 shows the type of establishment surveyed.

Figure 3-39: Type of Establishments Surveyed



The average **employment per establishment is 5**. It is observed that the **highest employment** per establishment is **for wholesale, at 8,** and the **least is for the manufacturing industry, at 3**.

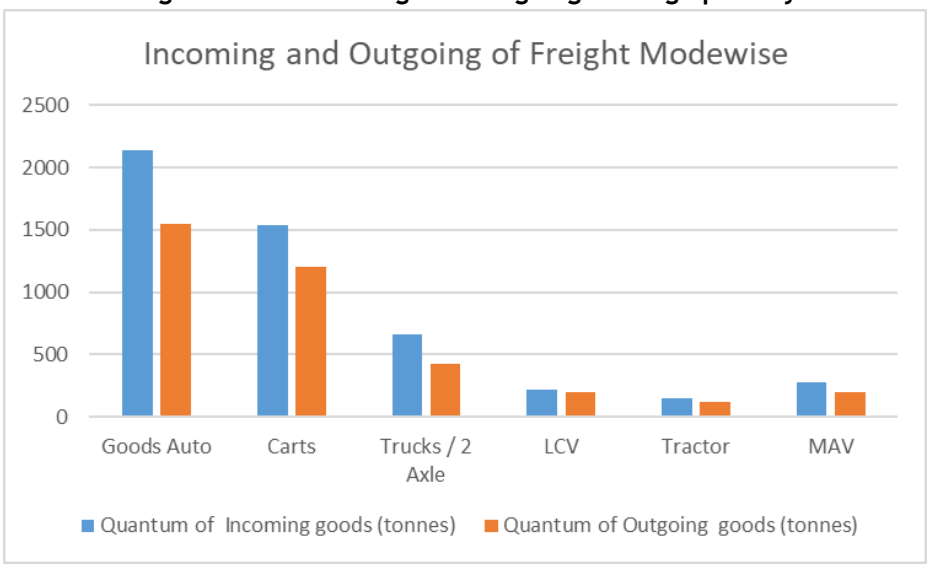
The **average number of visitors** per establishment per day is **observed to be 50**.

Since freight movement to these establishments has a major impact on the traffic flow and also has an impact on loading/unloading patterns, an analysis of incoming and outgoing tonnage of goods per day was calculated.

It is understood that most of the goods are transported in goods autos and carts. As the majority of activity type is retail, the transported goods would be in lesser quantities and to many points. Also, as the retail centers are located in the core of the city, it is easier for smaller vehicles to navigate.

Figure 3-40 shows the mode-wise freight movement seen in the city.

Figure 3-40: Incoming and Outgoing Tonnage per Day



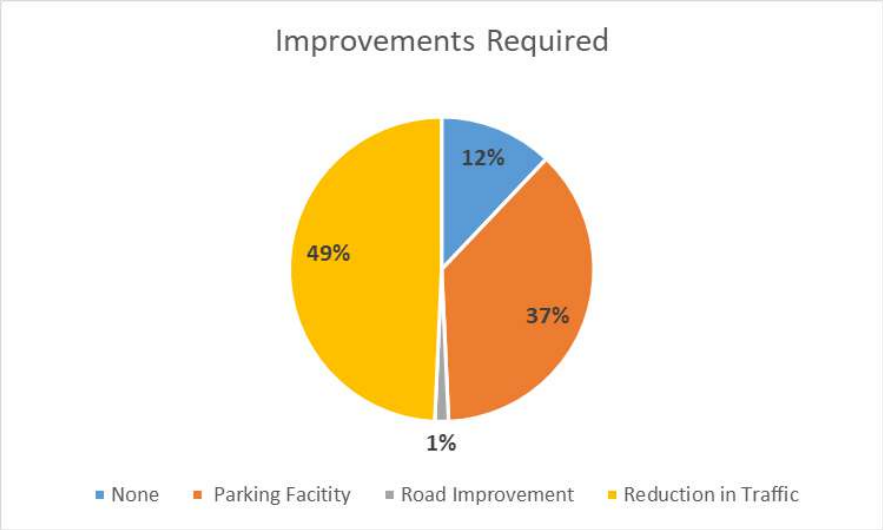
From a detailed analysis It has also been understood that while 83% are single establishments with exclusive premises, only 72% of the establishments share premises with others.

The opinion survey of the workers at the establishments about the commuting facilities indicates **49%** of the respondents are **unhappy or not satisfied** with the heavy traffic during their travel to the establishments.

Of the respondents, **37%** opined that **access to a parking space** would greatly help them.

Figure 3-41 indicates the required improvement as opined by commuters.

Figure 3-41: Required Improvement



3.9 OVERALL ANALYSIS AND MAJOR INFERENCES

The major inferences from the traffic and transportation surveys are as mentioned below:

Vehicle Registrations

- High share of two wheelers vehicles (76%) and considerable share of IPT vehicles indicates the need for a stranger public transport system.

Traffic Conditions

- Junctions like Vannarpettai Junction, Reliance Petrol Pump Junction and old bus stand junction were observed to be the most congested.

Traffic and Transport Inventory

- The RoW of every surveyed road was measured and it is observed that 28% of the roads have RoW less than 12 m followed by 28% having RoW of 12–18 m. About 70% of surveyed road do not have footpaths.
- Lack of safe pedestrian and NMT infrastructure facilities with encroachments are observed uniformly in the city. High on-street parking observed on Car Street and near the major terminals.

Traffic Safety

- Steady decline in road accidents, however further traffic design interventions are required.

Household Survey

- 96% of the households in the city own a personalized vehicle and, thus, showing the high dependency on private vehicles and reinforcing the need to strengthen the PT system
- Overall NMT modal share in the city needs to be further increased to achieve the desired livability for the city.

Travel Behaviour

- High share of daily trips to/from the cordon locations is attributed to the industrial nature of the city.
- 34% daily freight trips captured at cordons, shows 61% of the commodity to be food grains.8% of the trips are empty, hinting towards the need for freight demand measures.

IPT Operators

- Shared services are more popular and can be attributed to easy availability and economical services.
- Waiting time for the IPT operators to get the passengers vary from 10-15 minutes during the peak hour and the trip km vary from 5–10 km, in the major demand corridors.

Willingness to Shift & Establishment Survey

- Substantial share of commuters are willing to shift to public transport services. However, safety, cost, and travel time are the three most important criteria for the respondents while choosing a PT System
- The opinion survey of the workers at the establishments about the commuting facilities indicates **49%** of the respondents are **unhappy or not satisfied** with the heavy traffic during their travel to the establishments. Of the respondents, **37%** opined that **access to a parking space** would greatly help them.

4. TRAVEL DEMAND MODELLING

4.1 INTRODUCTION

The main focus of the Comprehensive Mobility Plan for Tirunelveli is developing a long-term transportation strategy for the study area with the help of an urban transport planning model.

The major dataset that shall affect the travel patterns are as follows:

- Changes in the transportation system (e.g., new/up-gradation of roads, public transport coverage, and systems);
- Changes in the land use (e.g., residential land use, commercial land use, SEZ, institutional areas);
- Changing demographics (population, employment, etc.).

The base network is developed in GIS using current roadway inventory data. Demographic and socio-economic data such as population, workers, employment collected from census and other secondary sources have also been utilized for the development of the model. The emphasis to build sustainable transport infrastructure encompassing various alternative modes of transport is based on the necessity to give due emphasis to public transport as it is the need of the hour.

Over the recent years planning agencies are developing short term, medium term and long term infrastructure-cum-land use master plans for development of the cities. These plans can be made with the help of such models provided they are periodically updated to take cognizance of the changes in demographics, spatial developments and economic situation in the planning area.

The current report discusses on the following key objectives of the CMP study including,

- Identify travel pattern of the residents of Tirunelveli Local Planning Area.
- Develop and operationalize an Urban Transport Planning model using state-of-the-art modelling techniques and software package, appropriate to the conditions and planning needs of Tirunelveli LPA.

For analysis, the study area has been divided into **73 Internal Zones and 14 External Zones**

4.1.1 Internal

The study area has been divided into 73 Internal TAZs as per the prevailing Master Plan 2021.

4.1.2 External Zones

Regions beyond the demarcated study area have been delineated into external zones based on the catchment of the existing transport links feeding into the study area. A total of fourteen external zones are considered that represent the outer cordon of the study area.

4.1.3 Planning Period

The Base Year for the study has been considered as 2022. As per TOR, the travel demand forecasts are to be prepared for a minimum of 20 years. Also, to keep coherence with the census year, the horizon year for CMP has been taken up to 2042.

4.2 PREPARATION OF DATA BASE

Data required for the analysis of travel demand can be categorized into three types:

- Planning variables
- Transport network
- Travel Demand and Characteristics

The base year data is summarized in the following sections:

4.2.1 Planning Variables

Planning variables i.e. population and employment are the two variables that were considered for estimating the travel demand at the zonal level. For the estimation of zone-wise population, Census (2011), Master plan (2021) and the existing built up in the study area were taken as reference. For the estimation of zone-wise employment, the land use as per Master Plan (2021) and spatial growth were used. Zone-wise employment estimation has been discussed in detail in the subsequent sections.

The distribution of population and employment density for the base year (2022) in the study area is shown in Figure 4-1 and Figure 4-2.

Figure 4-1: Population Distribution for Base Year (2022)

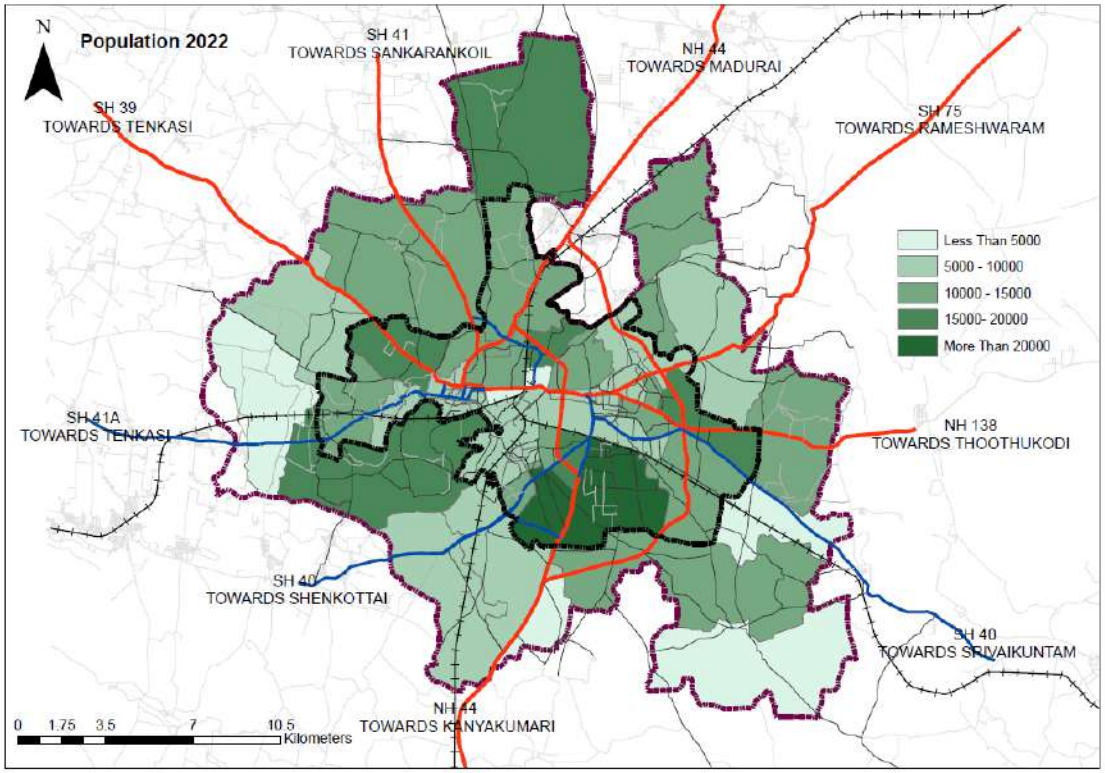
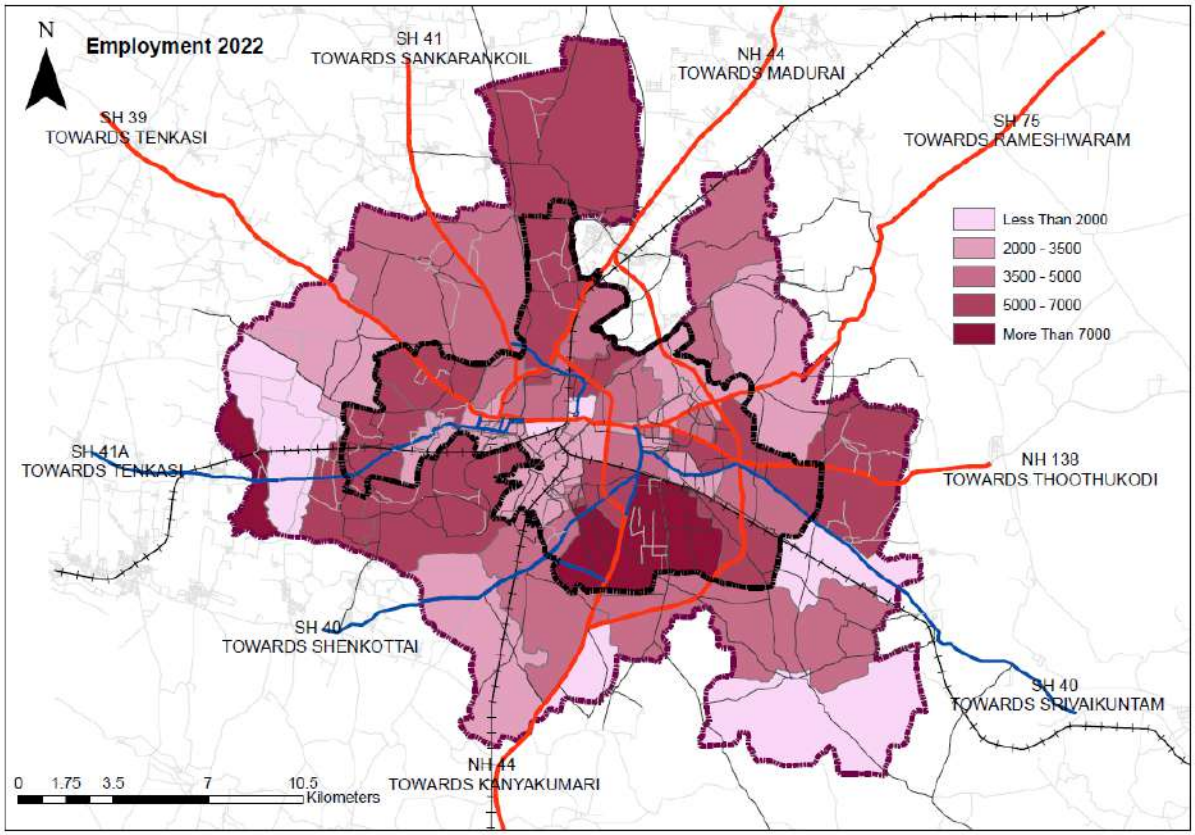


Figure 4-2: Employment Distribution for Base Year (2022)



4.2.2 Transport Network

The transport network in the study area primarily includes road networks (links) and nodes as shown in Figure 4-3. All the characteristics of the road network collected through the network inventory and speed and delay surveys serve as the input attributes to these links. Characteristics collected through network inventory and speed and delay surveys include length, carriageway type (divided/ undivided), type of operation (one-way/ two-way), number of lanes, average speed, capacity, etc.

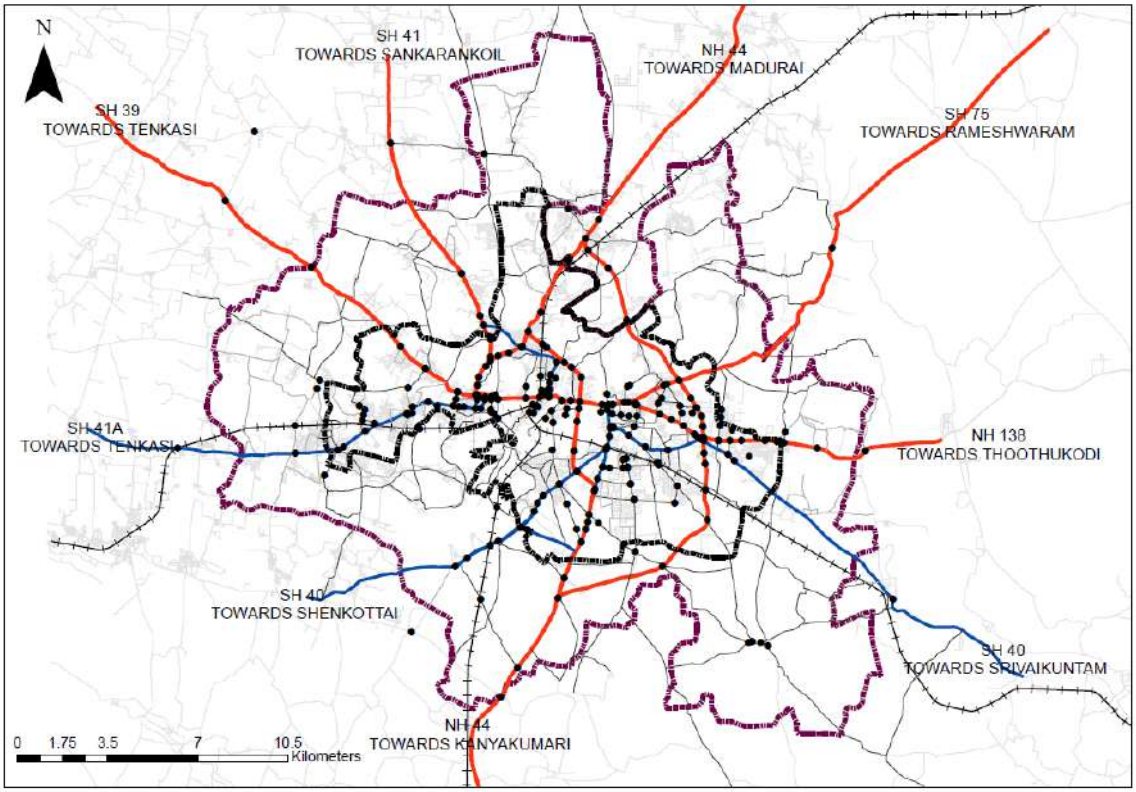
Apart from the road links and nodes, connectors and TAZs also form the basis for the development of the transport network files for the model. TAZs are developed to facilitate independent demand-supply analysis and planning for each of these zones. The connectors serve as imaginary links developed in the model to connect the centroid of a TAZ with the nearest node.

Table 4-1: Base Year Transport Network

S. No	Area	Number
1	Links	573
2	Nodes	679

3	Centroids	73
4	Traffic Analysis Zones	73

Figure 4-3: Links and Nodes for Base Year (2022)



4.2.3 Travel Demand Characteristics

Various traffic surveys were conducted to assess the base year traffic and travel characteristics in the study area. A household interview survey was conducted to obtain the socio-economic and travel characteristics of the resident population. O-D surveys conducted at the nine cordon locations and three public transport terminals have been used to assess the intercity travel demand and its characteristics. The result of these surveys[18] serve as the input to the base year travel demand model.

4.3 FOUR STAGE TRAVEL DEMAND MODELLING

The four-stage land-use-based transportation model is a sequential procedure –

First Step - Trip Generation – estimating the number of origins and destinations for each zone.

Second Step - Trip Distribution - attaching the origins and destinations for each trip to complete trips.

Third Step - Mode Choice - determining the mode of travel for each trip (Private, PT and IPT).

[18] The details of the surveys and analysis were already presented in the Interim Report and major survey inferences are presented in Chapter 3 of this report.

Fourth Step - Assignment – establishing routes and transit paths

4.3.1 Trip Generation

Trip ends of internal trips for the base year (2022) have been calculated from the validated O-D matrices. Trip generation models were built to forecast the number of person trips that will begin from or end in each travel analysis zone within the region for a typical day of the target year. Trip end models are developed using the stepwise linear regression technique. The explanatory variables include population and employment, which play a major role in developing the equations. The trip-generation equations developed for this study are presented in Table 4-2.

Table 4-2: Trip Production and Attraction Equations

Trip Type	Equations	R^2 Value
Trip Productions	*Trip Production (PUA) = 1.1968x * Population + 392.04*	0.86
Trip Attractions	*Trip Attraction (PUA) = 1.181 * employment +356.77*	0.85

Growth Factors for External Trips

Based on the econometric model (elasticity value between NSDP and vehicle registration of past data), the following traffic growth rates have been estimated for the external trips and are presented in Table 4-3.

Goods traffic and Intercity passenger traffic is assumed to grow at 5% per annum up to 2032 and 3.5% from year 2032 to 2042.

Goods traffic and Intercity passenger traffic is assumed to grow at 5% per annum up to 2032 and 3.5 % from the year 2032 to 2042.

Table 4-3: Growth Rates for External Trips

Year	Two-Wheelers	Cars	Trucks
FY2022-27	**5%**	**5%**	**5%**
FY2027-32	5%	5%	5%
FY2032-42	3.2%	3.2%	3.2%

4.3.2 Trip Distribution Model For Intra- City Trips

The Gravity Trip Distribution Model of the following form is calibrated to represent the base year travel pattern for the study area.

For this study the Gravity models has been used of the production constrained type. Production Constrained Gravity Model is of the form

$$Tij = \{Pi\ Aj\ f\ (\ Wij\ )\} / \{Aj\ f\ (\ Wij\ )\}$$

Where, Tij= Trips between zonal pairs i and j

Pi=Trip Production at zone i = ∑i Tij

Aj= Trip Attractions at zone j = ∑j Tij

f (Wij) = A function that separates zonal pairs i and j typically known as Friction Factor

Ri and Cj = Constants of proportionality

The gravity model is calibrated on the intra-city trips performed by the residents of the study area using the zone-to-zone shortest distance matrix generated by a computer program. Friction factors were calibrated for obtaining the least error between observed and estimated trip lengths. The maximum likelihood method of calibration is used to estimate the friction factor. An iterative procedure has been used to calibrate the friction factors for each trip length range. Table 4-4 gives the results for calibration of the purpose-wise gravity-type trip distribution model.

Table 4-4: Trip Distribution Calibration and Validation Results

Trip Distribution	Avg. Travel Distance (km)
Estimated Average Trip Length	7.2

4.3.3 Mode Choice Model For Intra- City Trips

A multinomial mode choice model of the following form has been developed to split the trips among the modes, car, and two-wheelers

$$P_j = \frac{e^{V_j}}{\sum_{\text{all } l} e^{V_l}}$$

Where,

Pj = probability of choosing mode j,

Vj = deterministic component of utility for mode j, j and l are indices for modes

The cost skims that are obtained in the assignment are used to calibrate the mode choice model. From the home interview survey data, a choice-based sample is produced containing information on the mode chosen, vehicle ownership, travel time, and travel cost for each individual. The information on the alternate modes, i.e., travel time and travel cost

available to the individual, are generated from the time and cost skims obtained in public transport and highway assignment procedures.

To see the validity of the above model, the utilities for all the modes are calculated using the travel time and travel cost skims obtained from public transport and highway assignment. The probability of choosing each mode is then worked out for each cell of the OD matrix of intra-city trips made by residents. These probabilities need to be applied to get the exact number of trips by car, two-wheeler, and public transport.

The results of calibration of the above mode choice model are given in Table 4-5.

Table 4-5: Results of Calibrated Mode Choice Model

Mode	% Trips	
	% Observed	% Modeled
Two-Wheeler	41%	40.28%
Car	15%	15.29%
Auto-Rickshaw	8%	7.59%
PT	23%	23.43%
Cycle	2%	2.72%
Walk	11%	10.69%
Total	100%	100%

4.3.4 Trip Assignment

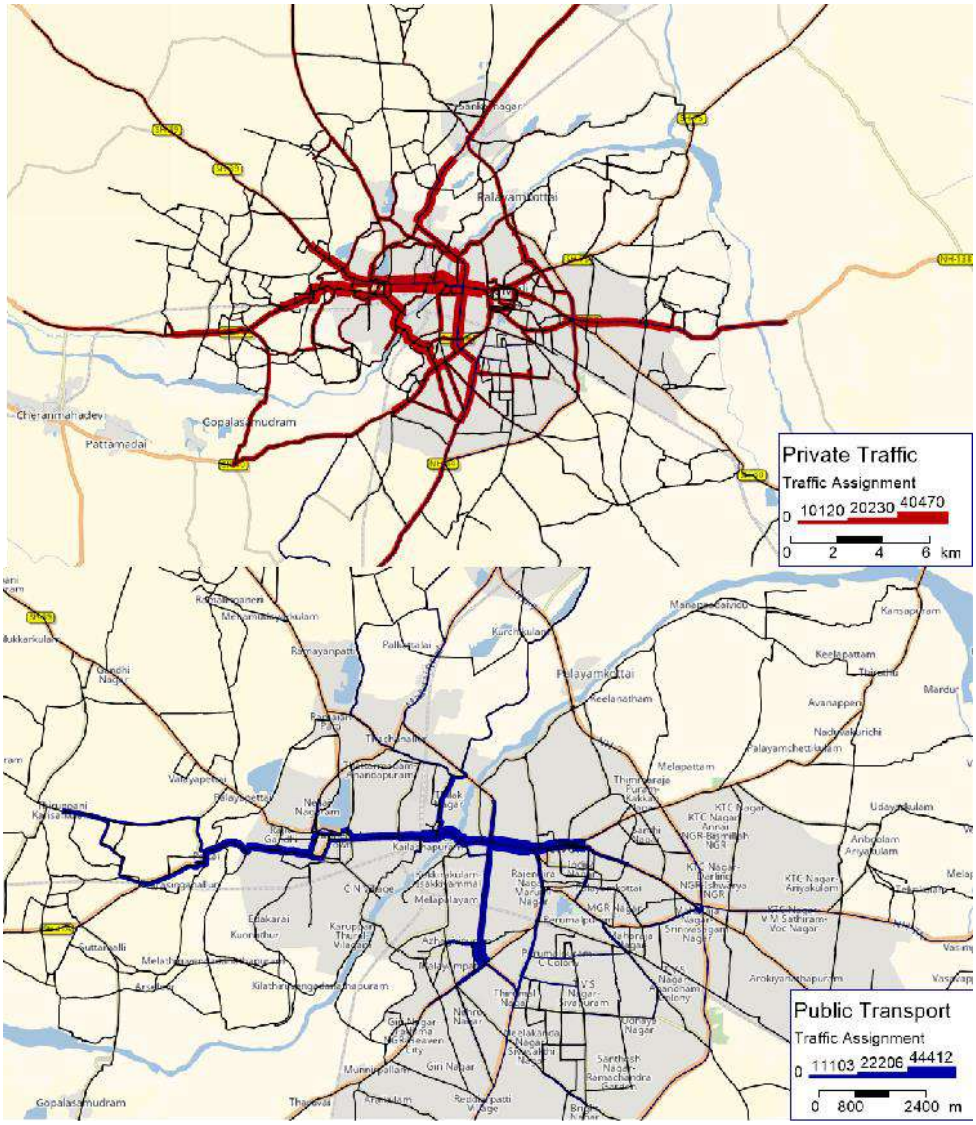
The assignment procedure adopted for the highway model is based on an equilibrium assignment with multiple demand segments (two-wheelers, cars, and other modes). The assignment is controlled to continue for as many iterations as is required to achieve a satisfactory level of convergence. In the case of this transport model, the process was continued until full convergence was achieved.

The methodology used for the assignment of private trips in this study is known as the Equilibrium assignment. The detailed methodology adopted, the iterations conducted, BPR function generated etc. are detailed out in Volume 2.

4.4 BASE YEAR MODEL RESULTS

It has been observed that the majority of arterial and sub-arterial roads in the city exceeds their capacity during peak hour. Some of the major roads that require immediate attention (i.e. strengthening of public transport or widening of roads or both) are Palayamkottai Road, Bypass Road, SH 40 and SN High Road Road. The private vehicle assignment has been depicted in Figure 4-4.

Figure 4-4: Base Year Private and PT Trips Assignment in Peak Hour (2022)



4.5 SOCIO ECONOMIC TRANSITION

The urban transport model developed for Tirunelveli was used to predict the travel characteristics for the horizon year under various transport network scenarios and land use. The model outputs will be used to identify the imbalance in the transportation systems against the growing traffic demand. This process will lead to the major requirement of the study, i.e. to develop medium- and long-term strategies to tackle the transportation issues for the next twenty years.

4.5.1 Population Projections

The demographic details from Census, 2011 & Master Plan (2021) were referred to compute the population of the study area for the years 1991, 2001, 2011, and 2021. Based on the CAGR of the following decades, the population projection for 2027, 2032 and 2042 has been done for the study area.

The population projections for the study area are shown in Table 4-6. The projections done below for population and employment are used for all scenarios and the TAZ-wise employment and population projections for horizon years are mentioned in Volume 2.

Table 4-6: Population Projections

Population	2022	2032	2042
	792,477	849,668	964,051

4.5.2 Employment Projections

As per the Census Working population projections, the total workforce in the Study area is 2.89 lakh, which constitutes 35.8% of the total population. It may be noted that this figure, shows the total workers living inside the study area the resident worker population. The employment for 2021 was estimated based on the employment growth rate between 2001 and 2011. The employment estimation for 2022 and projections for future years for the study area are shown in Table 4-7. For TAZ-wise employment redistribution for 2042, due consideration was also given to the areas falling in along the major mobility corridor.

Table 4-7: Employment Projections

Employment	2022	2032	2042
	289,560	332,694	375,828

Figure 4-5: TAZ-wise Population Distribution for 2022, 2032, and 2042

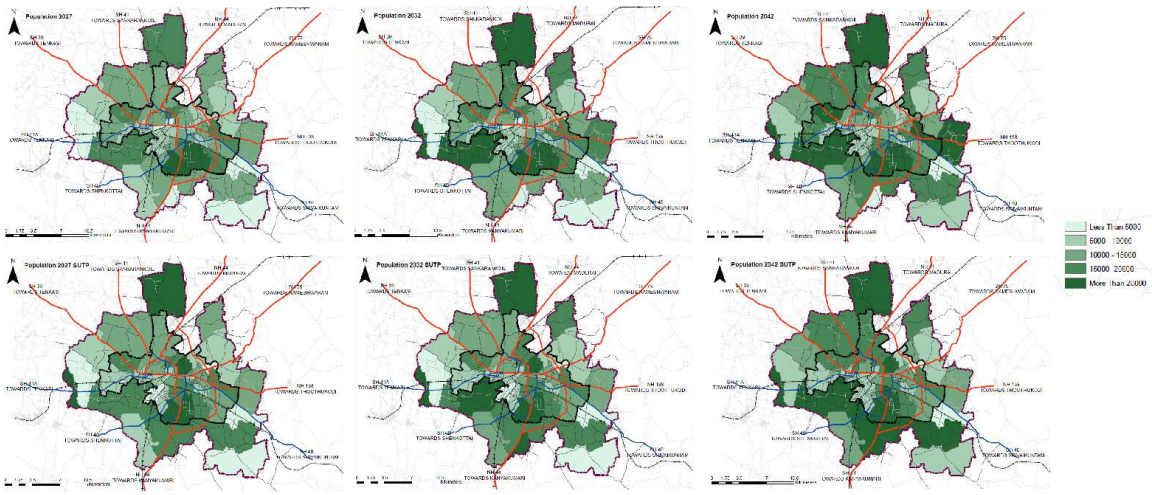


Figure 4-5, shows the TAZ - wise distribution of population for 2022, 2032, and 2042.[19]

The TAZ-wise population and employment for the horizon years 2027, 2032 and 2042 are attached in Volume 2.

[19] For SUT Scenario, wherein re - densification along major transit corridor is considered.

4.6 SCENARIO BUILDING

For the current study, four horizon year scenarios were developed based on the future development directions and required transport network considering the various transportation improvements.

The scenarios developed as part of the study are follows:

- Scenario 1: Business as Usual (Demographic Changes and ongoing projects) Scenario
- Scenario 2: Do Something (Business as Usual + Committed Proposals)
- Scenario 3: Sustainable Urban Transport Scenario (BAU + Committed Proposals + Proposed Projects + Land Use Proposals) Scenario
-

4.6.1 Scenario 1 - Business as Usual (2042)

The present scenario represents the future based on the continuation of past trends and is often used as a reference point or benchmark for assessing the need for policy interventions. The BAU scenario extrapolates existing trends and assumes no radical policy interventions for sustainable development and emission mitigations. Future transport demand is based on the preferences of different socio-economic groups in the base year. In terms of passenger transport, the BAU Scenario predicts increased car ownership and higher demand for motorization.

Details of BAU Scenario

Network

Business as Usual Scenario considered for this study only considers the existing road network and ROBs and subways which are presently under construction.

Internal Travel Demand Estimation

The trip ends for the horizon years 2032 and 2042 were obtained for total travel using the calibrated trip end models. These trip ends were split between the zones through the trip distribution model. Distributed trips are then split between the modes (Car, Two-wheeler, IPT, and Public Transport) using the mode choice model.

The horizon year trip distribution is different for alternative network scenarios due to different inter-zonal generalized costs. Thus, for each of the future networks and development scenarios peak passenger trip matrices were developed by an iterative mechanism considering the interaction between distribution, modal split, and assignment stages.

Travel Demand Forecast: BAU Scenario

By adopting the forecast assumptions detailed above and with the help of the urban model developed for the study area, travel demand has been estimated. Calibrated model has been used to estimate the demand for the horizon year 2042 and is presented in Table 4-8.

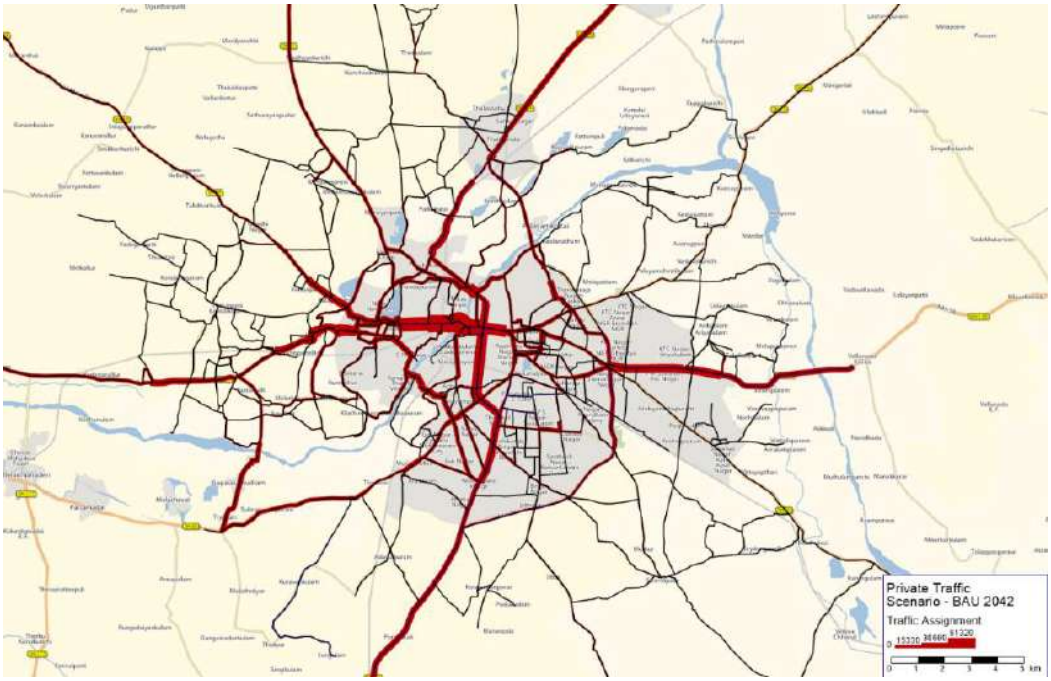
Table 4-8: Modal Share for BAU Scenario

Mode	2032 %Share	2042 %Share
Two-Wheeler	46.91%	49.57%
Car	17.85%	18.86%
Auto-Rickshaw	8.88%	9.42%
PT	14.35%	12.83%
Cycle	2.48%	1.82%
Walk	9.53%	7.50%

BAU Scenario Result

This would act as a guide for proposal evaluation. If no development is done on the network as described earlier and development happened based on the traditional approach, it would cause sprawl-like development where many new areas in suburbs would get populated with low density. This scenario would help to understand which parts of the city would need attention in terms of transportation development of various types. The trips for 2042 (PrT) were assigned on the network and are shown in Figure 4-6.

Figure 4-6: BAU Scenario PRT Assignment



4.6.2 Scenario 2 - Do Something Scenario (2042)

The do something scenario (2042) considers all the road network improvement which are sanctioned by the highways department or corporation as a part of Smart City Mission. It also considered the proposed expansion of industries at Gangaikodan. List of Projects under various scenarios are given in Table 4-9.

Network

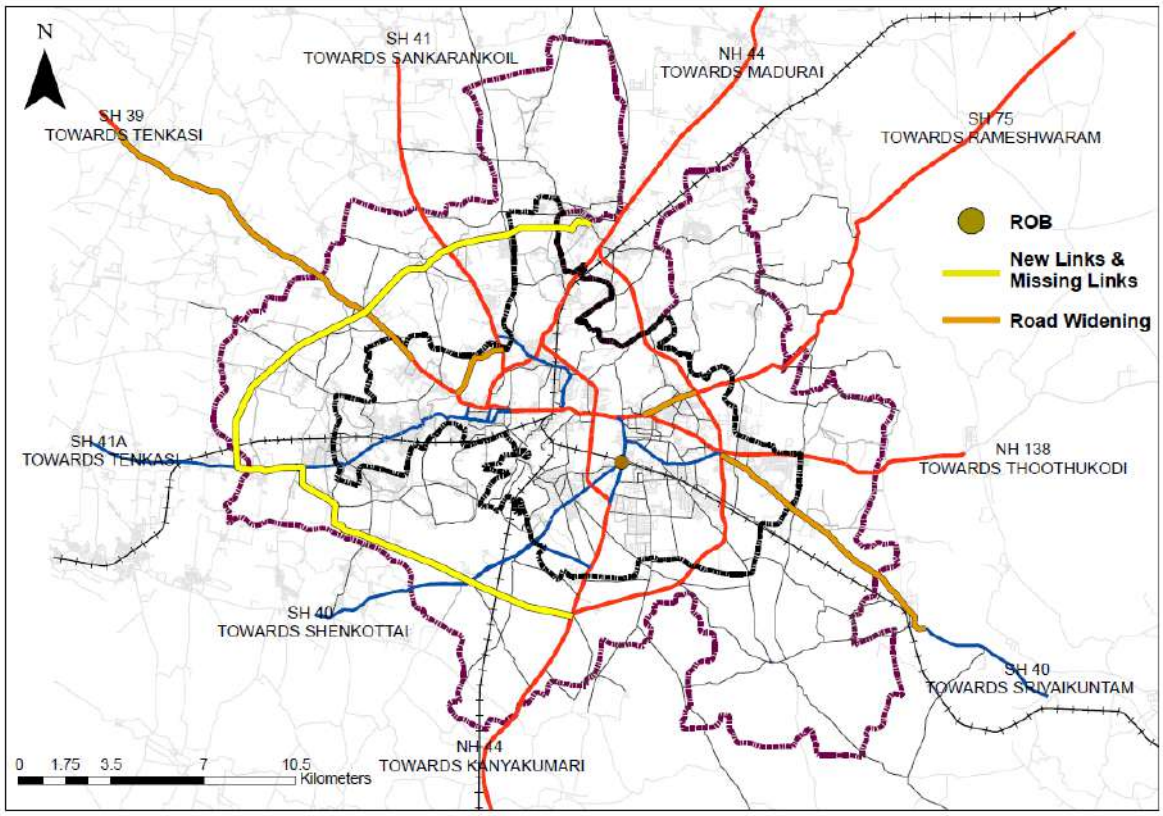
The following projects were considered for the development of Scenario 2 for the horizon year 2042.

- Development of 33 km of western bypass proposed by highways department
- Widening of 27 km of roads

Table 4-9: List of Roads Proposed for Widening (committed proposals) & New Links

S. No.	Road Name	Existing Lanes	Length (km)	Proposed Lanes
1	Western Bye Pass Road to Tirunelveli from Thalayuthu to Ponnakudi	0	33	4
2	Tirunelveli Shenkottai Kollam Road	2	14.5	4
3	Tirunelveli Palayamkottai Road	2	10	4
4	Sivalaperi Road- Multi Lane Highway Project	2	2.14	4

Figure 4-7: Additional Network in Do Something Scenario



Travel Demand Estimation: Scenario 2

By adopting the forecast assumptions detailed above and with the help of the urban model developed for the study area, travel demand has been estimated. Calibrated model has been used to estimate the demand for the horizon year 2042 and is presented in Table 4-10.

Table 4-10: Mode Share for Public Transport Scenario

Mode	2032 Do something	2042 Do something
Two-Wheeler	43.21%	47.51%
Car	16.40%	18.04%
Auto-Rickshaw	8.08%	8.93%
PT	13.43%	12.16%
Cycle	2.22%	1.70%
Walk	16.66%	11.66%

It was observed due to the induction of these committed proposals under this scenario, the overall mode share of private vehicles has increased but the V/C ratio of certain links improved. The trip assignment both for private vehicles and for public transport for the public transport scenario for 2042 is presented in Figure 4-8 and Figure 4-9 respectively.

Figure 4-8: Do Something Scenario PRT Assignment 2042

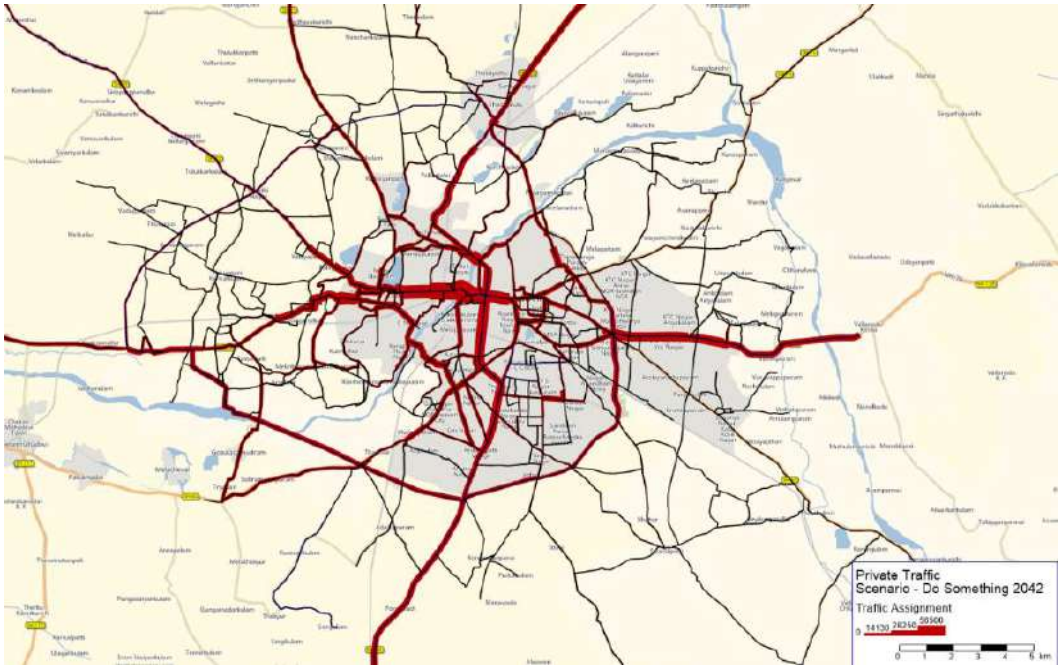
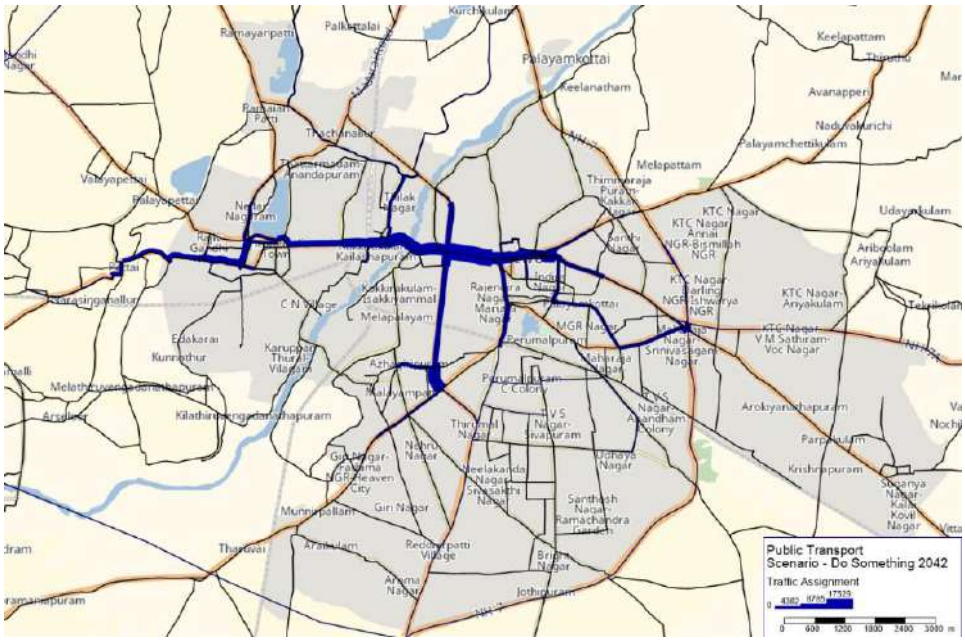


Figure 4-9: Do Something Scenario PT Assignment 2042



4.7 GOALS

On the basis of the CMP vision, various goals have been targeted for the horizon year. Table 4-11 shows the goals set to be achieved in the horizon year by implementing all the proposals recommended in this study.

Table 4-11: Goals for Horizon Year

Name of the Impact	Base Year -2022	BAU Scenario-2042	Do Something Scenario-2042	SUT Scenario (2042) - Target
Internal to Internal Trips				
Private Transport (PVT) Share	55%	67%	65%	<=40%
Public Transport Share	21%	13%	12%	>=35%

4.7.1 Scenario 3 - Sustainable Urban Transport Scenario (2042)

Keeping in line with the guidelines of Ministry of Housing & Urban Affairs, under the third scenario for 2042, the public transport share has been encouraged further by allowing re-densification along the major transit corridors. In addition to this, based on the modeled overall peak hour demand on the link connecting Palayamkottai and Tirunelveli Town, two higher demand public transit corridors have been considered in this scenario, from IRT Polytechnic till Palayamkottai along NH 44 on Trivandrum Road and from Sankarnagar till South Bypass along NH 44 and Bypass Road. Further, to complete the missing links and to attain the Ring-radial hierarchy for the city, around 70 km of the road network has also been considered (refer Table 4-12).

Table 4-12: SUTP Proposals

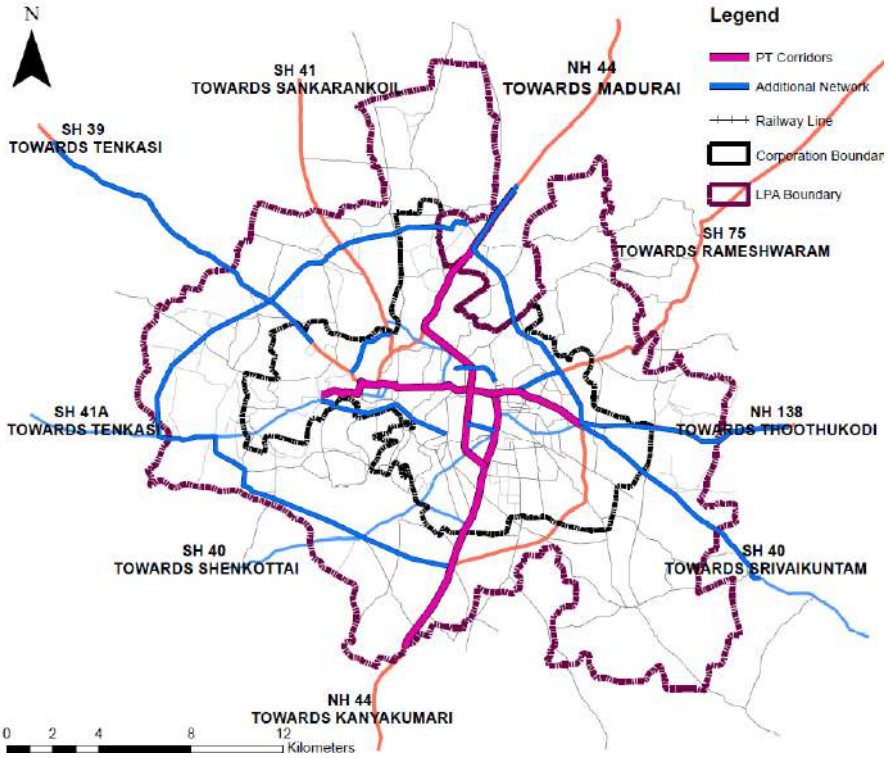
SUTP PROPOSALS			
	Corridor	**Road**	**Length In Km**
PT Corridors	1A	Pettai Palayamkottai	7.18
	1B	Pettai Palayamkottai	0.885
	1C	Pettai Palayamkottai	4.32
	2A	Trivandrum Road	3.43
	2B	Trivandrum Road	8.6
	3A	North Bypass	10.9
	3B	South Bypass	3.75
Link Proposals	Pettai Melapalayam Missing Link - 2 Lane	Cheranmahadevi Road to Kokkirakulam Road	6.03
	Vannarpet Palayamkottai Missing Link - 2 Lane	North Bypass to Trivandrum Road Link	1.33
	North Bypass Balabagya Nagar Missing Link - 2 Lane	North Bypass to East Street	1
	Melapalayam Palayamkottai Missing Link - 2 Lane	South Bypass to Railway Feeder Road	1.25
Freight Corridor	Gangaikodan Thoothukudi Freight Corridor - 2 Lane	NH 44	21.8
ROB	5		

Network Scenario

In addition to the proposals considered under the public transport scenario, the following projects were considered for development of Scenario 3 for the horizon year 2042.

- Development of 70 km of new roads and freight corridors proposed which includes the committed proposals in Do-something scenario.
- Proposal for three higher capacity public transport corridors.

Figure 4-10: Network Considered for SUT Scenario



Travel Demand Forecast

By adopting the forecast assumptions detailed above and with the help of the urban model developed for the study area, travel demand has been estimated. Calibrated model has been used to estimate the demand for the horizon year 2042. The travel demand and projected mode share for motorized vehicles and excluding walking are presented in Table 4-13 below:

Table 4-13: Mode Share for SUT Scenario

Mode	2032 SUTP	2042 SUTP
Two-Wheeler	29.53%	27.69%
Car	11.20%	10.49%
Auto-Rickshaw	5.48%	5.12%
PT	35.10%	37.24%
Cycle	3.13%	3.11%
Walk	15.57%	16.35%

It must be noted here that the public transport share in 2042 can be further increased than what is predicted in the SUT scenario, through incentivizing the public transport commuters, congestion pricing for private vehicles, and various other measures.

Results of SUT Scenario

The introduction of dedicated PT corridors along with additional network, giving better public transport coverage to the study area has considerably reduced the V/C values on the major road network.

The trip assignment both for private vehicles and for public transport in the SUT scenario for 2042 is presented in Figure 4-11 and Figure 4-12.

Figure 4-11: SUT Scenario PRT Assignment

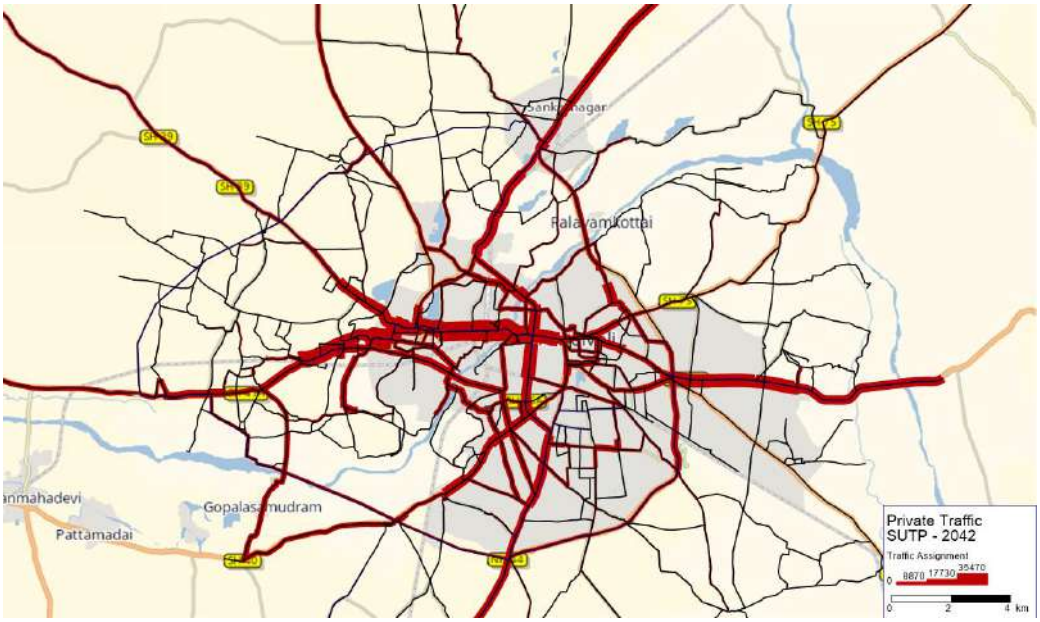
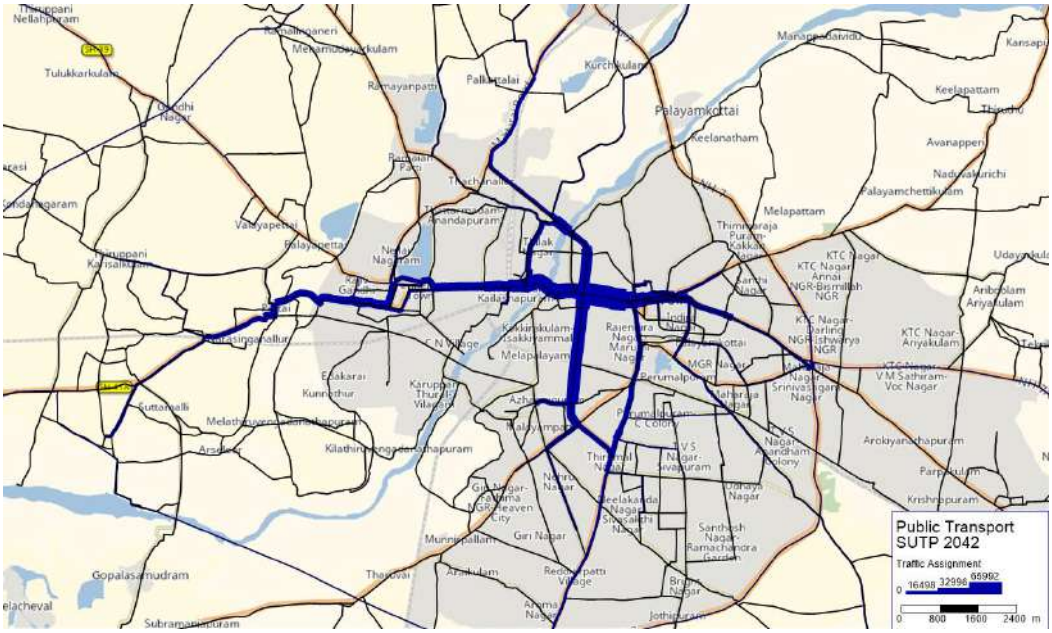


Figure 4-12: SUT Scenario PT Assignment



Based on the modelling exercise, the estimated average route wise PHPDT for the proposed higher capacity PT routes are shown in Table 4-14.

Table 4-14: Estimated PHPDT (Scenario 3, 2032, 2042)

	SUTP 2032		SUTP 2042	
Link Details	Cross sectional Values	PPHPD	Cross sectional Values	PPHPD
Murugankurichi Junction to Trivandrum South-Bypass	2672	1336	4552	2276

	SUTP 2032		SUTP 2042	
Junction via Trivandrum Road				
Trivandrum Bypass Junction to Punnakudi via Trivandrum Road	1115	558	3332	1666
Pettai to Vannarpettai via SH 41 A & SN High Road	5495	2748	9352	4676
Vannarpettai to Murugankurichi Junction via Trivandrum Road	8617	4309	13518	6759
Murugankurichi Junction to KTC Nagar via Tirunelveli Tenkasi Road	6679	3340	10364	5182
Sankarnagar to Vannarpettai via North Bypass Road	4167	2084	7008	3504
Vannarpettai to Trivandrum South-Bypass Road Junction	5330	2665	9167	4584

4.7.2 Comparison of Scenarios

Scenario results from the travel demand model are evaluated are on various indicators related to mobility such as total vehicle-kilometers, public transport trips and mode share for different scenario are horizon years. SUTP scenario provides least vehicle kilometers and maximum trips for the public transport for the both horizon years of 2032 and 2042 and is the best scenario from sustainable growth.

Modal Share comparison

The mode share of passengers for the year 2032 and 2042 for the modelled scenarios are mentioned in the Table 4-15. In the BAU and Do something scenario, there are no proposals to augment the public transport supply. The current trends are existing to continue with increase share for private modes and reduced share for public transport trips for the BAU and do something scenarios, with public transport modal share expected to drop to 14.05% in year 2032 and 12.36% in year 2042 for the BAU Scenario. Similarly, the infrastructure proposals in the Do something scenario results in reduction of the public transport share, but improvement are expected for Walk mode share due to proposed footpath infrastructure along the various corridors.

Table 4-15 Mode Share comparison

Mode	2032 BAU	2042 BAU	2032 Do something	2042 Do something	2032 SUTP	2042 SUTP
Two-Wheeler	46.91%	49.57%	43.21%	47.51%	29.53%	27.69%
Car	17.85%	18.86%	16.40%	18.04%	11.20%	10.49%
Auto-Rickshaw	8.88%	9.42%	8.08%	8.93%	5.48%	5.12%
PT	14.35%	12.83%	13.43%	12.16%	35.10%	37.24%

Cycle	2.48%	1.82%	2.22%	1.70%	3.13%	3.11%
Walk	9.53%	7.50%	16.66%	11.66%	15.57%	16.35%

Modal share of sustainable modes are expected to significantly improve for SUTP 2032 and 2042 scenarios due to extensive measures for improving public transportation supply, the operational and introduction of major transit corridors between Thalayoothu and Tirunelveli New Bus Stand has effectively contributed mode shift towards public transport. Increased use of public transportation also results from the introduction of feeder services to link mass transit stops, passenger information systems to reduce wait times for passengers, and MMI components at bus stops. The mode share for walking and cycling has increased as a result of placing a focus on sustainable transportation infrastructure measures by strengthening Walking and Cycling transport supply.

Vehicle-km and Passenger km comparison

Table 4-16 shows the results of total vehicle kilometres travelled, total goods km, and the passenger km for the year 2032 and 2042 for all the scenarios.

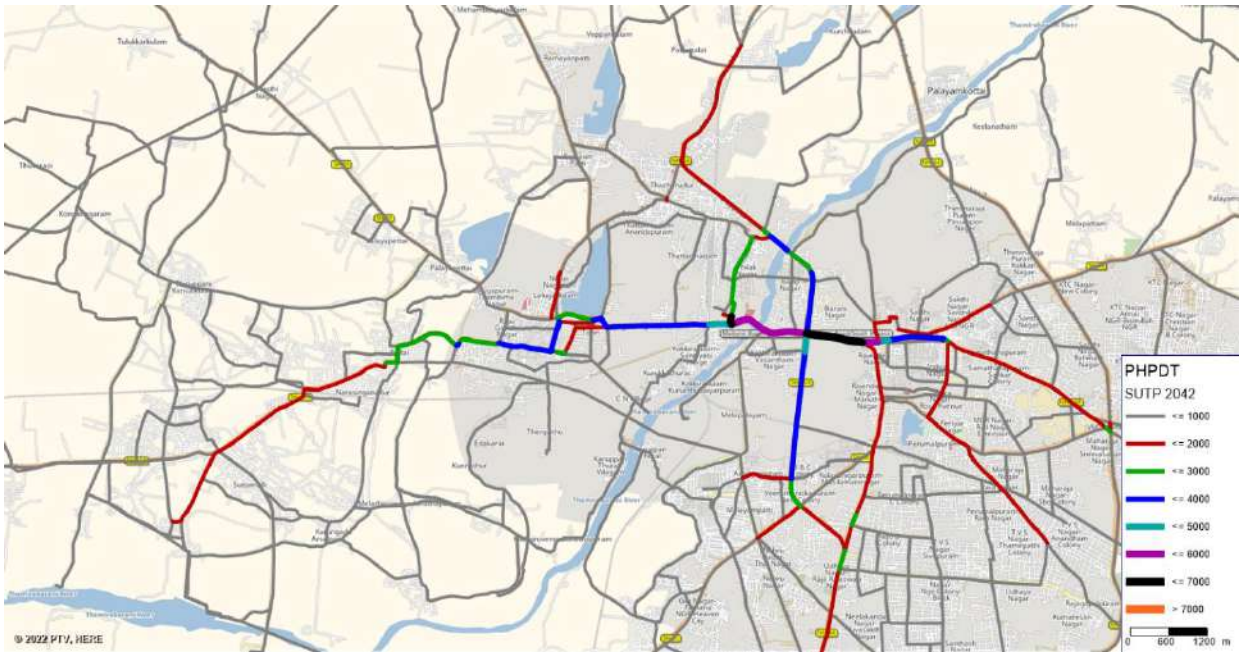
Table 4-16 Comparison of Daily Vehicle-Km in different scenario

	2032 BAU	2042 BAU	2032 Do something	2042 Do something	2032 SUTP	2042 SUTP
Total Vehicle km	72,00,042	90,01,707	68,88,414	89,12,613	56,82,388	60,17,079
Good Veh-Km	3,64,339	4,89,838	3,64,664	4,88,927	3,65,054	4,88,221
Passenger Private Veh-Km	67,28,053	84,22,510	64,26,490	83,39,581	51,06,356	52,76,822
Public Transport Pax-km	7,96,006	6,57,170	7,44,045	6,27,000	25,40,173	29,76,956
Average Trip Length – Public Transport	5.3	4.3	5.3	4.4	7	6.8

The number of passenger vehicle kilometers using private modes are increasing in the BAU and Do-Nothing scenarios. In the Do Something scenario, there is no focus on enhancing public transportation, which results in network traffic flow being negatively impacted by the increase in private vehicles.

In the SUTP scenarios, the private vehicle km considerably reduces, and there is noticeable improvement in the public transport ridership with the proposed interventions. Increase in public transport mode share and vehicle kilometer travelled is due to enhanced quality of service provided by the public transport, improvement in the last mile connectivity by introduction of feeder service has resulted PT passenger km travelled to be nearly 4 times as compared with the BAU scenarios. Figure 4-13 highlight the sections with high demand for public transport and their estimated PHDPT range.

Figure 4-13: SUT High Demand Mass Transit Corridor – Year 2042 – SUTP Scenario



5. URBAN MOBILITY PLAN

5.1 OBJECTIVES

The objective of the CMP is to develop a transportation vision, set goals based on the defined vision and develop specific actions in the form of short, medium and long-term transportation improvement proposals that will achieve the transportation vision for the area. The following objectives will address the existing and envisaged mobility situation in 2042 and fulfil the vision stated above:

- Restrict entry of personal vehicles in the core city area, reduce on-street parking and encourage public transport and pedestrian movement in the core city area.
- Prepare a public transport improvement plan including convenient access, integration with existing IPT system, provision of NMT facilities, creation of infrastructure.
- Develop short-, medium-, and long-term measures to ease traffic flow along major congestion points and major roads within the city.
- Develop a pedestrian safety infrastructure for safe and efficient movement of people within the city and along major corridors, and ensure safety by segregating their movement from vehicles.
- Restrict on-street parking at critical locations in the city and create off-street parking near major activity centers, transit stations/terminals to meet the growing parking demand.
- Implement traffic management measures such as a one-way system, access restrictions for heavy vehicle.

5.2 MOBILITY STRATEGIES

To achieve the goals of a low-carbon mobility plan, a multi-pronged approach consisting of the following strategies, is proposed.

It is important to note that each of the identified strategies is equally important and the order of listing does not imply priority. Each of the broad strategies includes sub-strategies, which are elaborated in the following sections:

5.3 LAND AND TRANSPORT INTEGRATION

Integrated land use and transport development promotes balanced growth using:

- Reducing travel demand;
- Reducing emission from transport (as overall vehicle-km travelled is less);
- Minimizing land requirements;
- Encouraging walkable/NMT - friendly neighborhoods;
- Enhancing the overall live ability of any place).

Across the world, various development concepts have progressed and been implemented. These are namely, Compact City Concept, Multi-Nodal Transit Concept, and Hybrid Concept (Schematic representation of which can be seen in Figure 5-1. Multi-nodal transit concept considers dispersion of major economic activity nodes and transit corridors around the main city center as in the case of Delhi. The compact city concept is observed in cities including Barcelona, Curitiba where the development of the city region is restricted up to certain limits and a hybrid concept is a combination of dispersed (multi-nodal) and compact development (Figure 5-2).

Figure 5-1: Concept of Development for Cities

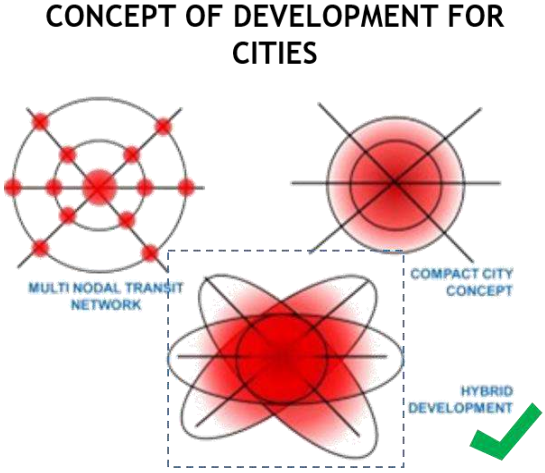
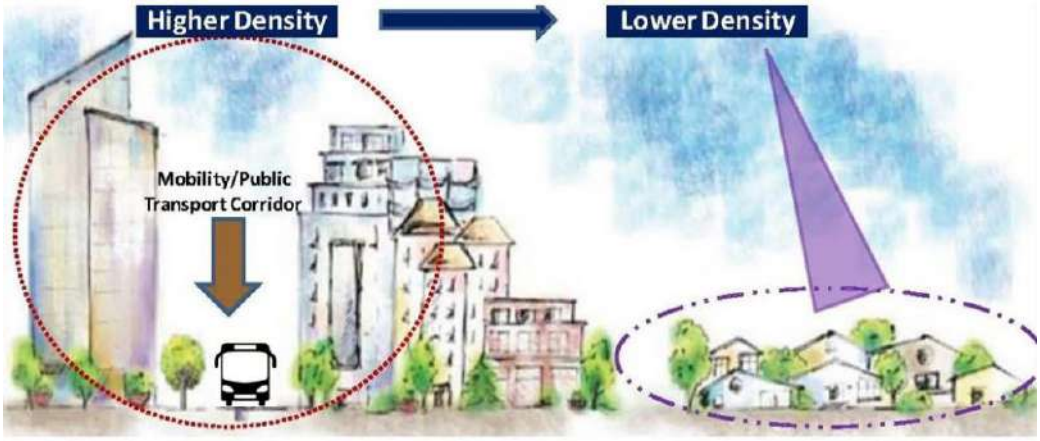
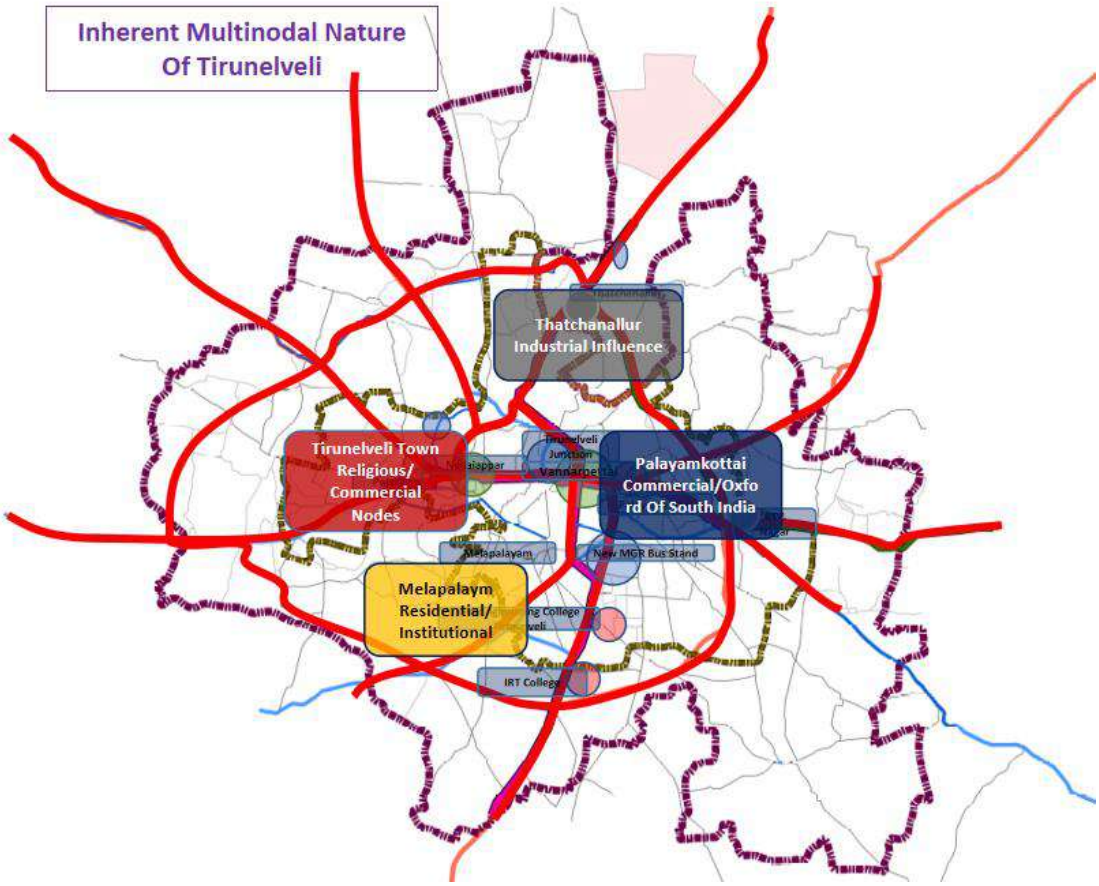


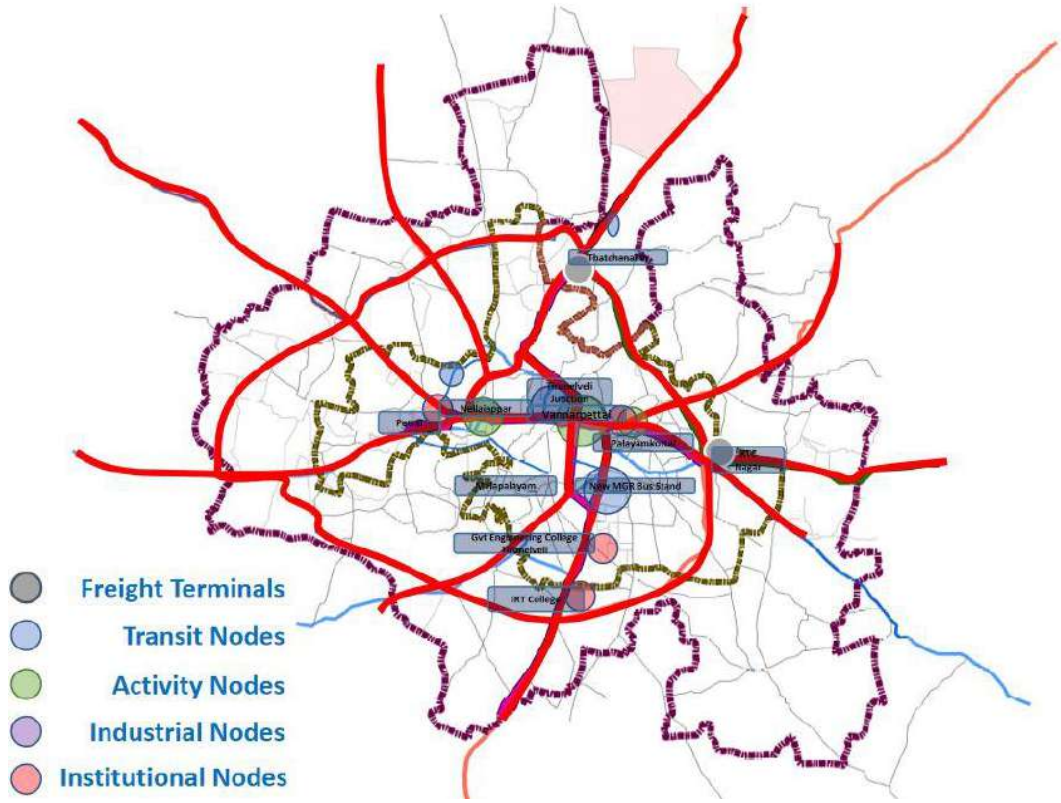
Figure 5-2: Concept of Development for Tirunelveli



The urban growth form and its spatial structure are articulated by two structural elements: Nodes and Linkages. Terminals, such as bus stations, railway stations and airports, are important nodes around which activities agglomerate at the local or regional level. Linkages are the infrastructure that support flows from, to and between nodes. The lowest level of linkages includes streets, which are the defining elements of the urban spatial structure.

Figure 5-3: Proposed Hybrid Growth Concept For Tirunelveli





The subsequent sections elaborate on the strategy for land-use transport integration.

5.3.1 Strategy for Land and Transport Integration

In the case of Tirunelveli, it is proposed that the city be developed on the lines of ***Hybrid Development***.

The Hybrid Model is an urban planning and urban design concept, which includes concentric, sector, and nuclei behavior of different processes in explaining urban land use. This kind of development is an efficient development as it integrates the strengths of each of the other approaches (such as concentric, nuclei, and sector) to provide a highly efficient land-use transport system. This model is proposed in Tirunelveli due to the following reasons:

(i) Major activity areas currently are focused in core areas (CBD) with mixed land use along roads.
(ii) To enhance and promote the high NMT mode share of the city and to retain the lower average trip length of the city.
(iii) To promote and provide a conducive environment for mixed-use development in the city.

To integrate transport and land use in Tirunelveli, the following are being proposed (refer Figure 5-3)

(a) Develop each of the upcoming development areas as activity nodes.
(b) Identify and develop urban mobility corridors to connect the nodes.
(c) Promote high density/mixed-use development along with major hubs, national highways and bypasses to encourage short trips.
(d) Propose corridors for high-density development.

5.3.2 High Density Mixed Land Use

Mostly mixed land uses have been developed along major road networks within city core areas. It was also observed that, urban development has not taken place evenly all along the road network in the place. However, not all the roads have sufficient widths and spaces to accommodate the public amenities required along with these developments. Therefore, the proposals have been developed in such a way that, the vacant patches of available land is put to maximum utilization and several activities centers/nodes in the future are proposed outside the core city like industrial areas, commercial areas, Transport Nagar and Inter-State Bus Terminals, etc. to de-congest the core areas.

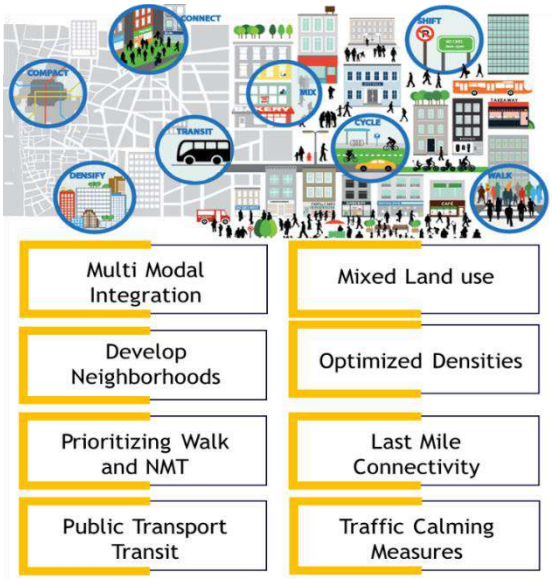
Thus, the development of a high-density mixed land-use development along key identified roads will help the user to access multiple activities within walking distance and, thus, reduce the need to travel. In addition, high-density areas will make the public transport system more efficient.

As mentioned earlier, some of the major transit nodes are already proposed by Master Plan 2021 in the study area:

i. **Transit nodes and Freight Terminals near Thalayoothu, Palayapettai and, KTC Nagar:** proposed in the northern, and eastern parts of the study area.
ii. **Industrial areas,** in the northern and western parts of the study area
iii. **Commercial spaces** along the link between Palayamkottai and Tirunelveli Town

These upcoming transit nodes will **influence the development of their surrounding areas** owing to an **increase in the movement of people and goods from these places.**

To maximize the potential of this development and create high-density areas along the major road networks, **High density Mixed Use Development** has been proposed as a specific strategy.

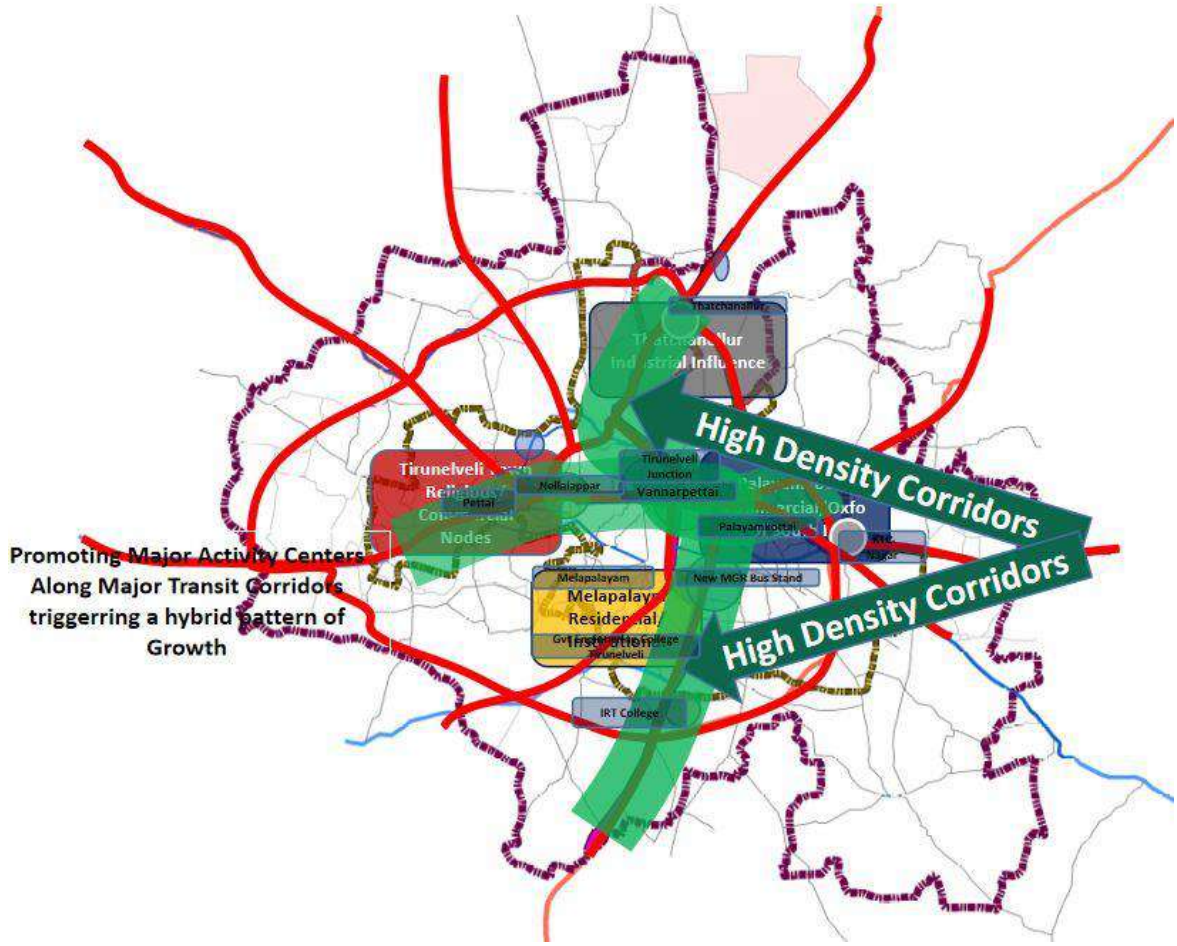


High Density Mixed Use Proposals along the major Public Transit Corridors will help in creating vibrant built environments with safe walking and NMT facilities, besides ensuring integration among various modes. Accessibility and connectivity will get a boost since resilient neighborhoods will provide the needs of daily living, within walking distance (0.5 to 1 km radius).

Thus. **High Density Mixed Land Use** zones are proposed to be developed (refer to Figure 5-4), which are as follows:

- Tirunelveli Town to Palayamkottai (east to west)
- Palayamkottai to IRT Polytechnic College via Trivandrum Road
- Sankarnagar to New NMR Bus Stand via Bypass

Figure 5-4: Proposed Corridors for High-density Development



Based on Masterplan 2021 prepared by Urban Development Department, **future developments are expected along the cardinal directions of the study area, especially the north- south corridor which has a lot of vacant land with development potential**. The above proposed mixed use zones will, thus, **aid this development to improve the accessibility of the region.**

The maximum permitted FSI in urban bodies of Tamil Nadu is 2 (without Considering premium FSI). For the purpose of encouraging High Density Development, the mobility plan recommends an FSI upto 3 in all the influence areas of the High Demand Public Transit Corridor.

5.4 ROAD NETWORK STRATEGY

Due to the multi- centric growth of the Tirunelveli study area, urban development has taken place from various different nodes like Palayamkottai, Tirunelveli Town, Thatchanallur and Melapalayam. The organically emerged network which worked for these areas individually failed to provide an efficient inter-connectivity between these urban centres. The road network improvement strategy proposed for the Sustainable Urban Transport Scenario in Tirunelveli aims at improving the inter-zonal connectivity in the city.

A well-connected and planned road network is essential for the easy and efficient movement of people and goods in a city and should add to the overall development strategy for the city. Road network development also includes improving the intersections for smooth flow and dispersal of traffic.

However, road network proposals are to be considered only if they are necessary as the provision of new roads and further widening will support the higher use of private vehicles. Hence, road improvement proposals are required to be developed such that they cater to all types of road users and help in de-congesting the junctions, improving the PT speeds and safer NMT movements. The proposals for improving road network include:

1) Development of a network of roads and missing link proposals
2) Road widening

5.4.1 Development of The Network of Roads

The Ring Radial road network is envisaged for the city, which shall ensure adequate traffic distribution on all road stretches without overloading and choking any particular stretch.

A total of **42 km of the additional road network** is proposed for the city which includes, **33 km of roads proposed under Highways and 9.6 km proposed to complete the missing links and to attain the ring radial hierarchy for the city.**

In addition to this, **5 river/rail over bridges** have also been proposed for the city to complete the network.

Attributing the industrial character and the heavy flow of freight traffic in the city, **22 km of the outer ring road- fright corridor is also proposed for the horizon year 2042.** This corridor will further enhance the connectivity of the study area in the coming decades and would ensure a smooth flow of passing through freight traffic.

Table 5-1 and Figure 5-5 shows the proposed roads, road over bridges and the outer ring road.

Table 5-1: List of Proposed New Roads and Missing Links

S No	New Road/Missing Link	Node Info	Length	Lanes
1	Pettai Melapalayam Missing Link - 2 Lane	Cheranmahadevi Road to Kokkirakulam Road	6.03	2 Lane

S No	New Road/Missing Link	Node Info	Length	Lanes
2	Vannarpet Palayamkottai Missing Link - 2 Lane	North Bypass to Trivandrum Road Link	1.33	2 Lane
3	North Bypass Balabagya Nagar Missing Link - 2 Lane	North Bypass to East Street	1	2 Lane
4	Melapalayam Palayamkottai Missing Link - 2 Lane	South Bypass to Railway Feeder Road	1.25	2 Lane
5	Western Bypass	Sankarnagar to Reddiarpatti	33	4 Lane

Figure 5-5: Development of the Network of Roads and Proposed ROBs

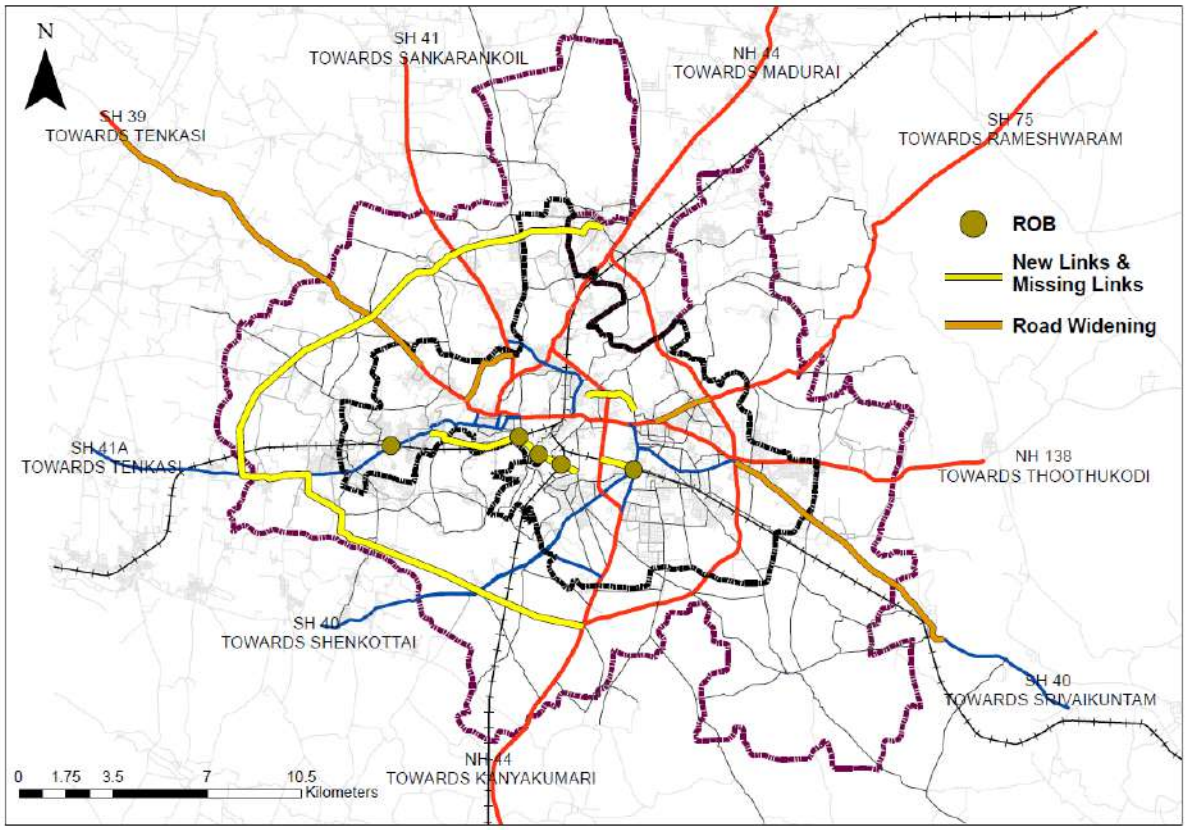


Figure 5-6, shows the ring radial pattern of roads proposed for the city. As these corridors include all the major spines within

Tirunelveli city, they should be designed properly by following the standards and guidelines. These corridors would be expected to have the ensuing cross-sectional elements:

1) Continuous kerb, footpath
2) Restriction or preferably prohibition of parking on the carriageway/shoulders
3) Street lights, pedestrian crossings, guardrails, etc.
4) Carriageway with proper camber and drainage

Some typical cross-sections for improving the links as mobility corridors are illustrated in **Figure 5-7.**

Figure 5-6: New Ring Radial Road Network Pattern for Tirunelveli

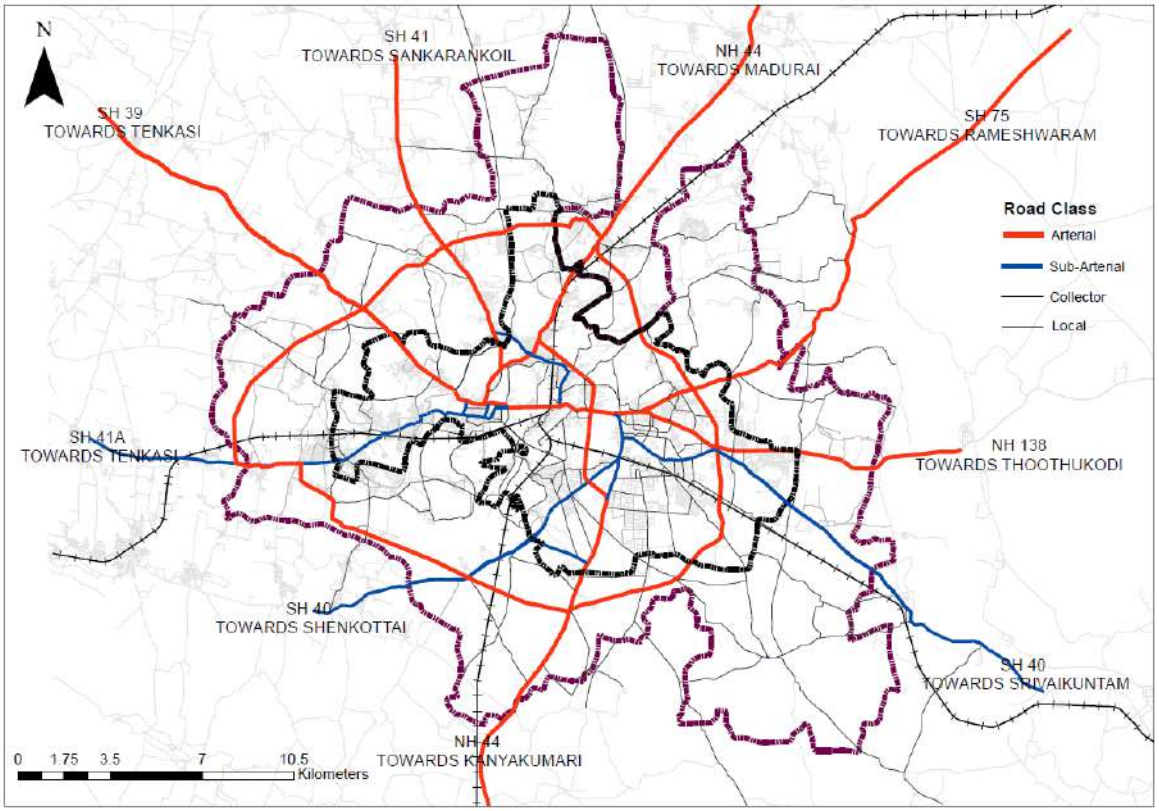
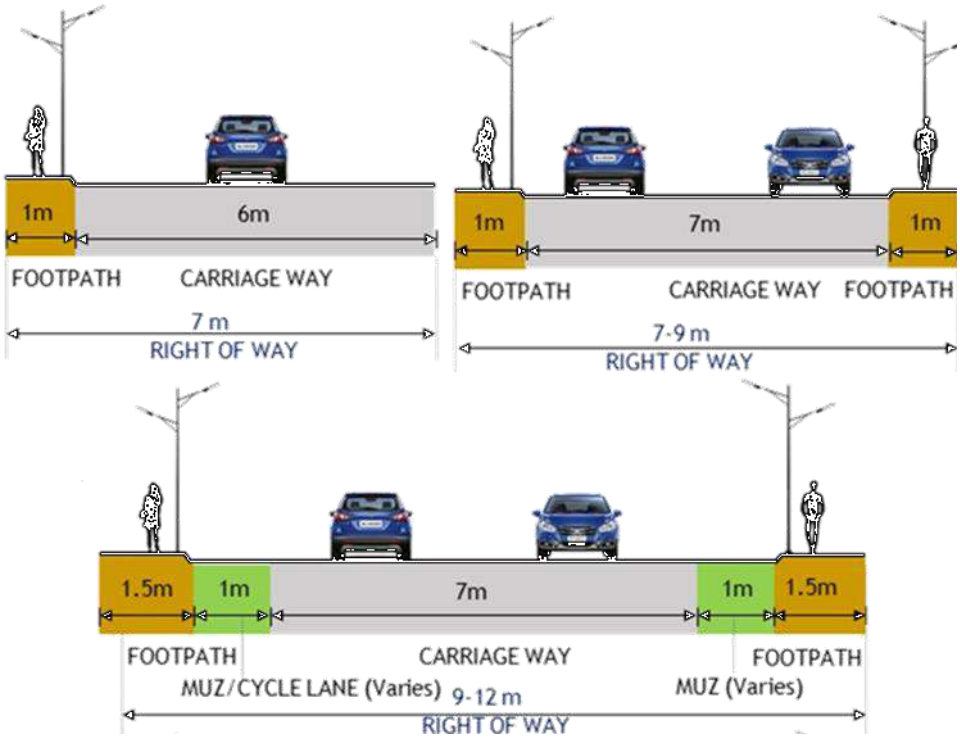
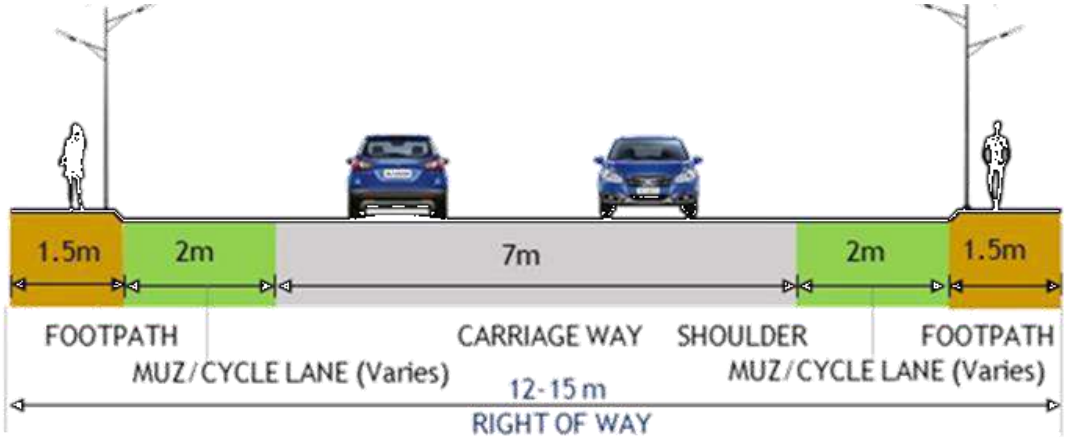


Figure 5-7: Typical Cross-section for Local and Collector Roads





5.4.2 Road Widening

The road widening proposal has been devised for the city based on the projected travel volume on the road network for the horizon year 2042.

A total of **30 km roads** have been proposed for **widening/upgrading in the Tirunelveli study area** as identified in Table 5-2.

Table 5-2: List of Roads Proposed for Widening

Sl No	Corridor	Length in Km	Lane
1	Tirunelveli Shenkottai Kollam Road	14.45	4 Lane
2	Sivalaperi Road	2	4 Lane
3	Valiyapettai Road	2.7	2 Lane
4	Thirichendur Palayamkottai Road	10.4	4 Lane

5.5 PUBLIC TRANSPORT

Tirunelveli, with its present fleet of 299 buses run by TNSTC and 92 buses run by private operators, has sufficient public transport fleet to caters to its mobility needs, however currently lacks coordination between different stakeholders along with a structure for the timely upgradation of the existing fleet size. The RTO Tirunelveli has frozen the permits for new private stage carriage routes. Therefore, in the subsequent years no additional private stage carriage routes are expected for Tirunelveli. The challenges related to public transport in Tirunelveli is given in Table 5-3.

Table 5-3: Challenges of the Current System

S. No.	Challenge/ Issue	Solution/ Recommendation
1	Lack of integration with other modes	Multi-modal integration with IPT systems and Rail based Systems to ensure IPT modes function as a complementary mode to the bus system.
2	Unequal Distribution of bus stops and Poor bus stops and infrastructure	Need to provide a bus stop at every 250 m to 500 m distance to ensure accessibility to the system.
3	Regulation of IPT Operations to strengthen the Public Transport Ridership.	Regulation of IPT operations on Dedicated High demand Public Transport Corridors.

Keeping in mind the current issues posed by the city bus system, it is understood that there is a **need for a more organized fleet upgradation structure.**

The following improvements have been proposed under the public transport system strategy for the study area:

1) Organized system for fleet upgradation
2) Creation and upgradation of supporting transport infrastructure
3) Dedicated high demand public transport corridor

5.5.1 Fleet Upgradation Required in Tirunelveli

Tirunelveli is required to maintain its fleet size to maintain the travel demand requirements in the horizon years. For the calculation, it is assumed that only TNSTC will undertake the entire public transport operations and a replacement of 10% of the fleet will be required every 10 years. The fleet requirement for the horizon years are given in Table 5-4.

Table 5-4: Fleet Requirement for Horizon Years

SUTP	Population	Fleet	Replacement (10% of the Existing Fleet)	Additional Fleet Required (replacement+surplus buses required based on population growth)
2022	735285	391	0	0
2027	792477	396	40	46
2032	849668	425	42	71
2042	964051	482	48	105

It is recommended that the additional fleet added shall be electric buses.

5.5.2 Creation and Upgradation of Supporting Transport Infrastructure

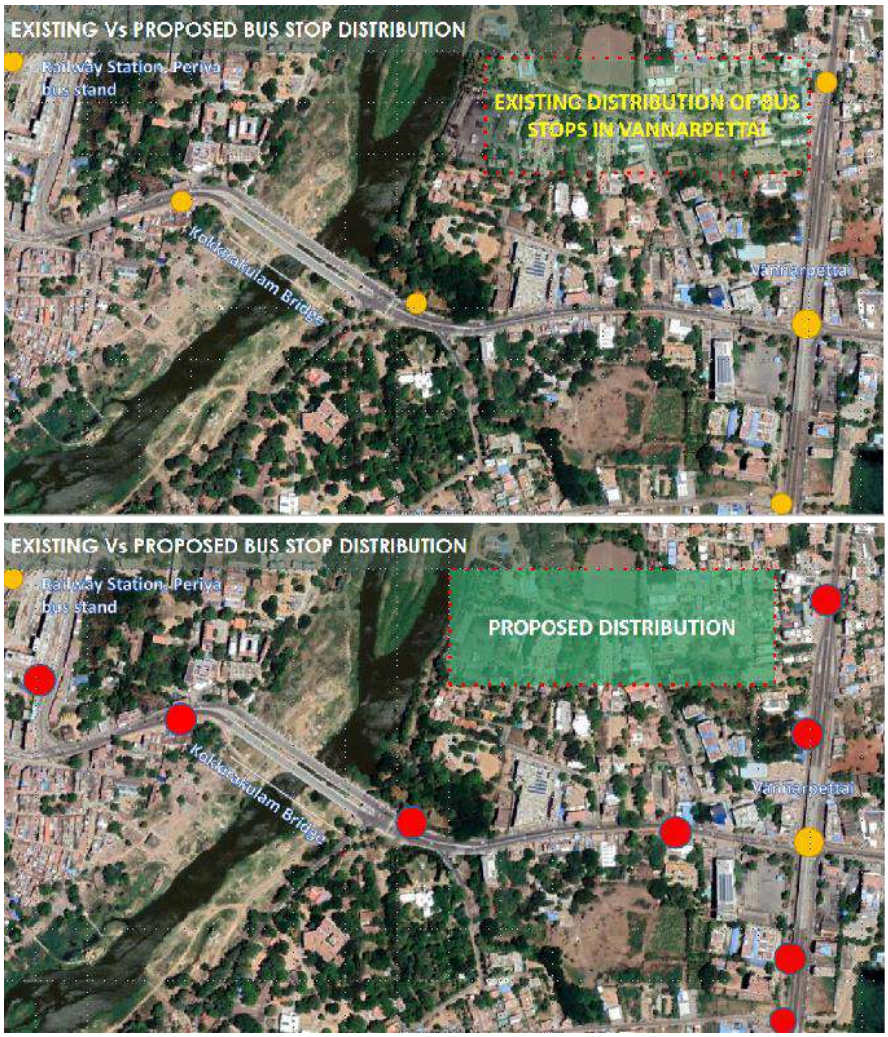
Proposed Bus Stops and Shelters

Though a considerable number of bus stops have been renovated under the Smart City (64 out of 90 bus stops in the corporation area), many major bus boarding areas lack infrastructure for passengers. Non uniform distribution of bus stops, is another issue related to the PT infrastructure (refer Figure 5-8 & Figure 5-9). **Also, Bus stops are observed to take up footpath space, making it important to critically plan the bus stop placements so as to** allow for developing continuous footpaths and cycle tracks where necessary by diverting the footpath or cycle track behind the stops.

Figure 5-8 Boarding alighting on the Carriage way near car street

Figure 5-9 Absence of Bus Shelters near Vannarpettai (major activity area, left), Poor Bus Shelter Condition (CSI Holy Trinity Cathedral Bus Stop, Right)

Figure 5-10 Bus Stop Redistribution Proposal



Proposal

Following are the standards to be considered while deciding on the bus stop locations.

- Bus-bays shall be avoided at all times within a distance of 100 m from the junction center point. This is because bus drivers generally stop in their linear path of travel, thus, forcing passengers to walk into the carriageway to board the bus. Also, vehicles behind the bus sometimes attempt to pass on the left, compromising passenger safety.
- Bus stops shall ideally be placed at 200-400m (refer Figure 5-10) intervals so that passengers can easily access the stop by walk. It is preferable to have bus stops staggered on opposite sides of the road.
- The length and width of a bus stop will vary depending upon passenger demand. However, it is recommended that stations be at least 2.5m wide which is adequate for a seating arrangement.
- Seating shall not be more than 450 mm above finish floor level. The finish floor level shall not exceed 150 mm above the carriageway.

An ideal representation of bus stop placement is shown in Figure 5-11. Number of Bus Stops required in the LPA area has been given in the Table 5-5.

Figure 5-11 Bus Stop Location

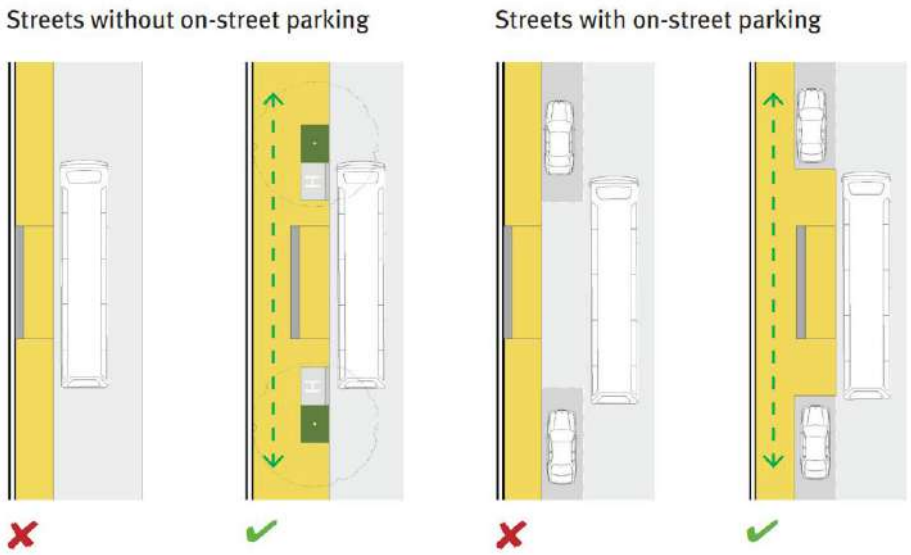


Table 5-5: Bus Shelters Required in the LPA Area

Existing Number of Bus Stops in Corporation Area	90
Number of Bus Shelters Required in the LPA area (both sides of the road)	470

Proposed Terminals, and Multi-modal Integration Points

Tirunelveli at present has two regional transport terminals, out of which the recently developed one, MGR New bus stand caters to al intercity bu services. The second one, Tirunelveli Periya Bus Stand is currently under construction and its functions have been shifted to the Exhibition Bus Stand (near town arch) and Vannarpettai bus boarding area.

However, the city needs more terminals to cater its future PT trip demands, Therefore as a part of the SUT proposal transport terminals have been proposed at Suttamalli and Thalayoothu which will mainly caters the intercity tips from neighbouring northern and western urban centres of the city. These shall be developed in the Phase 3, during which the existing terminals shall be converted in to **Traffic and Transit Management Centres** which shall only cater to city bus services.

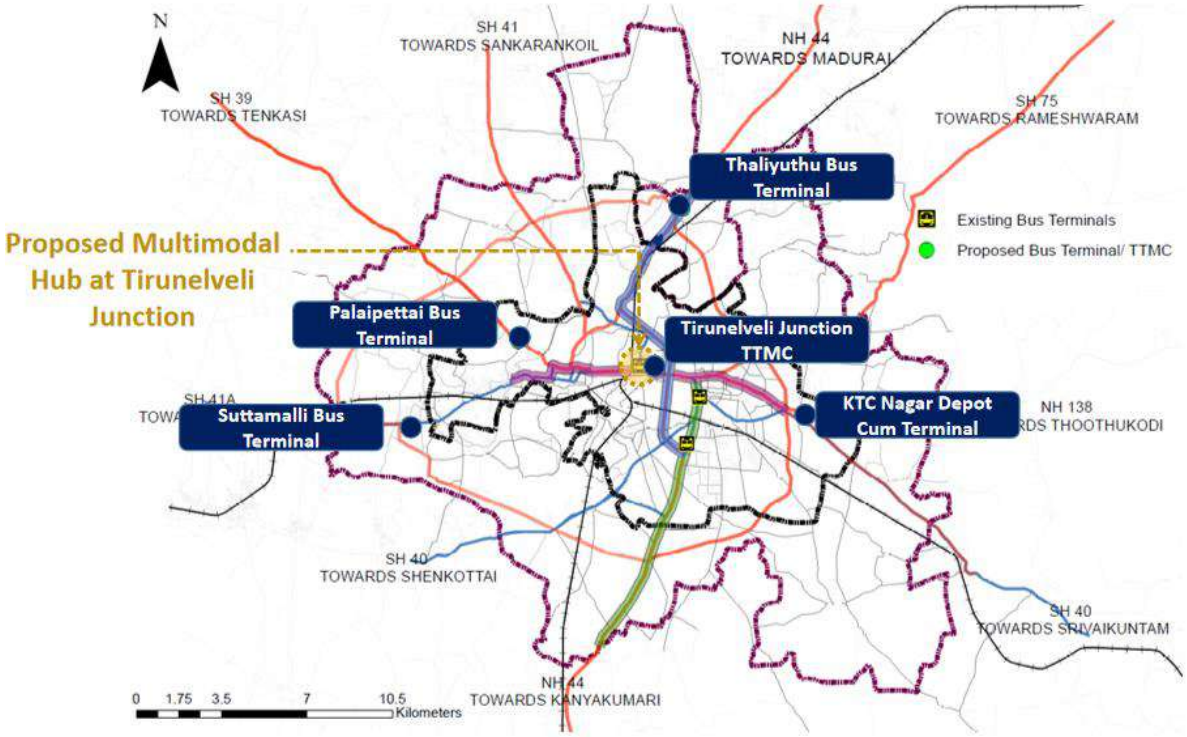
Periya Bus Stand due its proximity to the Junction Railway Station shall be developed in to a **Multi-modal Hub**, where physical accessibility between different modes is improved providing a seamless interchange between the modes.

- **Periya Bus Stand should be redeveloped as a multi modal hub.**
- **Four proposed Regional Bus Terminals** should also serve as the depot/terminals for the city buses and regional transport service buses.

Table 5-6: Bus Terminal and Multimodal Hub Proposals

S No	Proposed Bus Terminal/ Multi Modal Hub	Phase
1	Suttamalli Bus Terminal	1
2	Palaipettai Bus Terminal	3
3	Thalaiyuthu Bus Terminal	2
4	KTC Nagar Bus Terminal Cum Depot	2
5	Tirunelveli Junction Multimodal Hub	3

Figure 5-12 Proposed Bus Terminals and Multi-modal Hub



5.5.3 Proposed IPT/ Feeder System

Unreliable last mile connectivity impacts the overall quality and usage of mass transit and results in a mode share shift of Public Transport. While efforts are being made to enhance mass Public Transport, last mile connectivity has to be improved and linked into existing services.

An integrated system will aid ease of access for users. Auto-rickshaws and share Auto not only act as good feeder services to these mass transit options but can also be a mode of choice for occasional or short trips. They play a key role in improving sustainability for urban transport. There is a need to introduce new models of regulation and reforms that can be adopted for a more efficient and safer system that enable the rickshaw to have an optimal role in the transport mix.

The IPT services can provide first and last mile connectivity attracting more riders. The services are convenient as the pickup and drop off is provided at any point along the route. The Shared autos ply on narrow roads with less Right of way owing to their easy maneuverability enabling them to access the inaccessible locations.

- Due to the restrictive policies, IPT providers largely operate informally
- Drivers lack job security and benefits
- They also do not have documentation of income, which limits access to credit to purchase their rickshaws
- Drivers are often subjected to harassment and confiscation of vehicles
- Negative environmental implications due to lack of regulation on emissions • No regulation of fares
- Little integration between modes due to lack of co-operation inconveniences passengers
- Lack of safety regulations puts passengers at risk
- Concern for safety due to mixed traffic flow driven by growth in private vehicles

Attempts need to be made to organize IPT

1. Provide better service to passengers
2. Transparency of fares and complaints hotline
3. Driver behavior and road safety training
4. Dispatch services or “dial-a-rickshaw”
5. Include added features such as seatbelts, newspapers, etc.
6. Organize drivers and provide basic insurance, credit and allowances
7. Tea vendors can co-ordinate bookings and dispatch in return for rent-free space and a captive market of drivers
8. Medical and accident insurance and discounted medical facilities
9. Children’s education allowance
10. Integrate with mass Public Transport
11. Feeder services for first and last mile connectivity – Shared Auto from railway station to homes
12. Promote sustainability: Electric Autos, solar-powered rickshaw or rickshaws on CNG.

Current trends in urban transport highlight the usage of IPT modes (i.e. auto-rickshaws and taxis) in cities for daily commute trips, because of the poor quality of Public Transport. Thus, improving Public Transport in cities would be a key strategy in ensuring that auto-rickshaw services fulfill their intended role as feeder services instead of competing with Public Transport for long-distance trips.

In Tirunelveli, the IPT routes operated overlap with the major PT corridors. Although improving Public Transport in the city would be a key strategy, it is also important to ensure that auto-rickshaw/Share Auto services fulfil their intended role as feeder services instead of competing with Public Transport for long-distance trips. The same is achieved by rationalizing their major routes to feed into the PT corridors, designating the routes, stops. A common mobility card can also be introduced which can be used across the modes by the user.

As a part of Short Term Improvement Measures, a charging station for Electric IPT vehicles has been proposed in the Nellaiappar Temple Complex to promote the use of Electric IPT and making the complex carbon free.

The following are the proposal for improvement of IPT:

1. User Guidelines: The Government or the RTOs must ensure that the vehicle as well as the fitness of the driver is tested and verified for every 2 years. The use of eco-friendly vehicles should be encouraged. The drivers should also be enrolled in road safety awareness campaign and certified accordingly.

2. Fare Structure: Auto-rickshaw is not the most preferred mode of the locals in the state as the fare for the system seems to be unreasonably high. Auto-rickshaws are the last preferred options and are used only in case of urgency or emergency. Introduction of a metered system developed and controlled by the Government would enable transparency as well as increase dependency to its users. The fares may be revised by the Government based on the increase or decrease of the fuel prices.

3. Parking Bays: Allocation of parking bays for Pilots and Auto rickshaws at crucial nodes such as Bus Terminals, Busy Commercial Areas, Shopping malls, Theatres etc., should be provided with proper signage's and way findings. An average of 3 ECS at a spacing of 600 m is suggested.

4. Cab Aggregators: Similar to the autos/pilots, the taxis also have been charging the tourist exorbitantly. In this regard, the introduction of Cab aggregators such as the Uber/Ola may be used for operations in Tirunelveli. This would ensure better services, reliability and transparency for both the operator as well as the user.

5.5.4 Dedicated High Demand Public Transport Corridor

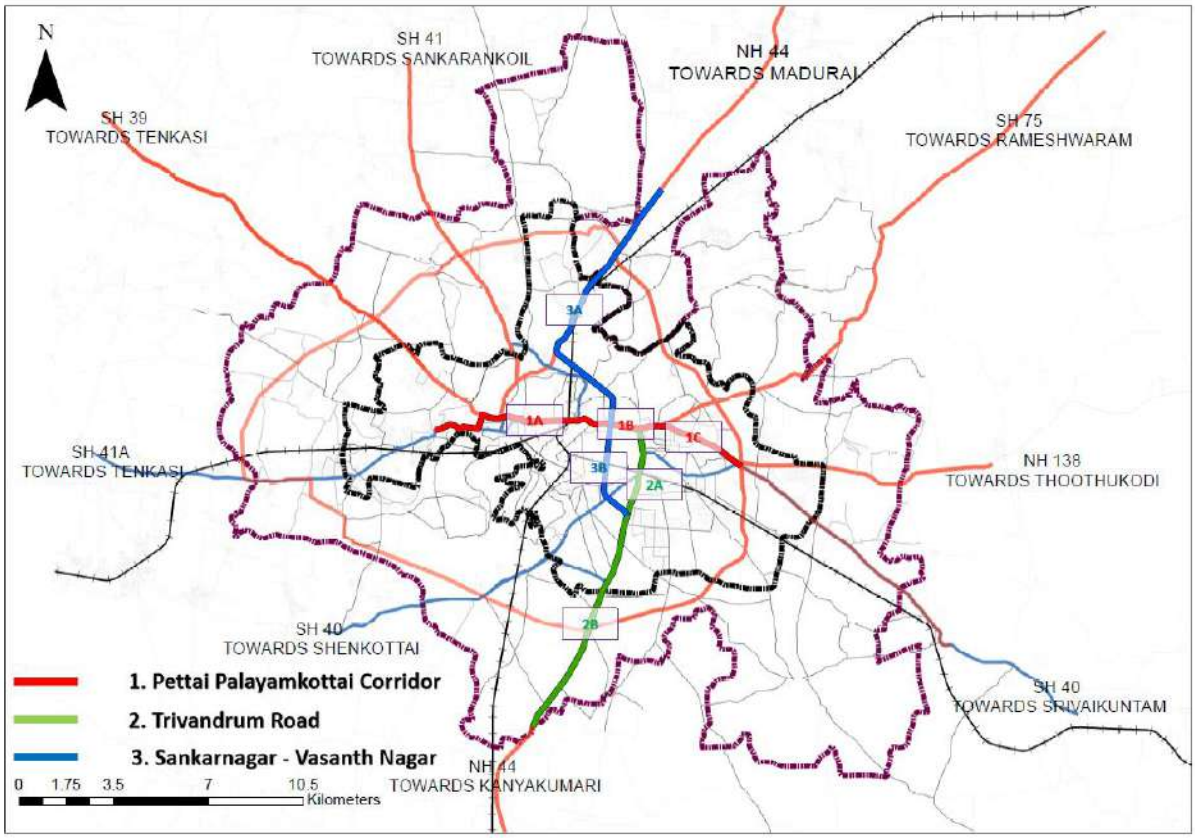
It is envisaged that buses will continue to be the major mode of public transport in Tirunelveli, and keeping in mind the increase in population and future growth of the city, **High Demand Public Transit Corridors have been identified for the study area covering a span of 39 km.** Figure 5-13 and Table 5-7 shows the proposed High Demand Public Transport Route

Table 5-7: Proposed High Demand Public Transport Corridor

Corridors Details				SUTP 2032		SUTP 2042	
	Link Name	Link Details	Length	Cross sectional Values	PPHPD	Cross sectional Values	PPHPD
1	SN High Road (Pettai to Palayamkottai)	1A Pettai to Vannarpettai via SH 41 A & SN High Road	7.18	5495	2748	9352	4676
		1B Vannarpettai to Murugankurichi Junction via Trivandrum Road	0.885	8617	4309	13518	6759
		1C Murugankurichi Junction to KTC Nagar via Tirunelveli Tenkasi Road	4.32	6679	3340	10364	5182
2	Trivandrum Road (Murugankurichi to Punnakudi)	2A Murugankurichi Junction to Trivandrum South-Bypass Junction via Trivandrum Road	3.43	2672	1336	4552	2276
		2B Trivandrum Bypass Junction to Punnakudi via Trivandrum Road	8.6	1115	558	3332	1666
3	Bypass (Sankarnag	3A Sankarnagar to	10.9	4167	2084	7008	3504

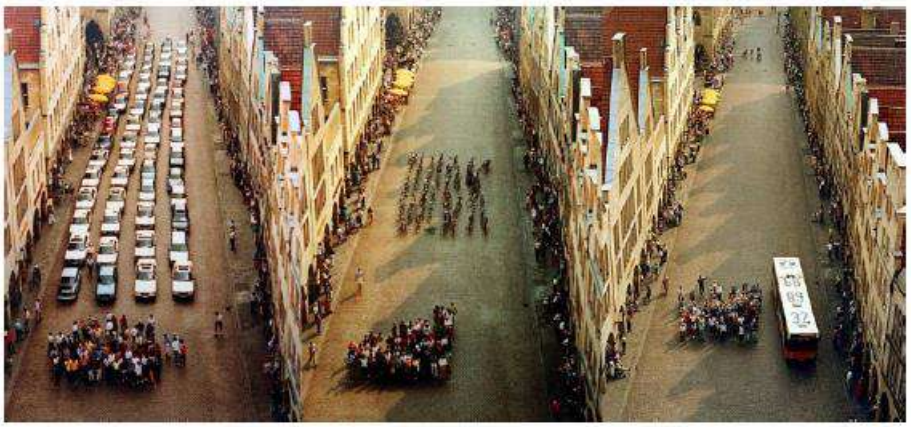
Corridors Details					SUTP 2032		SUTP 2042	
	ar to Vasanth Nagar)		Vannarpettai via North Bypass Road					
		3B	Vannarpettai to Trivandrum South-Bypass Road Junction	3.75	5330	2665	9167	4584

Figure 5-13 Proposed Mass Transit Corridors



5.5.5 Mass Transit System

A Mass Transit System is designed to move large numbers of people at one time. Mass Rapid Transit system usually runs in special guideways which will lead to lower travel time, and decreased congestion.



A number of technologies are available for Public Transport and as some of the technologies, especially metro rail, are highly capital intensive, it is necessary to have certain guidelines for choice of different transit modes. However, it is emphasized that buses will continue to be the major mode of Public Transport in Chennai, and hence citywide Integrated city bus service as per urban bus specifications is required. The selection of higher order system is based on the Passengers per Hour per Direction (PPHPD) and feasibility of implementation, along with other parameters as mentioned below.

Need for A Mass Transit System: From energy efficiency point of view, the use of mass transit is vastly superior when compared to using personalized modes of travel. Available literature shows that, to meet each kilometer of passenger travel demand:

A. A car consumes nearly five times more energy than a 52 seater bus with 82% average load factor

B. A car occupies over 38 times more road space per passenger in comparison to a bus

C. The fuel cost of two wheelers is 6.8 times, three wheelers 7 times and cars 11.8 times when compared to a bus.

Selection Criteria:

- Effectiveness of mode in meeting demand
- Cost
- Right Of Way Availability
- Environmental Impact
- Journey Time
- Safety
- Comfort
- Flexibility
- Reliability
- Fare
- Technical Sophistication

- Implementation Complexities
- Image

The guidelines for selection of mass rapid transit choice for the city is given as specified by working group Table 5-8and Table 5-9 on Urban Transport for 12th Five Year Plan of India and is based on on Guiding Documents, Past Studies on Various DFR's and Past Experiences.

Table 5-8: Proposed Mass Transit Corridors

Mode Choice	Desirable PPHPD	Population (Million)	Average Trip Length
Metro	>15000 for at least 5 km continuous length	>=2	>7-8
LRT at Grade	<=10000	>1	>7-8
Monorail	<=10000	>1	About 5-6
BRT	>=4000 and upto 20000	>1	>5
Organized City Bus Service as per UBS-II	>1 Lakh, 50000 in case of hilly towns	>2-3	
Source: Mode Selection as mentioned in 12th Five Year Plan (Recommendations of working group)			

However, a rule of thumb comparing different mass transit systems and their selection criteria at a macroscopic level is shown in the table given below. On the basis of this broader criteria for system selection, a Metro Neo system could perhaps be an ideal mass transit system on the identified mobility corridors in Tirunelveli. However, at this point of time, no particular system can be called out. The Alternative Analysis Study will evaluate dozens of parameters and recommend/name the most preferable transit system on the identified corridors.

Table 5-9: Criteria For Selecting Mass Transit System

	METRO	Metrolite/Modern Tram	Metro Neo
Capital Cost Per Km (Rs in Cr)*	200-250 (Elevated)	80-90 Cr-At-Grade	75 - 100
	450 -500 Cr (Underground)	135-150 Cr-Elevated	
RoW Options	Exclusive Grade Separated	At-Grade Segregated (Elevated/At Grade)	At Grade/
			Elevated
PPHPD	6,000-80,000	6,000-15,000 - At-Grade	**At-Grade: 3000 - 15000**
		6,000-20,000 - Elevated	**Elevated: 6,000-25,000**
RoW (M)	24m+	24m+ for At-Grade	24m+
		18m+ for Elevated	
Average Operating Speed (Kmph)	30 - 40	20 – 25 At Grade	25 - 40
		24-28 Elevated	

Cabin/Vehicle Capacity	250 – 300 Per Car	315 for 33 m Coach	Standard – 60 Per Bus
		402 for 45 m Coach	Articulated – 110 Per Bus
			Bi – Articulated – 170 Per Bus
Station Spacing	800 - 2000	500 – 1000	500 - 1000
Traction	Third Rail /Overhead	Third Rail /Overhead	Electric – Battery / Traction
Axle Loads (Tons)	15 - 17	10 – 11	10 - 11
Min, Curve Radius (M)	100	25 At-Grade	12 - 20
		50-75 Elevated	

5.6 NON-MOTORIZED TRANSPORT

The CMP envisions an environment where people are encouraged to walk in Tirunelveli through equitable allocation of public space and infrastructure, and access opportunities and mobility. The main objective is to increase the share of walking, cycling and other NMT modes by creating a safe and pleasant NMT network of footpaths, green-ways, and other facilities to serve all citizens. The design of the streets in the city must be consistent with best practices in pedestrian-oriented, multi-modal street design.

In Tirunelveli, currently, the city lacks adequate pedestrian infrastructure with a complete absence of planned cycle tracks. The intersections are devoid of safe pedestrian and NMT crossings, which have an adverse impact on the safety of pedestrians. Keeping this in mind, the following NMT proposals are devised for Tirunelveli under this CMP:

- Development of footpath facilities
- Pedestrian friendly intersections
- Development of cycle track facilities

5.6.1 Footpath Network Development

Pedestrian trips are generally short trips and can be observed everywhere in a city. Hence, the provision of pedestrian walkways should be mandated on all major roads and streets in the city. However, special consideration for pedestrians should be given near junctions (dangerous intersections) and major activity nodes (such as schools, colleges, offices). As the city completely lacks quality footpath infrastructure and since walk is an important mode for work/educational trips in the city, hence it is crucial to develop strategies to safeguard these trips.

CMP has identified all the major corridors for immediate provision of footpaths as per the design standards specified under IRC 103:2012: Guidelines for Pedestrian Facilities. The interventions proposed as a part of the CMP are as follows.

1. The footpaths have been proposed on the basis of the existing road widths, roads networks with > 12 m ROW have been proposed to have footpaths on both sides of the road, whereas all streets with ROW in the range of 9m to 12m are proposed to have footpath on one side of the road. However, roads above 30 m may be designed

according to NHAI guidelines or Urban Road Codes of MoHUA. All Arterial, Sub Arterial, Collector roads, in the developed portion of the city, are proposed to be developed with footpaths depending on their ROW. Typical cross-sections for the city are provided in the Figure 5-7 for roads of 7 m, 9–12 m and 12–15 m, 15–18 m,18–25 m, 25–30 m. Recommended cross sections for Footpath Zoning in Urban Areas are also shown in Figure 5-14

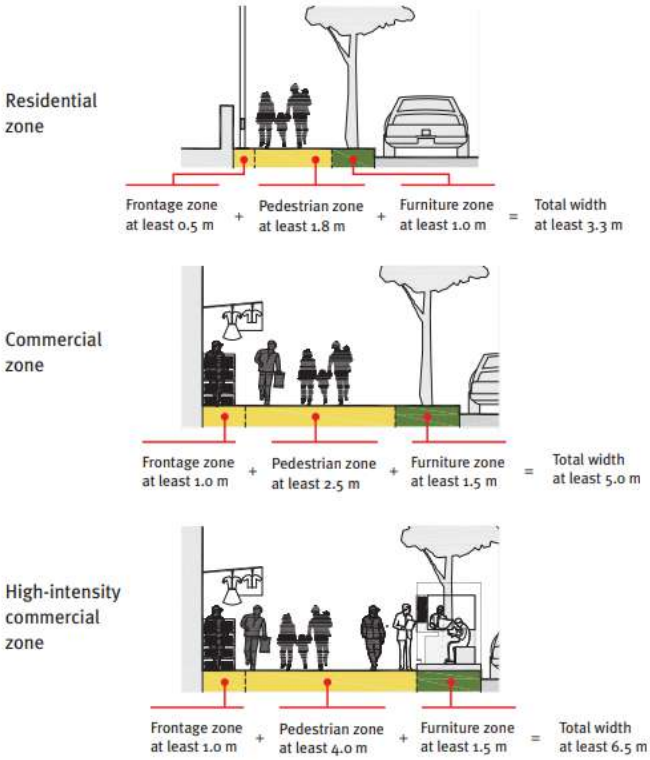
2. The footpaths are designed keeping in mind the area land use, the type of activities, the pedestrian footfall and the type of pedestrians it will cater. Shown in Figure 5-14 are typical footpath design standards for the various type of zones.

As part of short-term measures, it is proposed that **in Phase 1, entire 150 km of roads** be identified for the construction of new footpaths. All the links proposed for development under Phase 2 and Phase 3 will have footpaths built as per urban design standards.

Table 5-10: Footpath proposals for CMP.

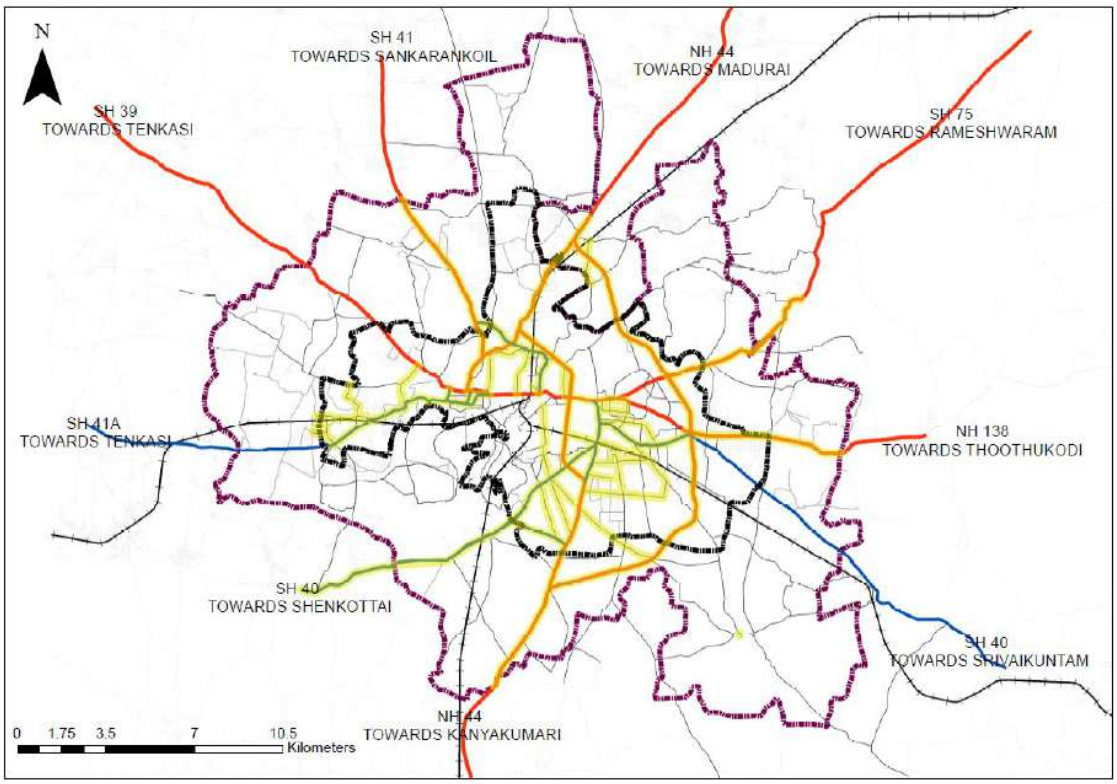
S No	Footpath Proposals on Major Links In Tirunelveli	Length in Km
1	Car Street	1.66
2	Tenkasi Tirunelveli Road	4.86
3	Tirunelveli Pottalpudur Road	6.97
4	S Mount Road	2.64
5	North- South Bypass	15.8
6	SN High Road & Trivandrum Road	7.48
7	Sankarankovil Tirunelveli Road	4.3
8	South bazaar Street	1.65
9	Tirunelveli Thoothukudi Highway	6.29
10	Ambai Road	1.41
11	Tirunelveli Shencottai Road	6.1
12	Kokirakulam Road	3.55
13	Netaji Road	2.44
14	NH 44	19.4
15	Madurai Road	4.32
16	Town Road	3.54
17	Sivalaperi Road	5.36
18	Puliangudi Tirunelveli Road	6.33
19	Nainarkulam Road	1.53
20	Madurai Road	3.12
21	SH 40	9.61
22	7th Street Palayamkottai	2.25
23	High Ground Road	4.01
24	Railway Feeder Road	4.18
25	St Thomas Road	2.44
26	Sivanthipatti Road	5.97
27	STC College Road	4.3
28	Reddiarpatti Road	3.97

Figure 5-14 Zone wise Footpath design



The footpath network is shown in Figure 5-15 important links on which footpath has been proposed has been given in **Table 5-10.**

Figure 5-15: Proposed Footpath Network On Existing Roads



All the junctions in Tirunelveli should be designed with due consideration for pedestrians. The footpath design should be uniform across the city. Depending on the volume of pedestrians, the area requires footpaths with minimum width varying between 1.8 m in the core city to 2.5 m in other parts of the city with a maximum height of 150 mm from the finished road surface.

The IRC and street design guidelines specify the minimum footpath width to be 1.8 m. In certain cases, where the available road ROW makes it difficult to provide 1.8 m barrier-free space for footpaths, segregation can be made at level with the road surface using different paving materials. Typical detail of footpath section is shown in Figure 5-16

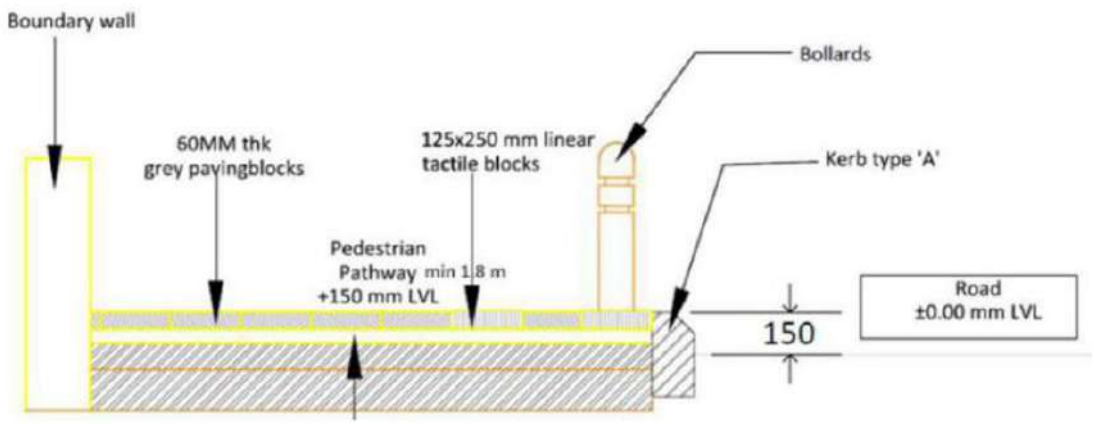
Safe Pedestrian network should be developed prioritizing schools, hospitals and other institutional areas of the city. It has to be made sure that all access roads to schools are pedestrian friendly.

- **The smaller local streets/residential streets** may not have sufficient width to provide a segregated pedestrian walkway. But these residential streets should also provide safe route to pedestrians. This can be achieved by
    - **Limiting The Speed of Motorized Vehicles**
    - **Installing Speed Breakers at Frequent Intervals**
    - **Providing Table Top Crossings Etc.**

The footpath design should be uniform across the city. Depending on the volume of pedestrians, the area requires footpaths with minimum width of 1.8m (barrier free space) and maximum height of 150mm from the finished road surface. However, the maximum height of 150 mm cannot be compromised in any circumstance. Increasing the footpath height to more than 150 mm makes them unusable by pedestrians, thereby defeating the purpose of providing the footpaths.

The barrier free designs in footpaths, (containing tactile pavement, ramps, etc) shall be designed based on the guidelines set by Institute of Urban Transport (IUT) and Govt of Tamil Nadu, in these aspects.

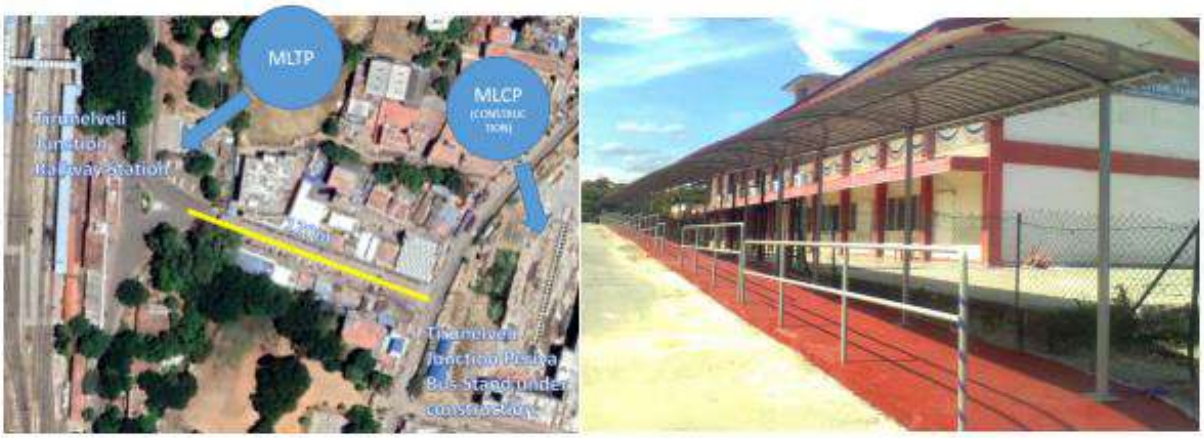
Figure 5-16 Footpath Detailing **(representative image, actual detailing will be based on guidelines set by Institute of Urban Transport& Govt of TN)**



5.6.2 TM Road Improvement

TM Road (refer Figure 5-17), which is the link between Tirunelveli Junction railway station and Tirunelveli Junction bus stand (presently under construction) is another major link which needs to be considered for the pedestrian network improvement. The 120 m stretch of street is currently encroached with on street parking and shops jutting into the footpath.

Figure 5-17 TM Road details (left), reference image, sample image covered pedestrian walkway (right)



Proposal: The CMP is proposing a pedestrian friendly plan for the TM road. The existing on street parking shall be shifted to the nearby MLTP (operational, beside the railway station) and MLCP (inside bus stand under construction). A covered walkway is proposed along the road, for easing the connectivity between the Railway Station and the bus stand.

5.6.3 Development of Cycle Friendly Streets

Cycling is increasingly recognized as a clean, sustainable mode of transport and a key in realizing the goal of sustainable urban mobility using reducing the number of vehicles and, thus, reducing greenhouse gas emissions. Bicycle friendly streets are designed considering the following principles:

- **Safety**: Segregated cycle tracks for an increased sense of security and safe route to schools and bus stops.
- **Connectivity**: The NMT network should connect major attractions and a complete consistent network with fewer missing links.
- **Comfort:** A more comfortable pedestrian and cycle path with facilities to support and encourage the use of NMT.
- **Ambience:** To make cycling a pleasant and great experience for its users.

From the primary survey, it is observed that 18% contribute a significant share of NMT trips in their day-to-day travel to work and other activities.

Difficulties faced by NMT users in Tirunelveli:

- Lack of NMT infrastructure
- Too many conflict points

- No integration with other modes
- Lack of NMT coverage
- Lack of promotion and awareness of NMT usage among people

It is, thus, proposed to have a total of 40 km of cycle track network comprising dedicated and shared tracks

- **Shared cycle lanes** – 19 km of shared cycle tracks of which 7.8 km in the second phase and 10.5 km in the third phase
- **Dedicated cycle tracks** – 21 km of segregated cycle tracks of which 18 km in the first phase covering areas other than the city core and 3 km in the second phase.[20]

Figure 5-18 shows the cycle track network proposed for the CMP and Table 5-11 gives the details of the proposals.

Figure 5-18: Proposed Cycle Tracks

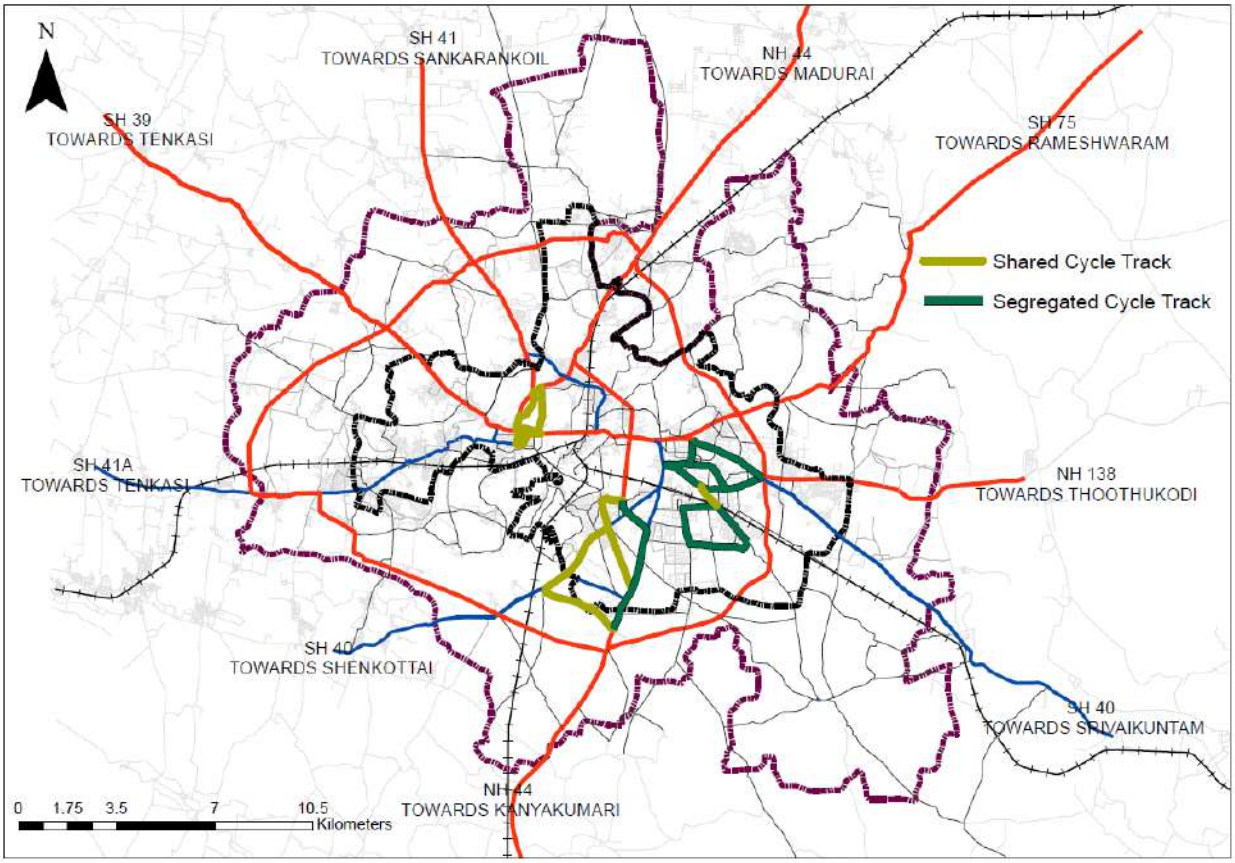


Table 5-11: Cycle Track proposals for CMP.

S.No	From	To	Via	Length (in Km)		Phase
				Segregated	Shared	
1	Pushpalata Group of Schools	STC	Pothigai Nagar Road, STC College Road	2.9		1

[20] *In addition, all new major roads shall have the provision for dedicated cycle tracks and foot paths, subject to the availability of land*

S.No	From	To	Via	Length (in Km)		Phase
				Segregated	Shared	
2	STC	Palayamkottai, railway Crossing	STC College Road	2.6		1
3	Pushpalata Group of Schools	Palayamkottai, railway Crossing	Sivanthipatti Rd	2	0.5	1
4	Govt Medical College	St Xaviers College	St Thomas Road & High ground Road Loop	6.7		1
5	St John's College	V M Chatram	Tenkasi Rirunelveli Road	2.8		1
6	St Johns College	Palayamkottai Market	Water tank Road	1		1
7	Town Arch Junction	Car Street- Tank Bund Road Intersection	Car Street, Nellaiappar Temple Complex	0	1.8	2
8	Nainarkulam Lake (south)	Nainarkulam Lake (south)	Tank Bund Road, Vaikalkarai Street, Sankarankovil Tirunelveli Road		4.3	2
9	St Thomas School Melapalayam	Saravana Shopping Mall	Melapalayam-South Bypass Link	0.5	0.5	2
10	Saravana Shopping Mall	Govt College of Engineering Tirunelveli	South Bypass, Trivandrum Road	2.5	0	2
11	Muslim Higher Secondary School Melapalayam	St Thomas School Melapalayam	Netaji Road		1.2	2
12	Govt College of Engineering Tirunelveli	Muslim Higher Secondary School Melapalayam	Trivandrum Road, Netaji Road	0.6	2.6	3
13	Govt College of Engineering Tirunelveli	Muslim Higher Secondary School Melapalayam	Araikulam Road, Tirunelveli Shenkottai Road	0	7.9	3

5.7 AREA BASED TRAFFIC MANAGEMENT

Traffic issues in some of the areas in Tirunelveli are critical and require a mix of traffic proposals given above. These areas have been categorized under area specific traffic management proposals, which are as follows:

5.7.1 Traffic Management for Car Street and Surrounding Areas

Car Street is the link that goes around Nellaiappar temple. Almost 50% of the street is encroached with a number of activities like street vending, on-street parking, goods loading and unloading etc. Being a place of religious importance and a major commercial market, it also experiences heavy pedestrian footfall.

Existing challenges related to Car Street are:

1. Challenges related to Pedestrian Movement

Nellaiappar temple premises is one of the locations having heavy pedestrian footfall, since it attracts pilgrims throughout the year, and also is an important commercial node of the city. Despite having heavy pedestrian footfall, the area lacks proper pedestrian infrastructure like footpaths, lane markings or signage (Refer Figure 5-21).

Figure 5-19 Entrance to Car Street presents a bottle neck, street encroachments

2. Challenges Related to Bottle Neck

The street is a prominent bus route, Tirunelveli Town Buses access Swami Sannathi Street via the town arch, enter the eastern car street and exit the Car Street via South Car Street -Cheranmagadevi Road. The two bottle necks of this route are - the one at the town arch junction and the other one at the Temple entrance. Entry and exit of buses due to these bottle necks are challenging (refer 5-22)

Figure 5-20 Unorganized Street Parking, Bus Boarding and other commercial activities on Car Street

Figure 5-21 Road Shoulders are severely encroached by parking, loading& unloading and street vending activities

3. Challenges Related to Mix of Activities

The street is heavily encroached due to illegal on street parking and street vending activities. (Refer Figure 5-19,Figure 5-20,Figure 5-22)

Figure 5-22 Car Street Connectivity

Short Term Proposals:

1. Traffic Management and alternate link development of Car Street

It is proposed that, beyond the point of Town Arch, towards the temple around the main Car Street, only two wheelers and E-Rickshaws need to be allowed banning all four-wheelers and buses. The buses are to be rerouted via alternate streets around the car street. All Buses, which enter the car street at present shall be rerouted via Arunagiri Theatre Road, Shenbagam Pillai Street, South Mount Road and Cheranmagadevi Road. Buses towards the north and north west (towards the direction of Tenkashi) shall be rerouted via the Nainarkulam road. New Bus Stops need to be proposed along the mentioned streets. These bus stops will be approximately at a distance of between 60m to 120m from the corners of the car street, which can be easily accessed on foot. It is also recommended to introduce battery operated E-Rickshaws that act as IPT, plying between Town Arch junction and the Car Street, and on the Car Streets around the temple. These measures will not only ease the congestion on and around Car Streets, but also will improve the environmental situation in the area.

While restricting vehicular entry towards the temple from the Arch junction, following provisions shall be made:

- Entry restriction of Cars, Buses and Goods Vehicles beyond The Town Arch, on the car street and Swami Sannathi Street shall be from morning 7 am to 10 pm. Only Two wheelers and E-Rickshaws shall be operated during the day time;
- Four wheelers approaching the area can use the existing off-street parking near the town arch. In addition to this, on-street parking can be permitted at Nainarkulam (Tank bund) Road at a premium pricing wherein the organized on-street parking need to redevelop along the corridor. All on-street parking need to be banned on the car street during the day time wherein two wheelers entering the car street shall utilise only the Multi-Level Two Wheeler Parking, being constructed as a part of Smart City situated near the Nellaiappar Temple. A special permit can be used to operate E-Rickshaws to ply on the car street which can be taken up by the temple administration.
- Car Street and Swami Sannathi Street, as well as the access routes to the new bus stops proposed on the alternate bus routes shall be developed as pedestrian friendly streets with proper street lighting, signage and lane markings.
- Street vending in the car-street shall use only designated street vending spaces properly marked on road.

2. Geometrical correction of Town Arch Junction

It is proposed to redevelop the entire junction as a part of improving the flow at the junction, wherein it is recommended to shift the junction slightly away from the existing position as shown in the Figure. Further while improving the entry/exit for each arm, it necessities for a minor land acquisition at Nainar Kulam road entry, Refer

Figure 5-26. Major advantage by redesigning the junction would be existing Town Arch will be retained in future. This will act as an entry/exit arm towards Nellaiappar temple side.

Subsequently, Town Arch becomes part of the eastern arm of the junction. Additionally, the junction is provided with table top crossings, pedestrian islands, along with proper signage. Besides, the boundary of the town arch is proposed to be protected using Bollards.

Figure 5-23 Existing Traffic Circulation in the Car Street Area

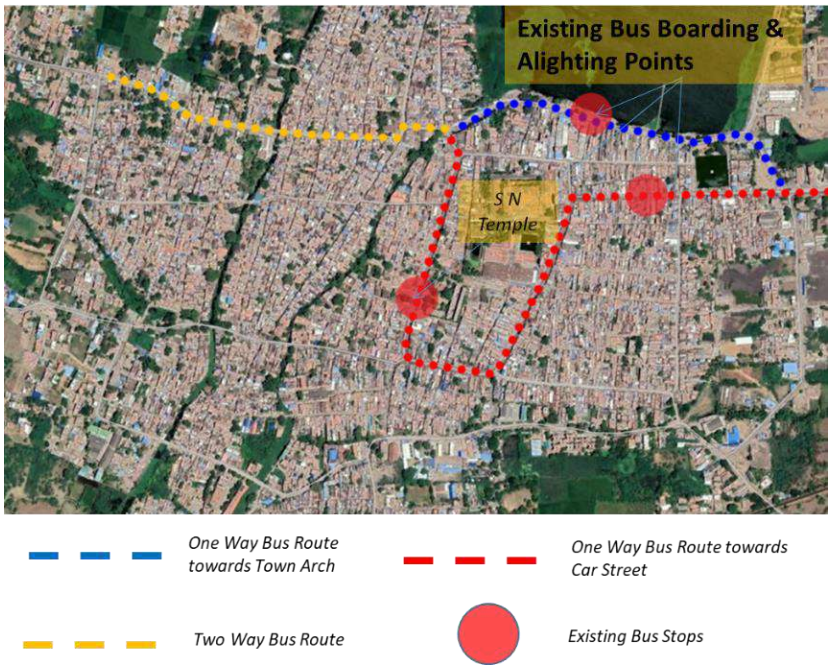


Figure 5-24 Proposed Traffic Circulation in the Car Street Area

Figure 5-25 Geometrical correction of the town Arch Junction

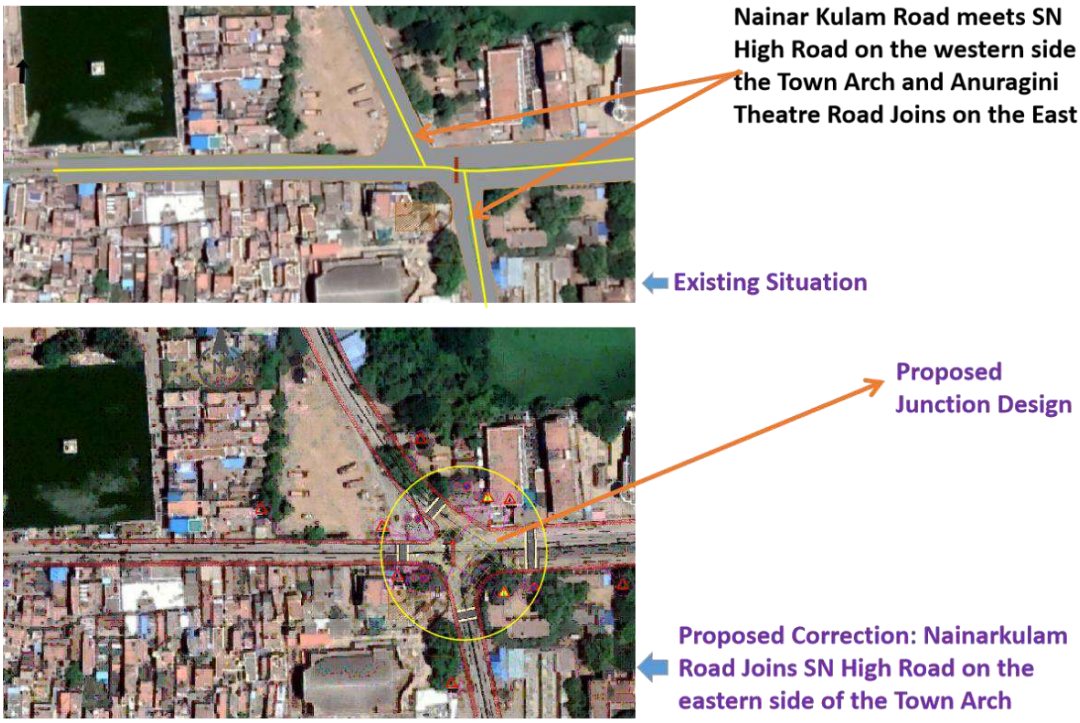
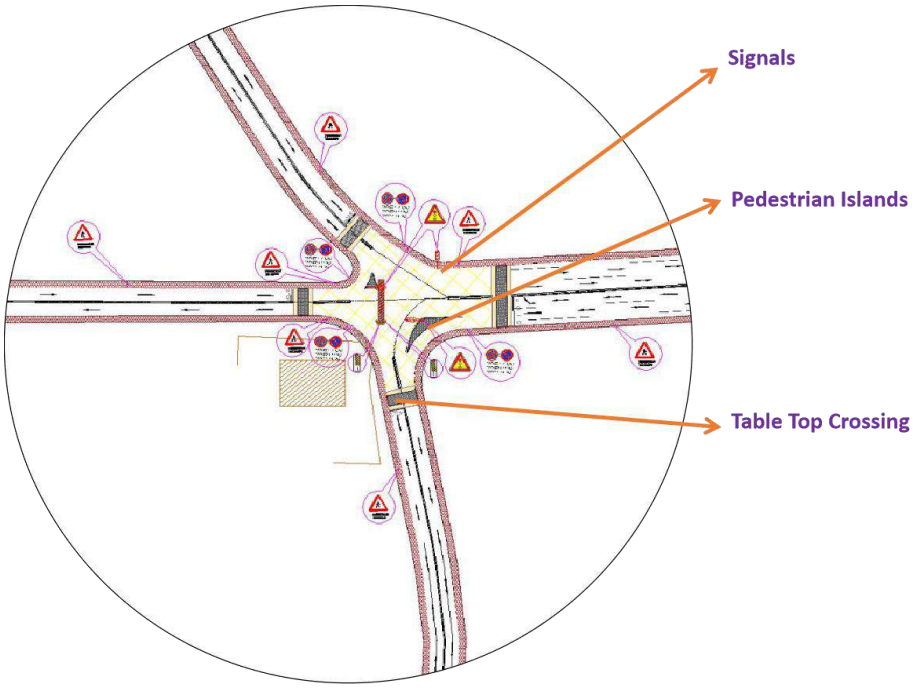


Figure 5-26 Geometrical correction of the Town Arch Junction (2)



5.7.2 Traffic Management for Vannarpettai Junction (Chellapandyan Flyover Junction)

Vannarpettai Junction lies at the heart of the City. It is the singular point of east-west connectivity within the urban area (refer Figure 5-27,Figure 5-28, Figure 5-29). It mainly connects Tirunelveli Town in the east to the Palayamkottai Institutional area in the west. The arm running in the north and south direction is the bypass road which leads to NH 44 in the North and South, via Madurai Road and Trivandrum Road respectively and the through

traffic between these points crosses the junction via the grade separated Chellapandyan flyover.

Figure 5-27 Vannarpettai Junction Connectivity

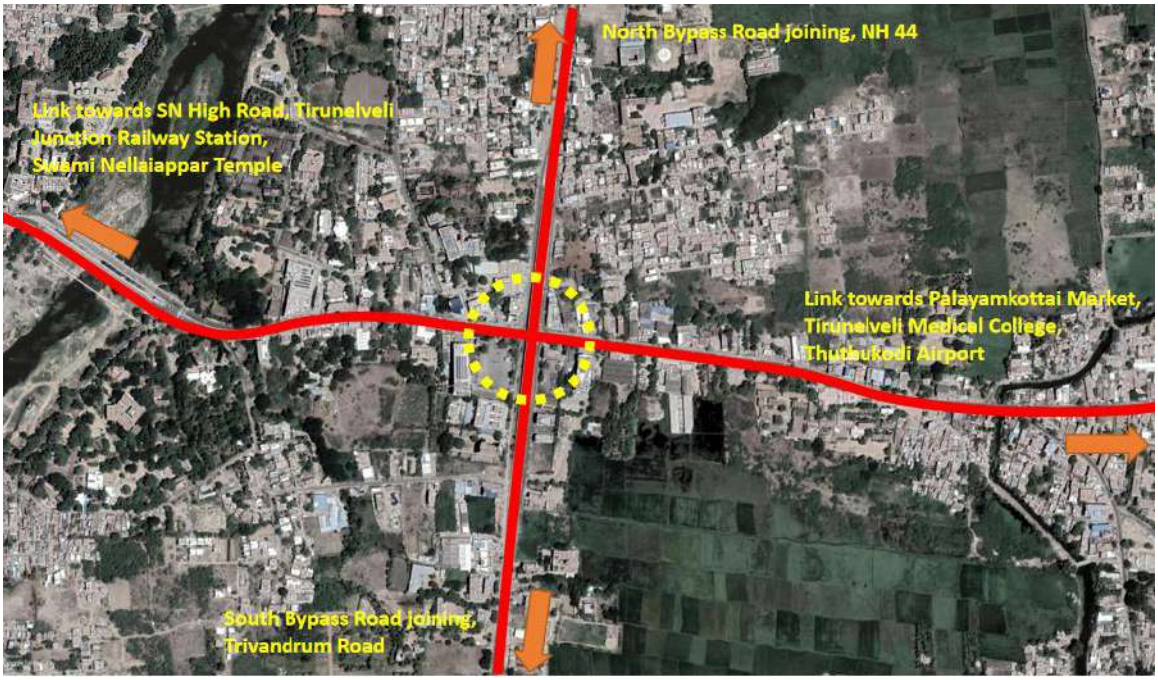


Figure 5-28 Vannarpettai Commercial and Institutional Points

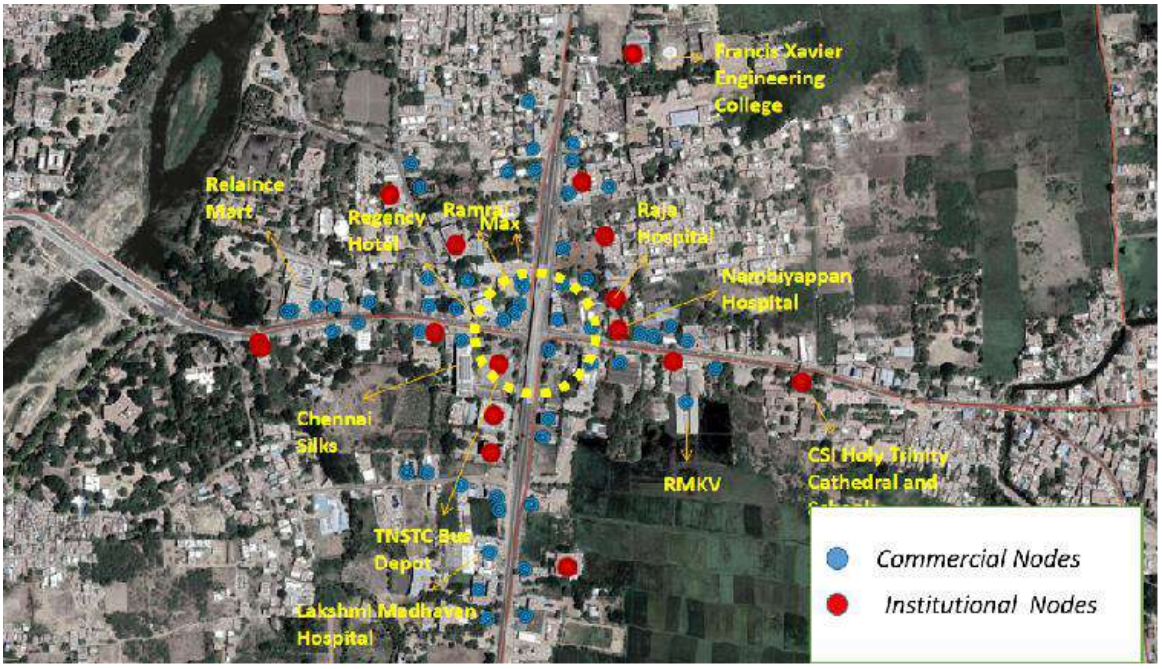
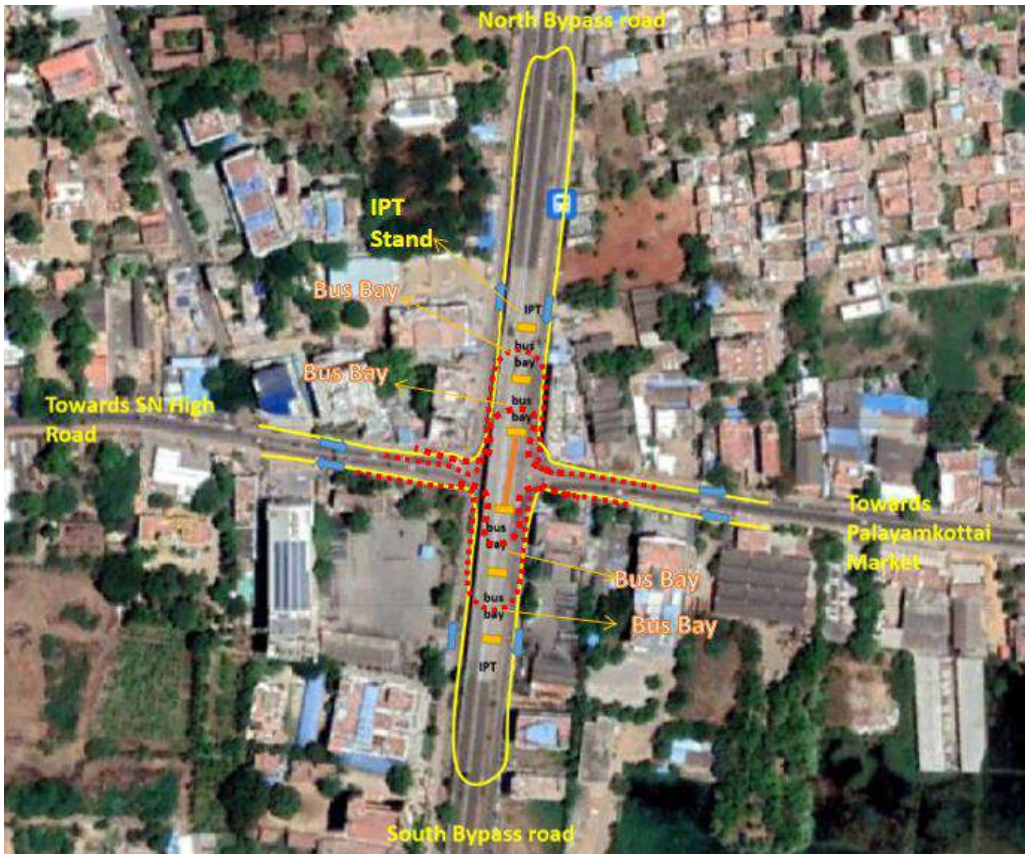


Figure 5-29 Existing Activities/Traffic Movement under the flyover



Challenges at the Junction

- East- West direction movement across the bridge is blocked using temporary barricades, all traffic needs to take a u-turn at north by pass and south by pass, to access the opposite road, therefore crossing at the junction has become problematic.
- As mentioned above, even the buses moving in the east west direction, need to cross the junction by turning under the flyover. Space under the flyover is being used for boarding and alighting of the passengers (Refer Figure 5-30).

Figure 5-30 Bus Boarding Alighting Activities taking place under the Chellapandyan Fly Over.

- Despite having heavy pedestrian footfall, there are is no proper pedestrian infrastructure in place (like footpath, zebra crossing, signage or lane marking) (Refer Figure 5-31).

Figure 5-31 Heavy Pedestrian Footfall at Vannarpettai, creating pedestrian and vehicular Conflict points on the service lanes.

Proposals

1. Traffic Management Measures

- Removal of the barricade under the fly over to allow east- west straight movement. The total number of buses accessing the junction during peak hour time is 240, out of which, 186 buses cross the arms across the flyover, (126, in the east west direction and 60 towards west to south and east to north direction). All these buses are having to take a U-turn under the flyover, throughout the day, causing traffic congestion.
- While allowing the through movement of the buses via the junction, signalisation of the junction is also recommended.

2. Shifting of Bus Boarding Points

- Bus boarding points shall be relocated from under the flyover to the side roads. Currently, the existing bus stop before the Vannarpettai junction, is beyond a distance of 800 m, in the direction of Tirunelveli town (near Kokkarikulam bridge) and 560 meters towards the direction of Palayamkottai (near CSI cathedral). Therefore, the relocation of the bus stops will not only eliminate the congestion due to bus movement under the flyover but also helps to maintain an adequate distance between them. Refer Figure 5-32.
- Three bus boarding points shall be proposed on either side of the roads, on each of the arms, to accommodate all the buses.

3. Pedestrian and New Bus Shelter Provisions in Vannarpettai

- Due to the heavy pedestrian footfall in the area, access controlled footpaths shall be proposed for junction.
- The Junction shall be also provided with table top pedestrian crossing and pedestrian island shall also be designed (refer Figure 5-33).

- The Chellapandyan Statue is proposed to be shifted 5 meters north, near to the flyover pillars.[21]

Figure 5-32 Redistribution of Bus Boarding & Alighting Points

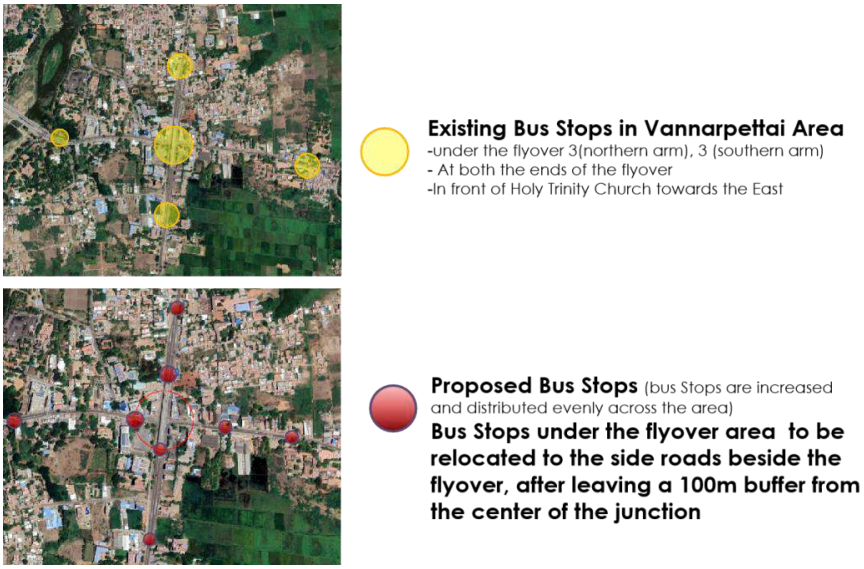
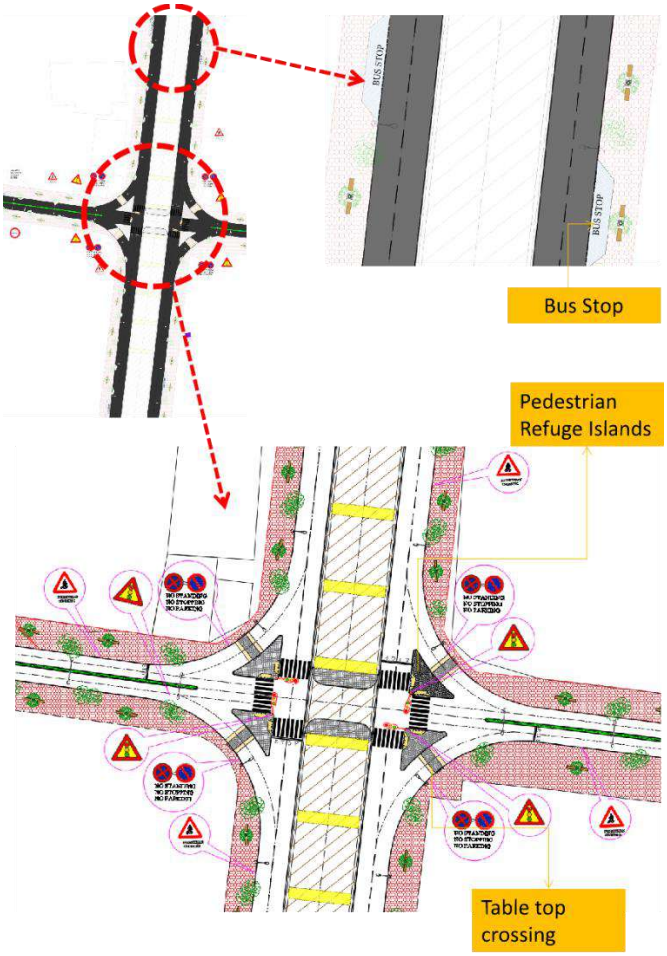


Figure 5-33 Proposed Junction Design for Vannarpettai Junction



[21] A detailed study on the social impact assessment shall be taken up prior to the implementation of the proposal.

5.7.3 Traffic Management for Pettai

Pettai is the eastern most part of Tirunelveli Corporation, with SH 41A passing through its centre with a RoW of 12m, making four sharp curves (refer Figure 5-34). Currently the bus boarding points, which are extensively used by the students are located right at the edge of the curve. The link is severely encroached by on-street parking as well as shops. The present road space is insufficient to carry the traffic.

Figure 5-34 Area based Management in Pettai

Figure 5-35 Pettai Rotti Kadai Mukku

Proposals

1. Shifting of Bus Boarding points.

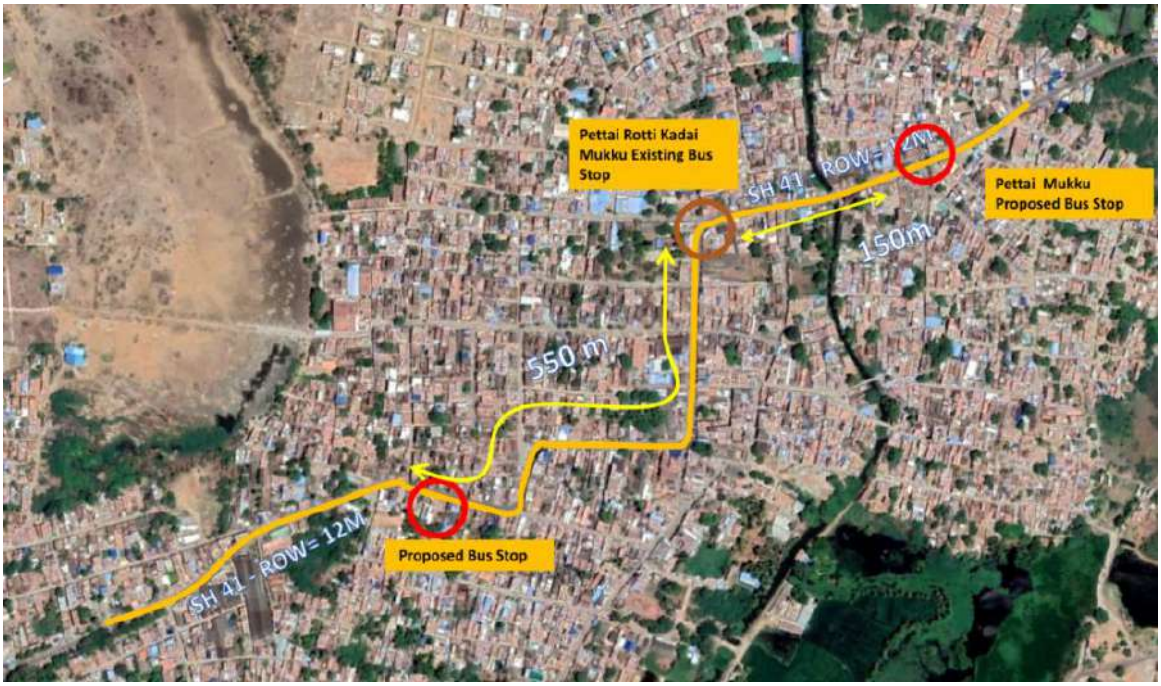
Bus Boarding alighting activities shall be removed from all curves and relocated to straight road.

2. Speed Reduction

- Speed shall be kept less than 25kmph on all roads with RoW less than 12m

- Rumble strips shall also be used to control speed. Lane markings using thermoplastic paints shall also be used.
- Traffic Cones shall be used to mark the edge of the road.

Figure 5-36 Shifting of Pettai Roti Kadai Mukku Bus Stop



3. Management of Side Spaces

- Any type of encroachment, including those contributed by the adjacent buildings needs to be removed from the road.

5.8 FREIGHT MANAGEMENT

5.8.1 Freight Management Policy

Freight transport should be considered in all the planning and policy prepared for the city to give considerable recognition to its management. For efficient management of freight within the city, periodic stakeholder consultations should be held. The freight policy should aim at efficient and reliable handling and distribution of goods and services. Freight policy principles adopted for Tirunelveli are as follows:

a) Manage the overall demand placed on the regional infrastructure by balancing the needs of freight and passenger traffic.
b) Develop truck terminals near cordon points and consolidation centers near the major commercial/industrials areas for effective distribution of goods in the city through sustainable transport choices like LCV, E-rickshaws, and Cycle rickshaws.
c) Bypass the external freight traffic passing through the city.

5.8.2 Freight Terminals and Dedicated Freight Corridors

(i) The following are the proposals for the development of truck terminals in Tirunelveli (Figure 5-37)

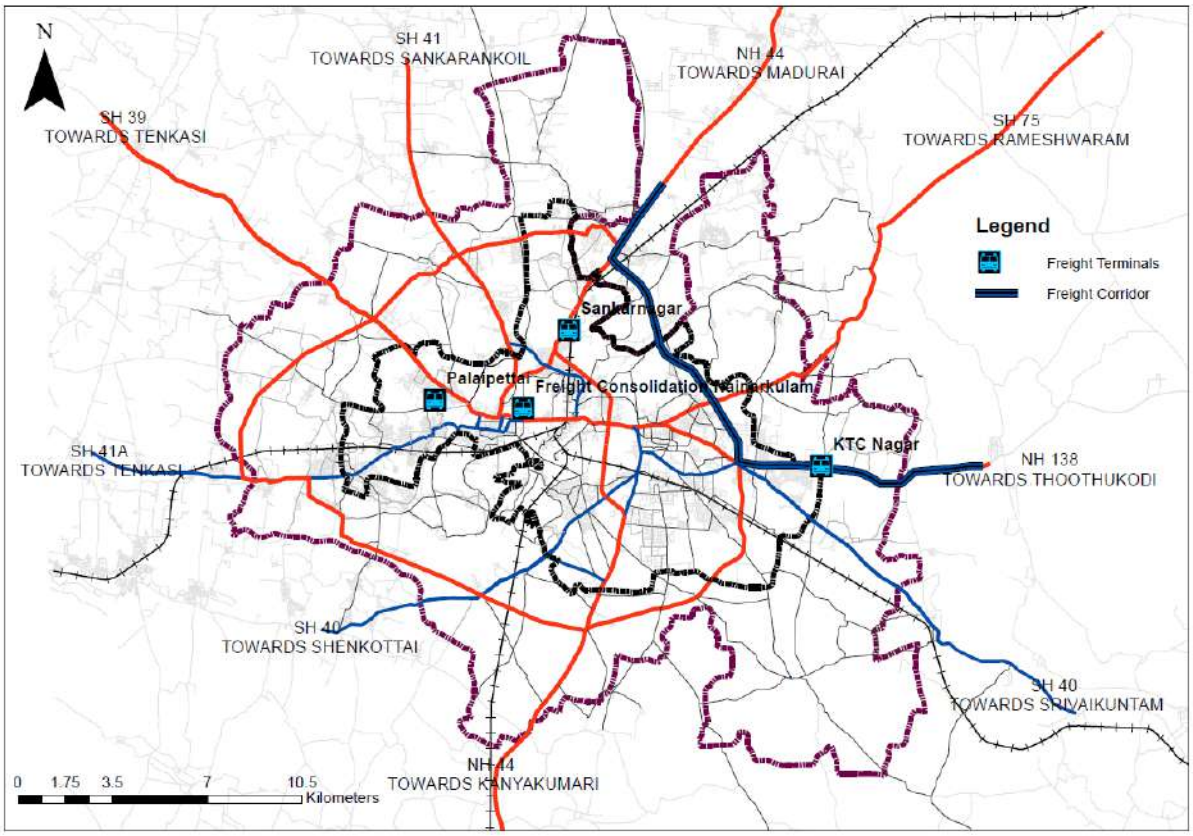
(ii) Truck Terminal has been developed along Palai Pettai Link Road as a part of Smart city, to which the existing truck parking along the Tank Bund Road will be shifted soon,

(iii) The CMP also proposes freight consolidation centre in the market near Nainarkulam.

(iv) A freight corridor has been proposed along the link connecting Gangaikondan SIPCOT with Tuticorin Port, which currently experiences heavy freight traffic.

(v) Two additional freight terminals have been proposed, along the proposed fright corridor as a part of Phase 3, one at Thatchanallur and another at KTC Nagar

Figure 5-37: Existing and Proposed Freight Facilities



5.9 TRAFFIC ENGINEERING AND MANAGEMENT

Traffic engineering aims at achieving safe and efficient movement of people and goods on roadways. It focuses on road geometry, sidewalks, crosswalks, cycling infrastructure, traffic signs, road surface markings, traffic signals, etc. Traffic management includes various strategies adopted to efficiently manage the movement of vehicles like one-way systems, no parking zones, etc.

These measures generally qualify as short-term measures for bringing in immediate relief from traffic problems. A combination of several measures can prove to be an effective means of problem-solving. These measures are not very capital intensive and give instant results.

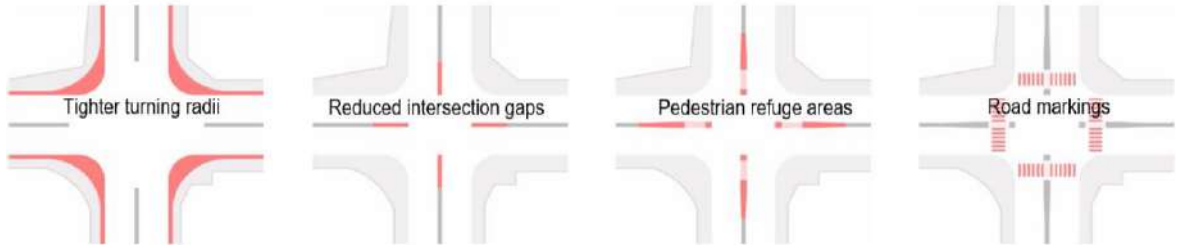
5.9.1 Junction Improvements

It has been observed that traffic accident rates are usually higher at intersections. Many factors affect accident occurrence at intersections, including traffic volume, traffic control, frequency of access points and number of arms, speed limit, median type and width, number of traffic lanes, existing turn lanes, and lighting level. Intersection improvements are recommended to facilitate the movement of public transport, safe movement, and crossing of pedestrians at junctions.

Junctions coming along the dedicated cycle tracks should be designed accordingly with priority to the cyclists. Pedestrians should be given priority at all the junctions. If it is difficult to channelize the pedestrian movement, it is advised to install pelican signals. Intersection improvements are recommended to facilitate the movement of public transport and safe movement and crossing of pedestrians at junctions.

Sample junction improvements measures that could be done are shown in the Figure 5-38.

Figure 5-38 Examples of Typical Junction Improvements



In the case of Tirunelveli, a total of 13 junctions have been identified for junction improvement[22] as shown in Figure 5-39 and Table 5-12.

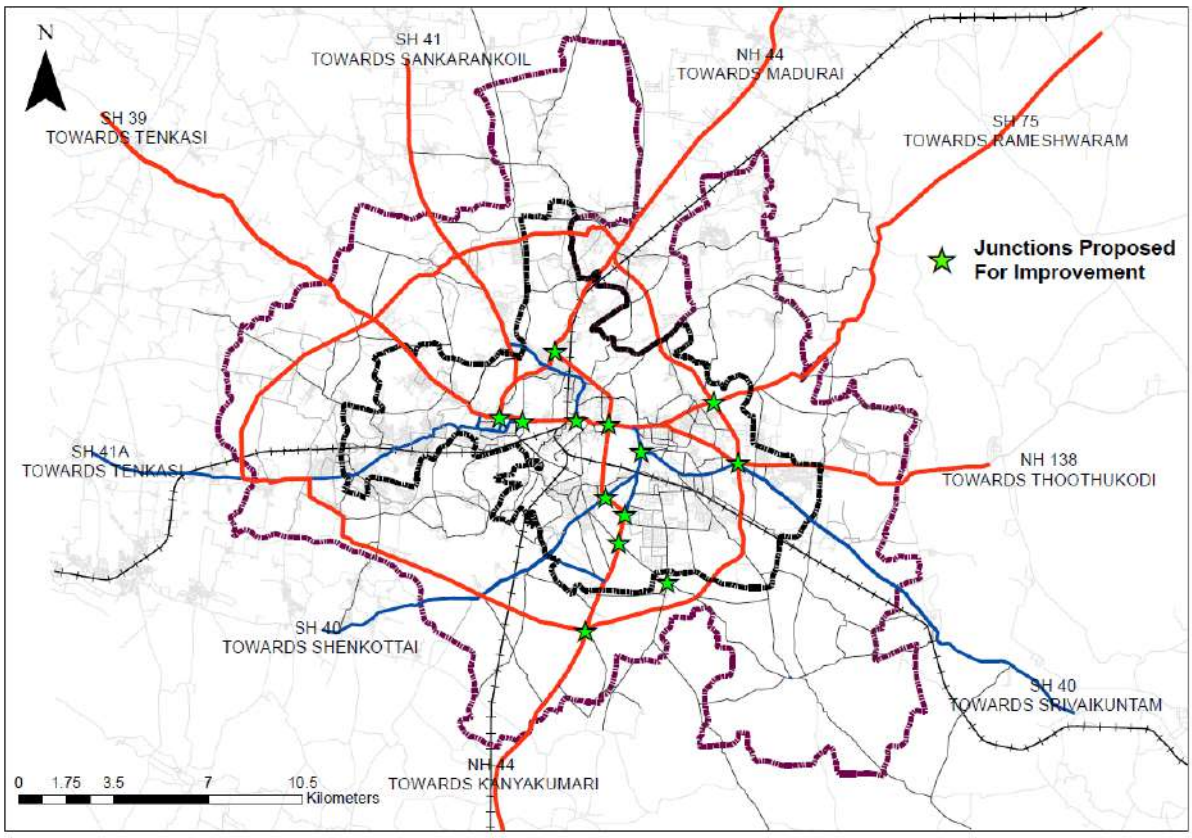
Table 5-12: Short-term Junction Improvement

S No	Junction Name
1	Vannarpettai Junction
2	Town Arch Junction

[22] *Further, it is suggested that all junctions on new roads or road being widened to be developed as per IRC guidelines or urban road codes*

3	Katta Bomman Statue- SN High Road Junction
4	Reliance Junction
5	Tenkasi- Tirunelveli- Sankarankoil- Tirunelveli Road (S. Street) Junction
6	Trivandrum Road South Bypass Road Junction
7	Thachenallur Junction
8	V C Chatram Junction on NH-44
9	Palai Bus Stand Junction
10	Reddiyarpatti Junction
11	Govt College of Engineering Junction
12	IRT Polytechnic College Junction
13	NH44 Sivalaperi Road Junction

Figure 5-39: Junctions Identified for Junction Improvement



The section below shows some sample junction designs for improvement:

Reliance Junction

Challenges

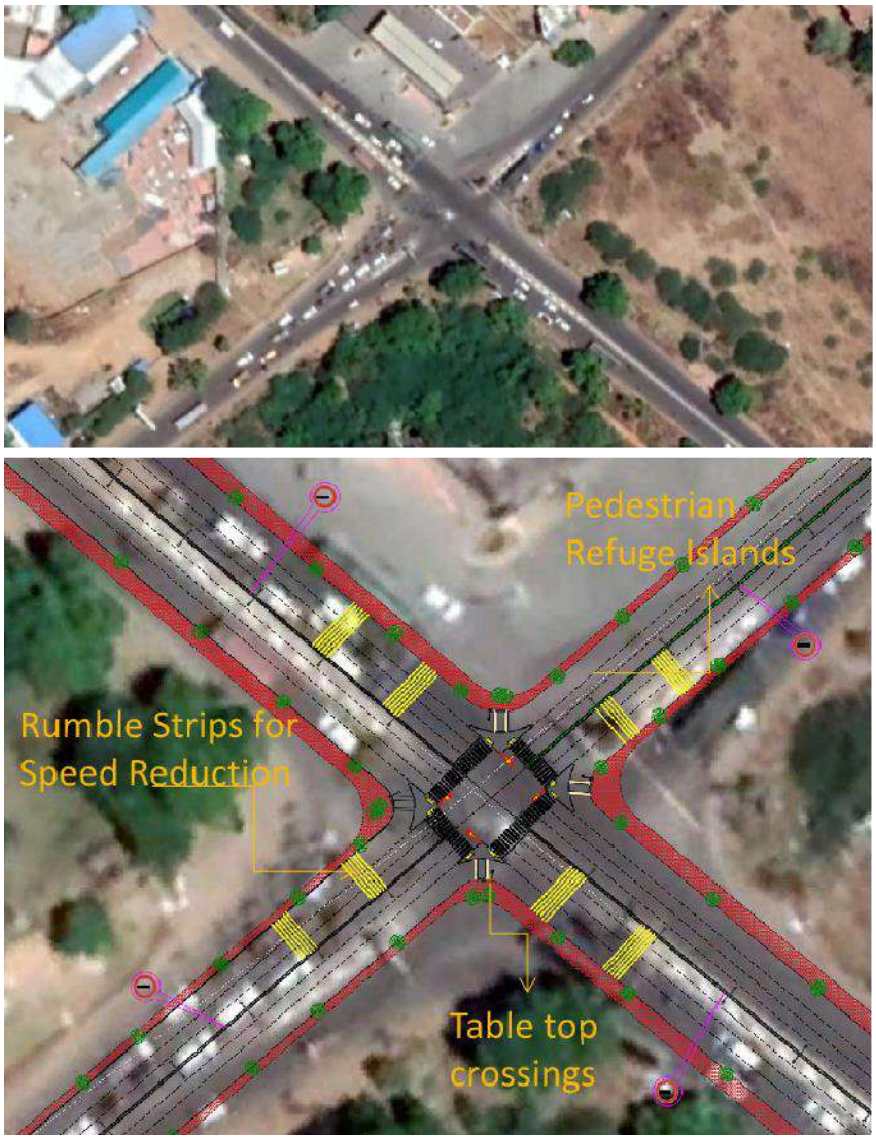
- Major Accident spot in the city
- There is no surface treatment done to control the speeds of the vehicles exiting the flyover, making it a concern for accidents and other mishaps.
- There are no lane marking at the junctions.

Proposal

- At grade Pedestrian friendly infrastructure facility shall be proposed.
- Lane Markings shall be provided (Existing and Proposed
- Figure 5-40)
- Barrier free accessibility features like slopes on the islands and footpaths shall also be given
- Surface treatment shall be done to control the speeds of the vehicles.

Existing and Proposed

Figure 5-40 Existing and Proposed Junction Arrangement for Reliance Junction



Tenkasi Tirunelveli- Sankarankoil Road (S Street Junction)

Challenges

- RoW Constraints, 9m RoW observed on all the arms.
- Staggered 3 arm Junction
- There is no surface treatment done to control the speeds of the vehicles exiting the flyover, making it a concern for accidents and other mishaps.
- There are no lane marking at the junctions.
- Shops encroaching the road
- Lane Markings shall be provided (Figure 5-41)
- surface treatment shall be done to control the speeds of the vehicles
- Traffic Curve mirrors shall be installed at the turnings.
- Enforcement on prohibition of encroachments on RoW.

Other Junctions which are proposed for Improvement are:

- Thachenellur Junction
- Katta Bomman Statue- SN High Road Junction
- V C ChatramJunction on NH-44

Figure 5-41 Existing and Proposed Junction Arrangement for Car Street- S.Street junction

5.9.2 Corridor Improvements

As a part of the CMP SN Highroad was selected for the corridor improvement proposal which involved measures like geometric corrections and beautification. The designs proposed for the corridor improvement are as given in Figure 5-42, Figure 5-43 and Figure 5-44.

Figure 5-42 Proposed Road Stretch, SN High Road

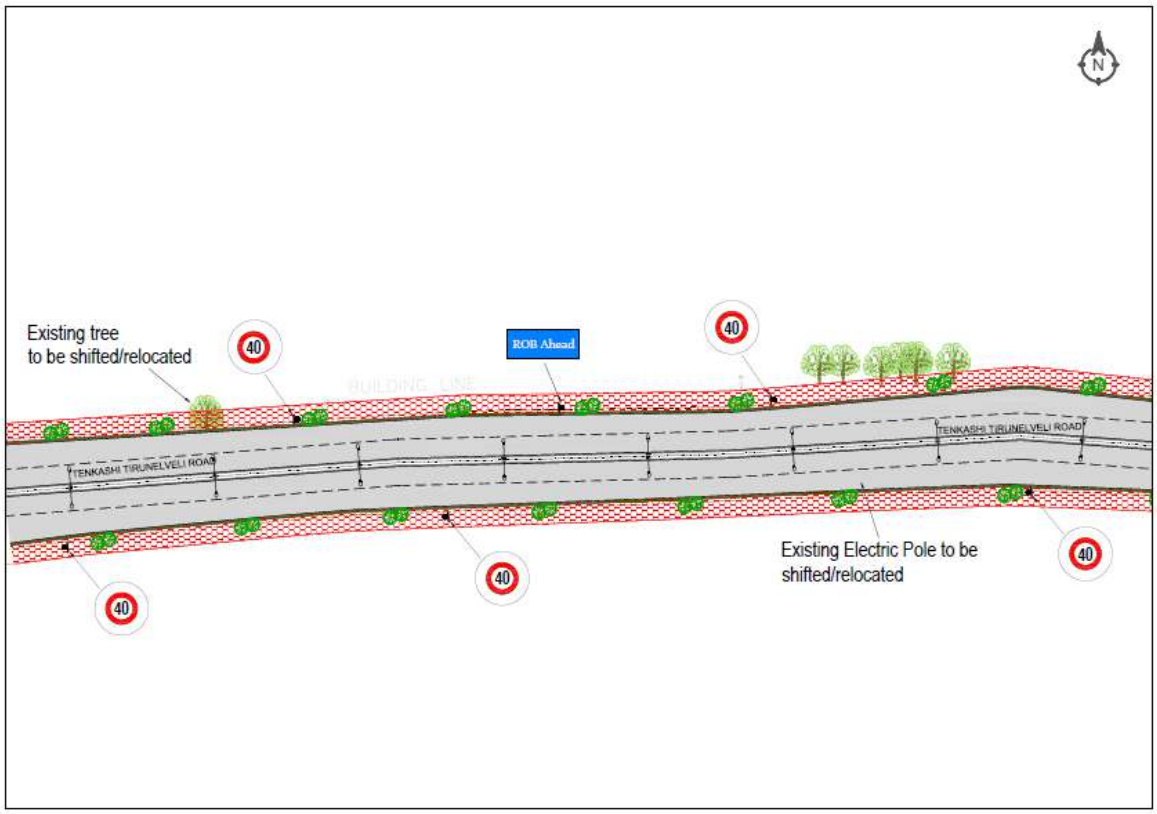


Figure 5-43 Proposed Sivasakti Theatre Road- SN High Road Junction

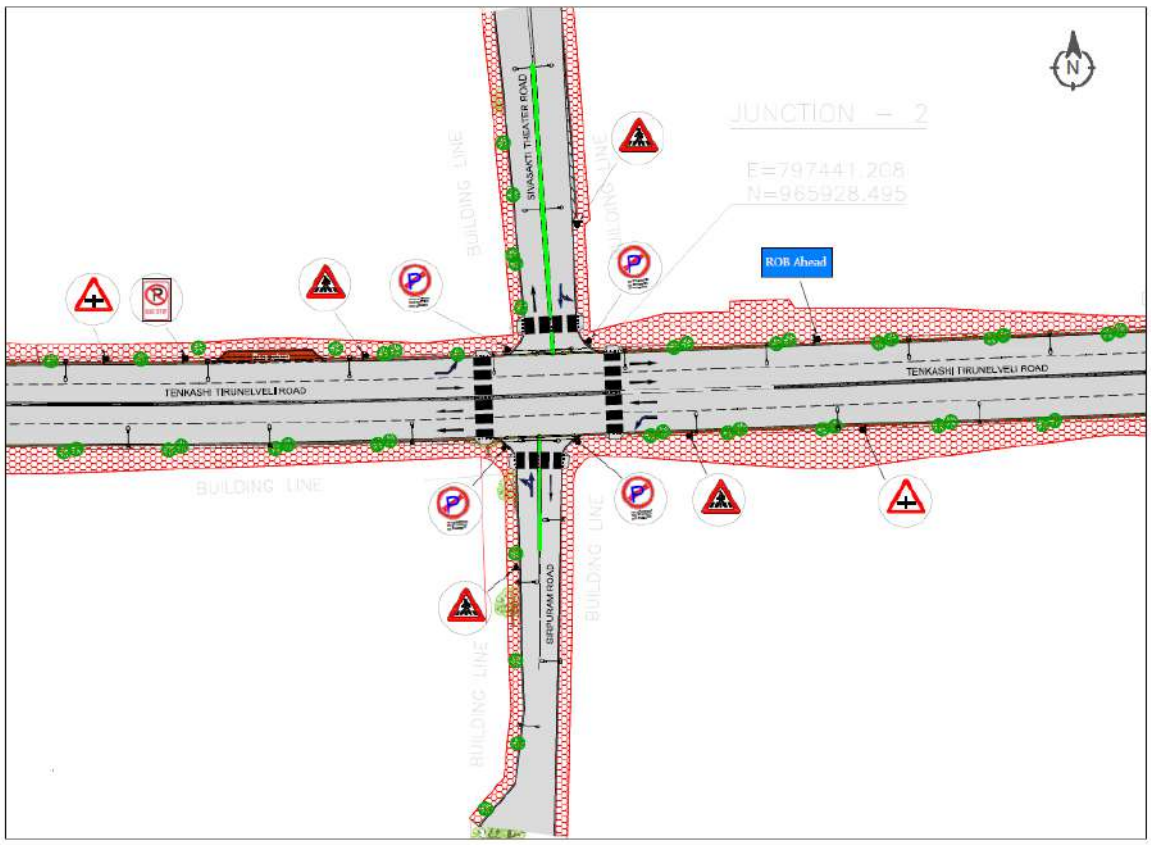
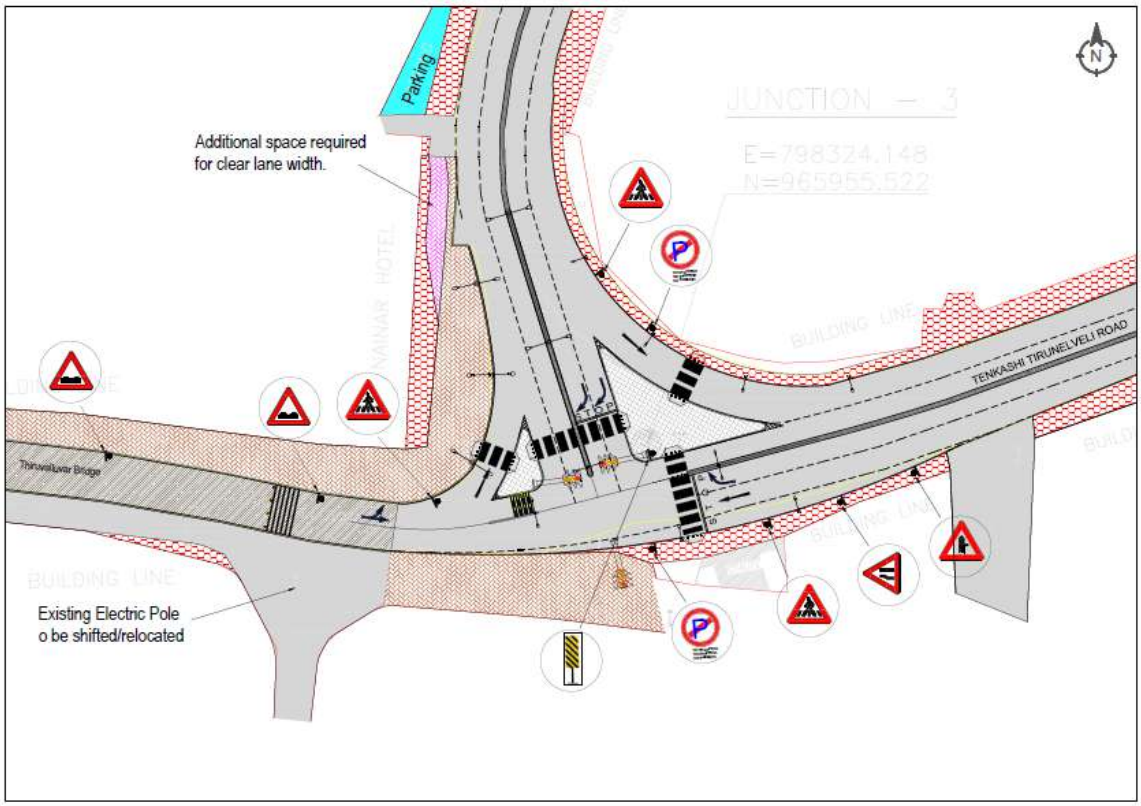


Figure 5-44 Railway Station Road Irattai Paalam Junction[23]



5.9.3 Smart Signals

Smart traffic lights or intelligent traffic lights are vehicle traffic control system that combines traditional traffic lights with an array of sensors and artificial intelligence to intelligently route vehicle and pedestrian traffic. They can form part of a bigger intelligent transport system or command and control system already existing in the city.

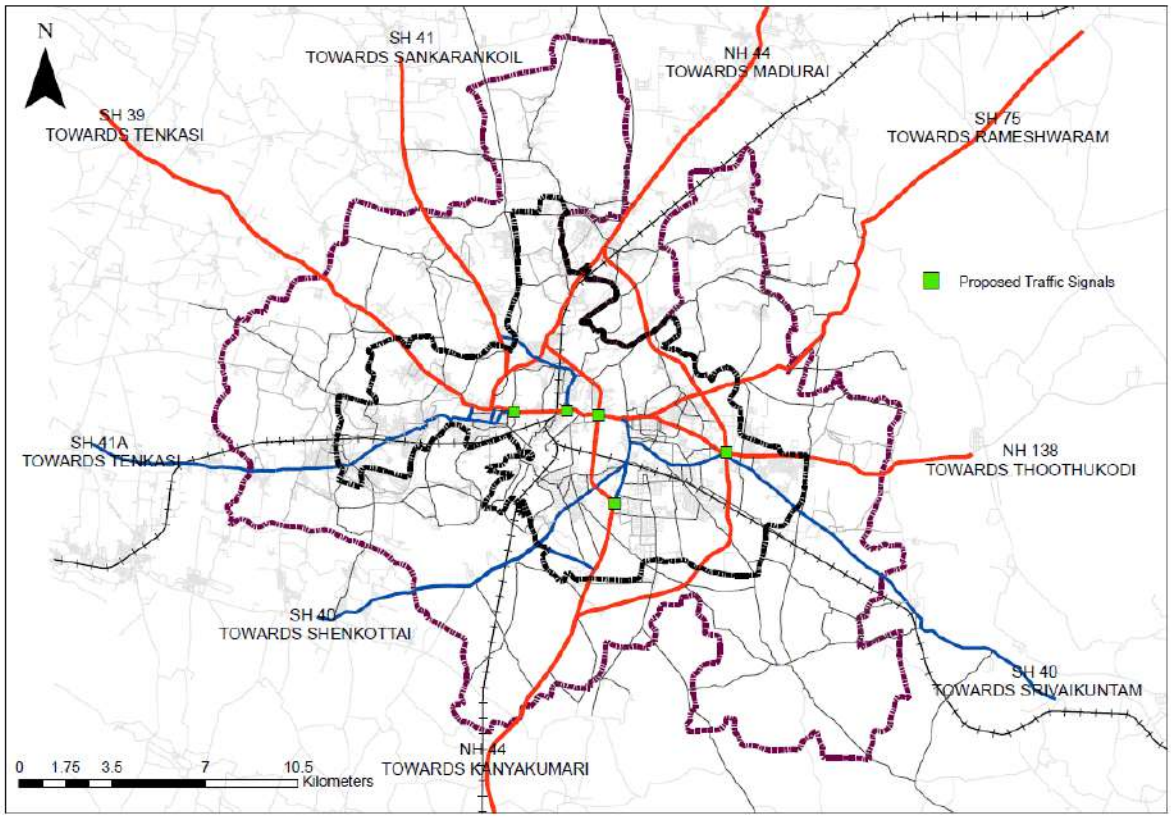
Based on the high traffic numbers at the important junctions, 5 junctions have been identified for smart signals, all of them proposed under phase 1. The list of junctions identified for smart signals in the future years is shown in Figure 5-45.

Table 5-13: Smart Signal Proposals

S.No.	Junction Locations
1	Town Arch Junction
2	Vannarpettai Junction
3	Railway Station Road- Irattai Paalam Junction
4	NH 44 Tiruchendur Road Junction
5	South Bypass Road Trivandrum Road Junction

[23] It is proposed that only two wheelers and autos shall be allowed on the bottom deck of irattai paalam. Reflective mirrors need to be placed wherever there is a blind spot in the double Decker bridge

Figure 5-45: Smart Signal Locations



5.9.4 Road Pavement Marking and Signage

Even though road signs and markings are provided on some of the major road stretches of Tirunelveli, they are absent on many of the other roads. It is recommended that proper signage be installed at all appropriate locations. Traffic control devices such as Centre lines, Traffic Lane lines, stop lines, pedestrian crossings, parking space kerb marking for visibility, obstruction marking, etc. must be provided keeping in view all users of the road and especially for nighttime driving. All the traffic signs should be facilitated as per the guidelines provided in IRC: 67-2012. All new roads proposed to be developed should have road markings and signage as per IRC: 67-2012.

Figure 5-46 shows various mandatory and informatory signs used as a part of traffic management measures.

Figure 5-46: Various Traffic Signage for Placement along Identified Roads

5.9.5 Intelligent Transport Systems

ITS encompasses all modes of transportation- air, sea, road and rail and intersects various components of each mode- vehicles, infrastructure, communication and operational systems. Broad overview of this concept can be seen in Figure 5-47. This project is intended to focus on certain components of Intelligent Traffic Management System (ITMS), wherein system will be seamlessly managed with centralized management software to manage traffic in Tirunelveli Municipal Corporation area and major corridors and to integrate with other smart city initiatives and support sustainable development to meet the growing traffic demand.

The ITMS components and their functions are as given in Table 5-14.

Figure 5-47: Broad Overview of ITS

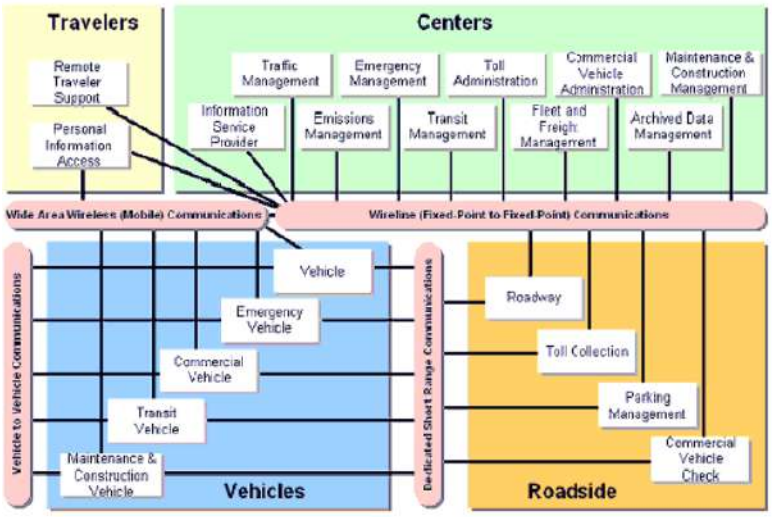
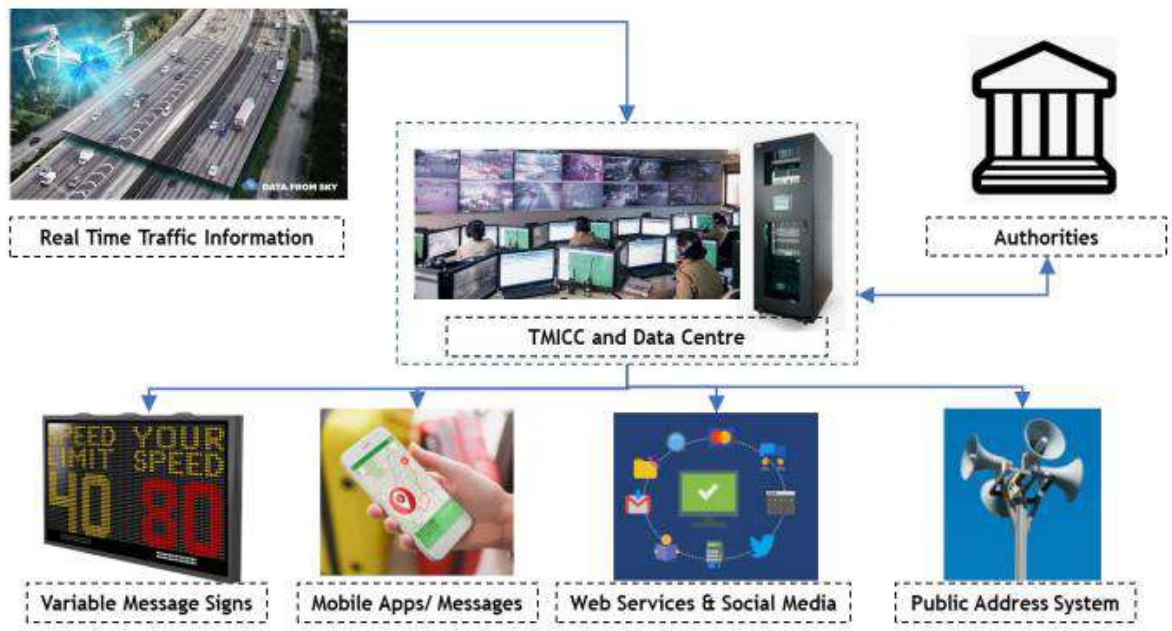


Table 5-14: ITMS Components

S No	ITMS Component	Function
1	Traffic Signal Monitoring and Design	This component majorly deals with installation of signal systems, signal design and signal optimization.
2	Area Traffic Control System	Area Traffic Control System (ATCS) is an intelligent real time dynamic vehicle actuated traffic control system which adapts signal timings automatically based on the real time traffic demand at intersection
3	Information Dissemination System	Two-way communication between all road way equipment and data from all other proposals and C4
4	Green Corridor	A green corridor is a sequence of green signals for the allocated vehicle from source to destination. An RFID is fitted in the emergency vehicle and RFID readers are installed at every Traffic Junction
5	Parking Management System	Sensors would be deployed in the parking area and through the mobile app, users can book the parking slot and have online payment option as well

6	Incident Detection System	A process of handling multi-agency, multi jurisdiction responses to disruptions. Efficient and coordinated management of incidents reduces their adverse impact on public safety, traffic conditions, and economy.
7	Commercial Vehicle Monitoring/ Entry Restriction system	A process of handling commercial vehicle activities like vehicle usage, driver behavior/ID etc. from a central place
8	Traffic Management and Information Control Centre	A hub or nerve center of a traffic management system comprising, Collection of data on traffic conditions in real-time (speed, volume across various elements of the transportation network - highways, state and local roads), analyzing of data and control of traffic management systems traffic signal systems, variable messaging signs, parking and transit information systems.

Figure 5-48: Overview Of TMICC



The identification of locations for implementing these components would take a detailed feasibility study.

5.10 PARKING MANAGEMENT

From the parking survey, it was observed that all the major roads of the city have high on-street parking. Effective parking strategies are essential to managing unauthorized parking activities in the city. The parking strategies should address the issues, which will in turn reduce automobile dependency. The various infrastructure-related measures proposed for efficient parking in the city are as follows:

5.10.1 Designated Off Street Parking Spaces

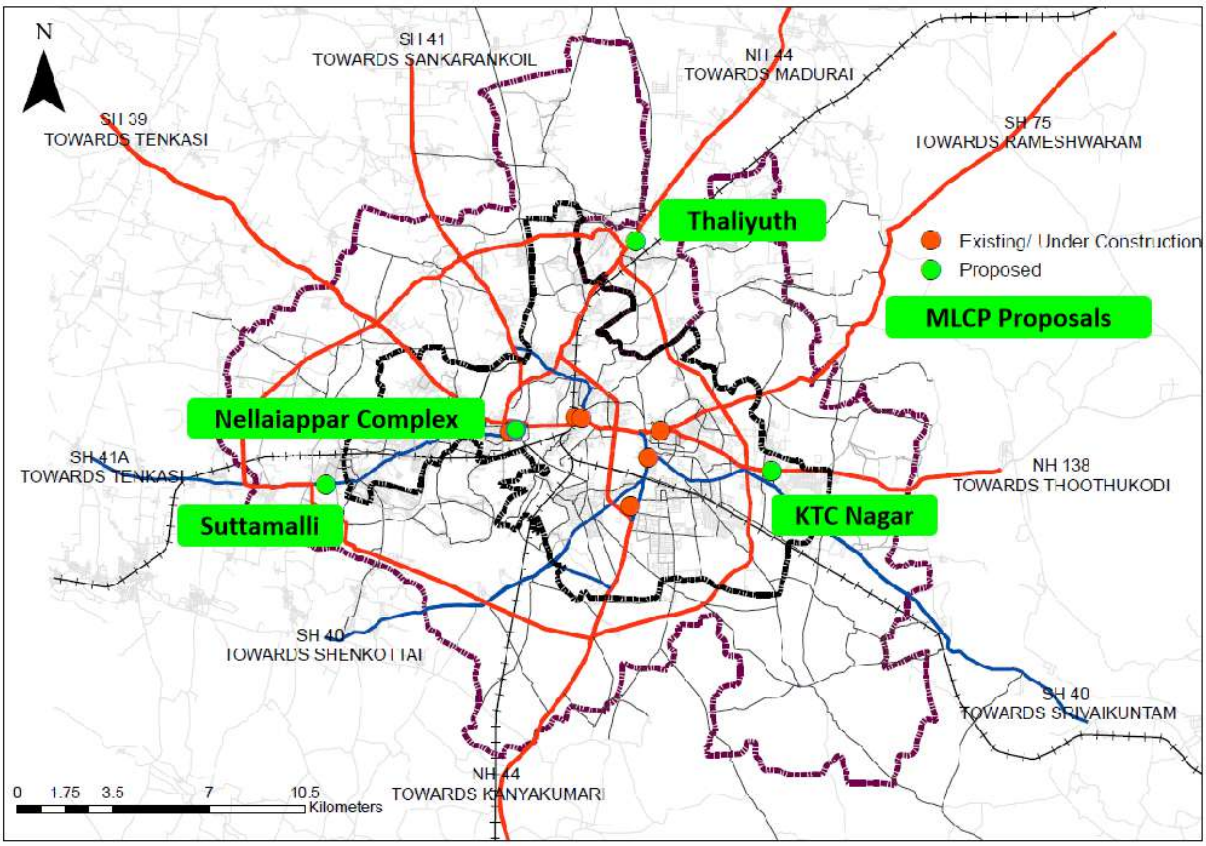
Based on the parking demand assessed for the horizon year 2042, the following off-street parking locations are proposed for the city:

- Several Multi Level Parking have already been proposed as a part of Smart City Mission in the Table 5-15.
- In Addition to this three Off Street Parking facilities are proposed adjacent to proposed Bus Terminals in the SUTP scenario.

Table 5-15 List of Parking Proposals

	Existing/ Under Construction Multi Level Parking Proposals	Type	Proposal
1	Nellaiappar Temple Complex	MLTP	Smart City
2	TM Road near Tirunelveli Junction Railway Station	MLTP	Smart City
3	MGR New Bus Stand	MLTP & MLCP	Smart City
4	Tirunelveli Periya Bus Stand	MLTP & MLCP	Smart City
5	Palayamkottai Bus Stand	MLCP	Smart City
	Off Street Parking Proposals		
1	Suttamalli	MLTP & MLCP	SUTP
2	Thaliyuth	MLTP & MLCP	SUTP
3	KTC Nagar	MLTP & MLCP	SUTP
4	Nellaiappar Temple Complex	MLCP	SUTP

Figure 5-49: Off-Street Parking Proposals



Also, for the effective utilization of the proposed parking spaces, the following measures are proposed:

1. Smart Parking
2. Parking Pricing
3. Enforcement

5.10.2 Smart Parking

Smart Parking Systems is a parking strategy that combines technology and innovation to achieve easier, faster, and denser parking. It uses an IoT (Internet of Things)-based system and can offer a range of services, such as information on the availability of parking space both at general and at a granular level, space optimization, parking guidance and search time reduction, parking reservations, parking price, parking enforcement (payment/overstay violations), prior information to users through mobile/web applications, etc.

Smart Parking Systems can be divided into categories, based on the range of services they can provide.

Parking Guidance and Information System (PGIS): This system provides information that aids the decision-making process of the drivers in reaching their destination location and aids them in locating a vacant parking space within the car park facility.

Transit-based Information System: Transit-based information system concentrates on guiding users to park-and-ride facilities. It provides real-time information on the status of

each car park and public transportation, such as the schedules and traffic conditions to the public. The additional information provided enables the users to plan for transit in advance without getting into any inconvenience.

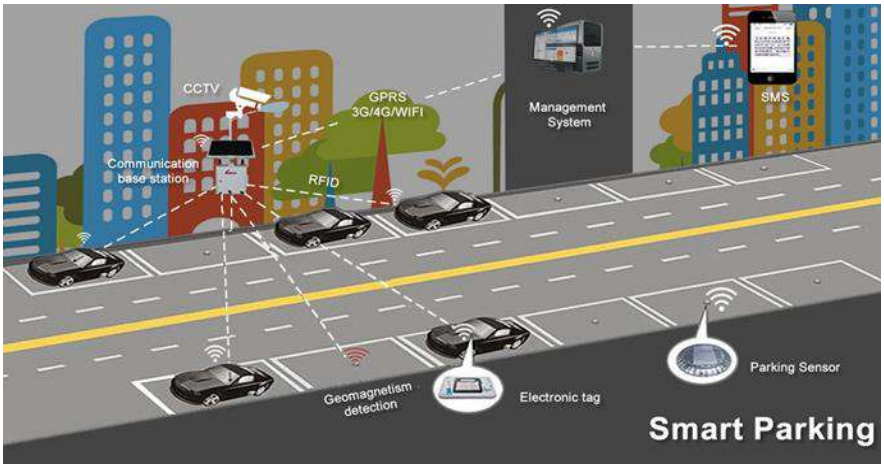
Smart Payment System: Smart payment system revamps the payment method via parking meter and introduces new technologies. It also reduces maintenance and staffing requirements for payment-handling purposes as well as traffic control.

E-Parking: E-parking provides an alternative for users to enquire about the availability and/or reserve a parking space at their desired parking facility to ensure the availability of vacant car park space when they arrive at the parking facility. The system can be accessed via numerous methods such as SMS or through the Internet.

Automated Parking: Automated parking involves the use of a computer-controlled mechanism, which allows users to drive up to the bay, lock the cars, and let the machines automatically place the vehicle in the allocated space. This type of car park offers maximum utilization of space as it is machine-controlled, unlike conventional car parks where space is needed for navigation of vehicles within the car park.

Based on the requirement of the place and desired services, the most suitable technology or combination of these technologies can be planned.

Figure 5-50: Smart Parking



5.10.3 Parking Pricing

Parking pricing and time limits are important parking management mechanisms that help in enhancing the turnover of parking bays and ensure access to limited on-street parking in high parking demand areas. The following criteria could be used to determine the parking fees:

1. **Land Values**: It is usually observed that parking demand is high in areas with high land value. A market approach on parking pricing would be to deal with parking as a commodity and price based on the value of the land it occupies. The NUTP also suggests a land-value-based approach for determining parking fees.
2. **Distance from Transit**: High parking charges should be levied on parking in places that are well-connected with transit facilities. This should be done to discourage private vehicle use.

3. **Distance from Off-street Parking Facility**: The price of parking on streets adjacent to off-street parking facilities should be higher as they are more convenient to access. Here off-street prices will be considered as a benchmark and ensure optimum usage of the facilities provided.
4. **Vehicle Type and Duration of Parking:** There should be variations in pricing for different vehicle types and duration of parking. Short-term parking should be encouraged by disincentivizing long-duration parking. This will ensure a quicker turnover, which is very important in parking facilities near commercial areas. Parking rates should be based upon prorated numbers determined by the size of a vehicle, ranging from a two-wheeler (0.25 ECS) to a bus (4.0 ECS).
5. **Time-of-the-Day/Occupancy-based Pricing**: This price setting could be based on either a target average occupancy on the street or price higher, the locations are known to saturate easily. Daytime-of-the-day pricing can be adopted on stretches where the demand rises and then reduces over the peak and off-peak hours of the day, respectively.

Figure 5-51: Parking Pricing

5.10.4 Enforcement

To ensure that all on-street parking areas and parking lots in off-streets are clearly marked and easily identified, specifically, the following standards should be heeded to:

1. On-street parking spaces shall be designed as per IRC: SP: 12:2015
2. Boundaries of all on-street parking spaces will be marked by white line as indicated in IRC: 35- 1997
3. Signage marking parking and no-parking areas shall be marked as per IRC: 67-2012

Certain following guidelines need to be observed while defining the no-parking areas:

4. Prohibition of parking for at least 50 m from all junctions
5. Prohibition of parking at least 10 m from all zebra crossings
6. No private vehicle parking beneath multi-modal transit stations
7. Street parking, if necessary, should only be provided at a distance of 50 m from the metro station

For enforcing parking near schools, hospitals, educational institutes, and other facilities, authorities can facilitate and encourage them to involve volunteers, traffic wardens, or others to manage to park. The conceptual representation of parking at nodes is as shown in Figure 5-52.

Figure 5-52: Conceptual representation of parking at nodes

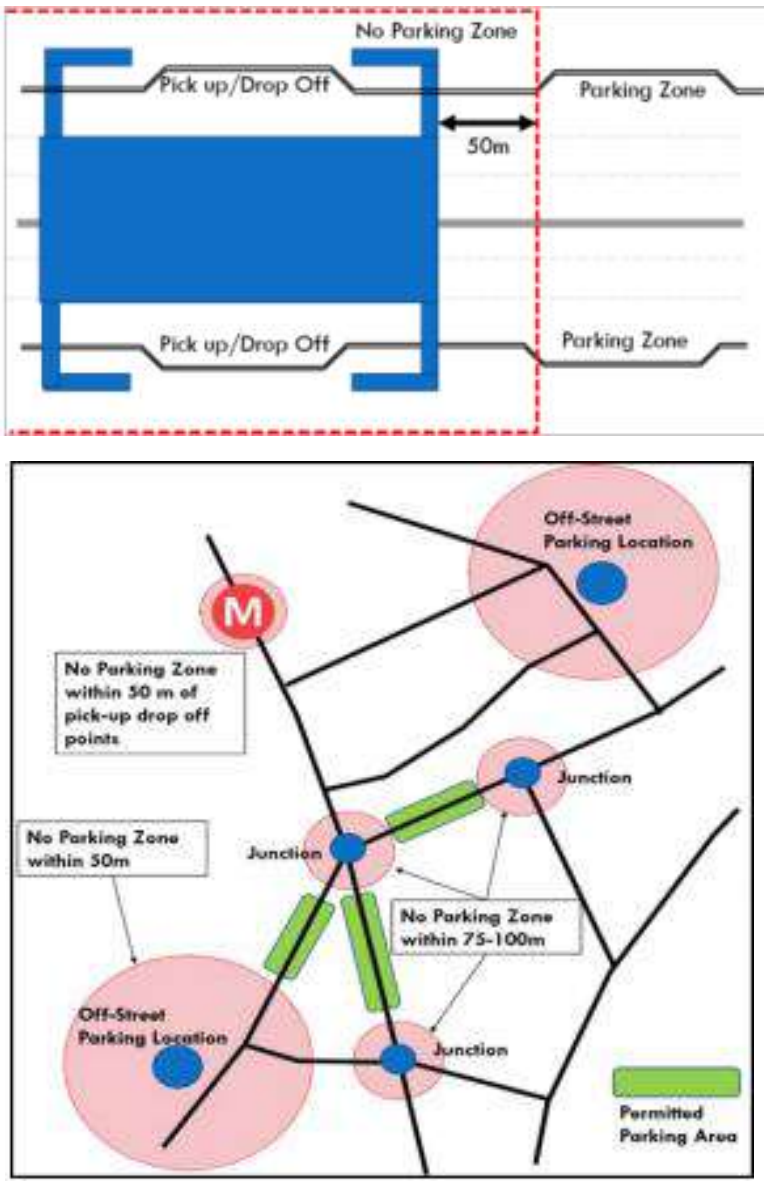


Figure 5-53: Summary of all proposals identified for Tirunelveli

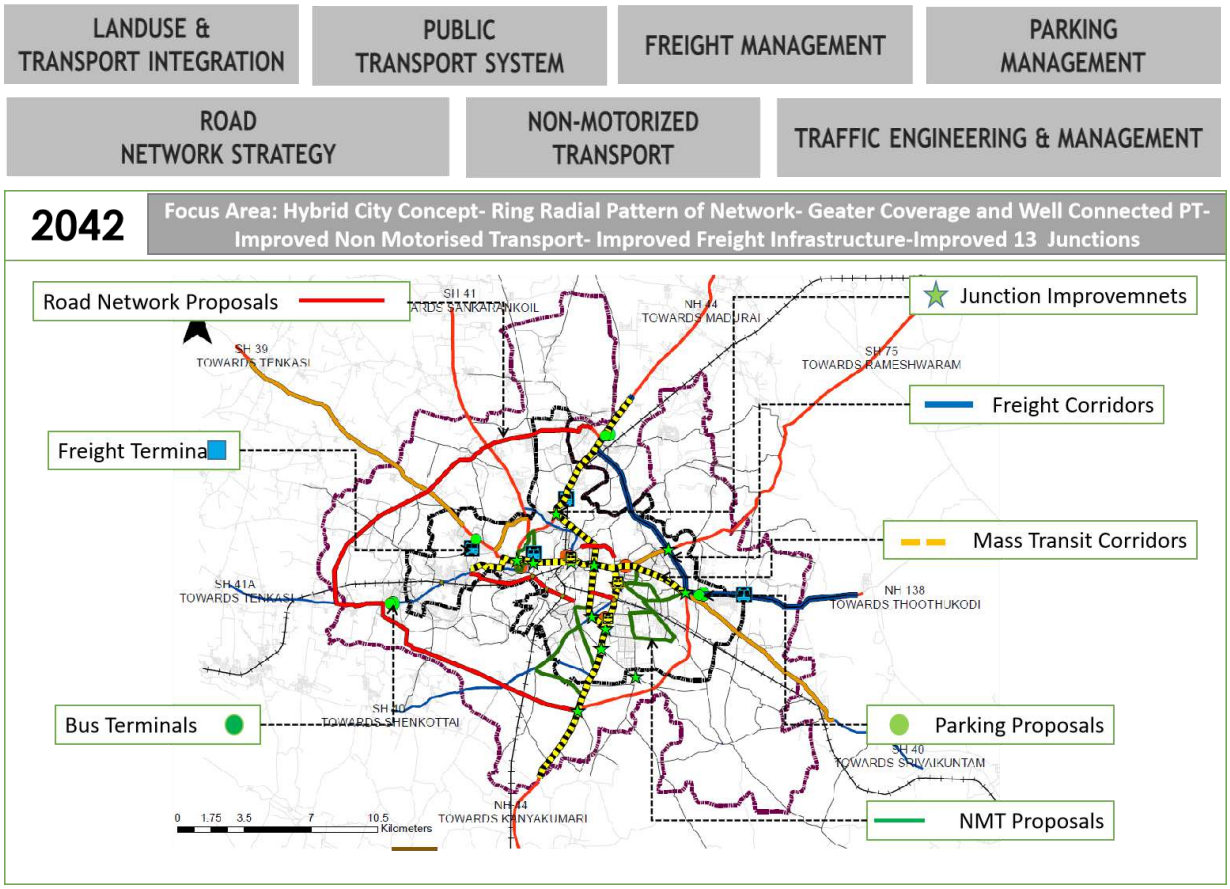
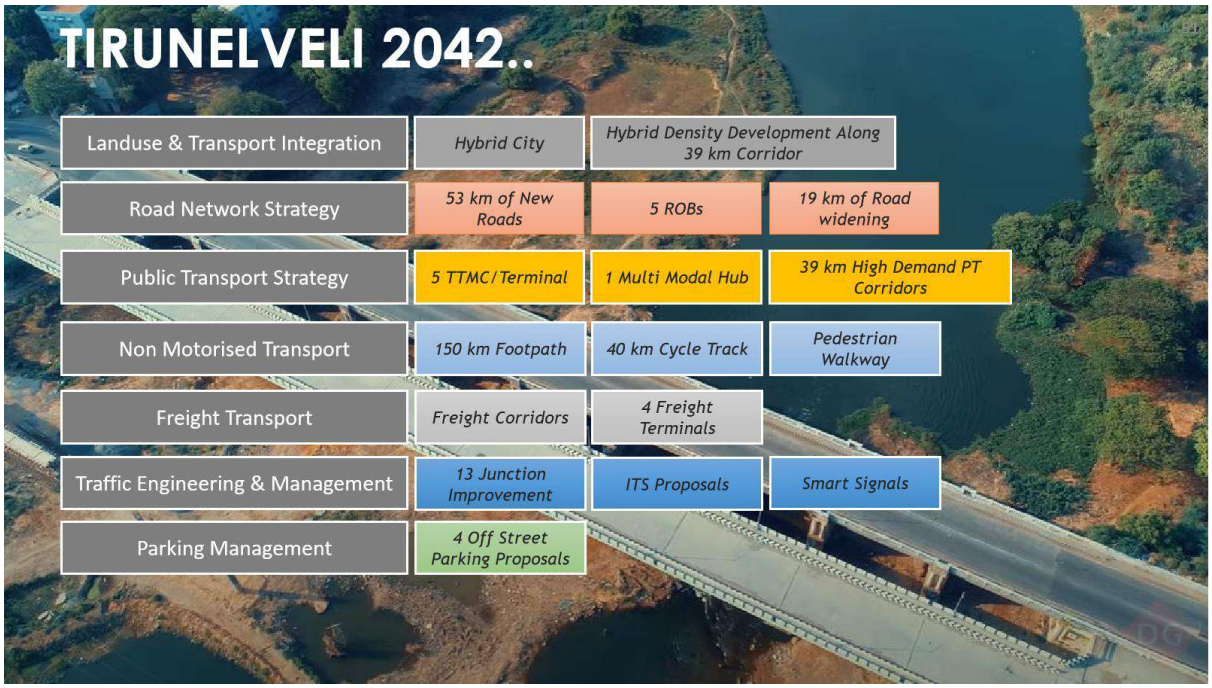


Figure 5-54: Key Summary of Identified Proposals



6. SERVICE-LEVEL BENCHMARK

6.1 INTRODUCTION

Benchmarking is a tool used by public agencies to make more informed decisions regarding performance, make comparisons internally and with other organizations, and continuously improve performance using the lessons learned through this comparison process. Benchmarking allows public agencies to direct limited resources to the programme. Benchmarking helps to establish baseline measures of performance and monitor the agency's performance over time, and also how it compares with the other organizations. It improves performance by sharing lessons learned from different entities.

The National Urban Transport Policy (NUTP) 2006 highlights the crucial link between transport demand and land-use planning and the need to develop an integrated mobility plan for each city. Accordingly, each city should develop a comprehensive mobility plan with a focus on accessibility, mobility and traffic flow (in that order). Rather than the present approach of 'predict and provide', it has to be 'planning for the desirables". However, there needs to be some yardstick to measure and compare the effectiveness of policies and urban projects across cities. Urban agencies in India currently do not have any system for measuring the performance of urban transport activities, assessing impacts of projects and taking further action on them. The service-level benchmarks (SLB) issued by MOUD specify parameters to measure the effectiveness of land use-transport planning in Tirunelveli.

The SLBs describe the levels of transport performance like safety and access, pollution, accidents, congestion, etc. in Tirunelveli currently. They indirectly reflect the state of governance in the city. Above all, these benchmark indicators allow stakeholders to quantify the past, present and changes in transport and its sustainability.

6.2 COMPUTATION OF INDICES PERFORMANCE-LEVEL BENCHMARKS FOR URBAN TRANSPORT

In Service Level Benchmark, four levels of Service (LOS) have typically been specified. They are LOS1, LOS2, LOS3 and LOS4. The LOS1 represents the highest performance level whereas LOS4 represents the lowest. Hence, the goal is to attain LOS1. This section computes the LOS for each benchmark and cites the inference in line with MoUD guidelines. The computation of LOS has been detailed following the MoHUA 2009 Handbook on SLB in the below section and the legend color code followed to benchmark the level of service is as below.

	LOS 1
	LOS 2
	LOS 3
	LOS 4

6.3 SERVICE-LEVEL BENCHMARK- 2022 & 2042

Indicator	LOS 2022	1 Excellent	2 Fair	3 Poor	4 Requires Substantial Improvement
Public Transport Facility	2	Presence of organised PT, Supply Availability of PT, Service Coverage, Average Wait Time, Level Of Comfort in PT			
Pedestrian Infrastructure Facility	4				Signalised Intersection Delays, Footpath Coverage in City, Street Lightig
Non Motorised Transport Facility	3			Availability Of Cycle Tracks	
Level Of Usage of ITS	4				Availability Of Traffic Surveillance, GPS facility, Signal Synchronization, Passenger Information System
Travel Speed Motorised and Mass Transit	2		Average Travel Speed Of Private & Public Transport		
Availability of Parking Spaces	4				Availability Of Parking Spaces
Road Safety	3			Fatality Population, NMT & Pedestrian Fatality	
Pollution Levels	1	Levels Of Oxides of Nitrigen, Sulpher SPM, & RSPM			
Integrated Land Use- Transport System	4				Population Density, Mixed Use Zoning, Overall FSI, FSI along Transit Corridors, Completeness Of Road Network, % of Land under Transport

Indicator	LOS 2022	LOS 2042
Public Transport Facility	2	1
Pedestrian Infrastructure Facility	4	1
Non Motorised Transport Facility	3	2
Level Of Usage of ITS	4	2
Travel Speed Motorised and Mass Transit	2	1
Availability of Parking Spaces	4	2
Road Safety	3	1
Pollution Levels	1	1
Integrated Land Use- Transport System	4	2

7. FUNDING MECHANISM

The creation of sustainable transport infrastructure is a prerequisite for ensuring low carbon growth of Tirunelveli, which cannot be realized without arranging sufficient funding mechanism.

The possible funding sources that are available to the departments/agencies (concerned with a particular type of infrastructure) for funding transport infrastructure in Tirunelveli are elaborated further.

7.1 GOVERNMENT PROVISIONS

Budget allocation by the Government of Tamil Nadu: This includes budgetary support from the State Government for various urban mobility-related proposals, including implementation, operation, and maintenance of infrastructure assets. Some of the flagship missions targeted at urban development/transport/urban rejuvenation are as discussed below:

7.1.1 Smart City Mission

To tackle the various problems of urban development including those of traffic and transportation, Tirunelveli city is also proposed to be a 'Smart City' under the Smart City Mission of the Ministry of Housing & Urban Affairs, Government of India. Under this programme, the city will move towards smarter infrastructure, with transport being one of the major components of urban infrastructure. Under this, Central Government has allocated Rs 965 crores so far to the city of Tirunelveli to improve the quality of life for its citizens through the provisioning of basic infrastructures and smart solutions. As part of the Mission, various initiatives identified for implementation in the field of sustainable urban mobility in the city are: traffic management, smart road, ITS facilities, etc.

7.1.2 Atal Mission for Rejuvenation and Urban Transformation (AMRUT)

Atal Mission for Rejuvenation and Urban Transformation (AMRUT) was launched on 25 June 2015 to provide basic services to households and build amenities in urban areas to improve the quality of life for all the residents, especially the poor and disadvantaged. Out of the total budget, urban transportation funds have been allocated for components such as pedestrian footpath/footsteps, elevated footpath, parking lots.

7.2 DEBT (BANK LOANS AND PROJECT FINANCE)

7.2.1 Financial Institutions and Non- Banking Financial Companies (NBFCs)

Lending from Financial Institutions and Non-Banking Financial Companies (NBFCs) for the development of infrastructure in the form of project finance. However, the availability of this type of financing greatly depends on the health of the macro-capital markets.

7.2.2 Infrastructure Investment Trusts (InvI Ts)

Apart from traditional bank loans, Investment Trusts have emerged as a good option for funding primarily real estate and infrastructure projects. Given the importance of infrastructure and real estate sectors and the paucity of public funds available to stimulate their growth, Real Estate Investment Trusts (REITs) and Infrastructure Investment Trusts (InvITs) are getting increasingly popular to facilitate additional channels of financing. InvITs are collective investment schemes similar to a mutual fund, which enables direct investment of money from individual and institutional investors in infrastructure projects to earn a small portion of the income as a return, without owning the assets. There are several InvITs registered with the Securities and Exchange Board of India (SEBI) that can be considered for specific urban mobility-related project financing in Tirunelveli.

7.2.3 National Investment and Infrastructure Fund (NIIF)

National Investment and Infrastructure Fund (NIIF) has been set up to ensure funding of the country emerges as a good option for funding primarily real estate and infrastructure projects. Given the importance of infrastructure and real estate sectors and the paucity of public structure projects by refinancing loans originally taken for project development, thereby enabling original project financiers to recycle their capital following the commencement of operations.

7.2.4 Advertisement Revenues

The rolling stock consisting of buses and trains is an excellent means for advertising. In addition, stations, en-route stops, and the corridor also provide ample space for advertisements. These rights may be sold based on a fixed fee or even on a revenue-sharing basis.

7.3 MULTILATERAL DEVELOPMENT BANKS

MDBs such as the Asian Development Bank (ADB) and the World Bank play a critical role in facilitating infrastructure development. With the growing emphasis on low-carbon mobility solutions to reduce Greenhouse Gas (GHG) emissions from the transport sector (as per the Paris Agreement), various MDBs have aligned themselves.

The services offered by MDBs include multi-currency loans, grants, equity, guarantees, technical assistance (TA) programmes, and co-financing activities in conjunction with other MDBs, multilateral development agencies, and public and private organizations. MDBs may lend for longer tenures and at lower rates than private banks, and have greater flexibility in designing debt-servicing requirements. Many MDBs also provide default indemnities through credit guarantee facilities to leverage infrastructure projects to lower costs.

7.4 INNOVATIVE FINANCING

To fund the imposing needs of urban infrastructure, in general, and transport, in particular, there are several innovative methods which, due to their ease of implementation and high usage, act for many local governments as sources of general revenue. The National Urban Transport Policy of April 2006 also emphasizes the innovative use of land as a resource for financing public transport projects. Some of these innovative methods are listed here.

7.4.1 Urban Transport Funds

It was in the Ninth Five Year Plan that a need was felt to set up a National Urban Transport Development Fund. This fund would provide financial assistance for urban transport projects in the country, preparation of feasibility studies, project reports and training, and R&D activities. Similar funds at the city level may also be encouraged to meet the share of contribution of the state and the urban local governments in urban transport projects. It is, thus, proposed that in Tirunelveli a dedicated UTF is set up within UMTA, which would enable the authority to allocate funds to various agencies in the urban mobility area. It will also provide UMTA with the financial strength to undertake activities to achieve its objectives, including day-to-day operations. It is envisaged that the function of management of UTF shall be carried out by a separate division of the secretariat, called the Fund Management Division (FMD), under the overall guidance of the UMTA Board. The FMD is envisaged to manage all financial matters about UMTA, including the collection and disbursement of funds. The FMD shall also be responsible for monitoring expenditures of implementing agencies that have been granted funds from UTF.

7.4.2 Property Development

Besides the value from direct-use benefit from an urban transport project through fare box revenues, advertising revenues, license fees from business activities, and real estate development rights, there is a substantial benefit from the transport project owing to an increase in economic activity along corridors as well as an increase in value of land and real estate nearby stations, bus terminals, and transport corridors. In this option of real estate development, property developers are invited to develop corridors and share profit with transport organizations arising out of such sale of the property. The choice of such instruments would depend upon the demand for commercial and residential real estate in the proximate area, the effectiveness of property tax administration and collection system, the institution responsible for city planning and development, and the availability of instruments for managing real estate development and trading of real estate development rights.

7.4.3 Land Value Capture

Beyond improvements in mobility itself, investments in urban transport will lead to higher property values in the developed areas (and to higher municipal rates linked to those properties), the greater orientation of development along with transit directions, and better anchors for land-use planning, among others. To generate funding from the value created in the proximity zones, a ‘Betterment Levy’ or ‘Land Value Tax’ can be imposed. This tax is aimed at landowners, as it focuses on land value rather than on the property value. The tax is designed to capture the value created by the provision of public services surrounding the areas in which the services have been provisioned. This option could help generate upfront resources from beneficiaries for partially funding the capital cost to incentivize real estate development in the project influence zone, a higher FSI should be allowed. An upfront fee to ULB can be paid by owners of commercial buildings to increase a built-up area.

7.5 INTERNATIONAL DEVELOPMENT AGENCIES

IDAs, besides MDBs, are also an important source of loans, grants, financial services, and technical assistance for infrastructure projects. IDA support may take the form of Official Development Assistance (ODA), which was drawn from around 40 national agencies, 31 non-government agencies, and 26 international institutions in 2015. ODA generally takes the form of loans, grants, and technical cooperation agreements for training, development planning, financing of study teams and experts, and the provision of equipment.

Both MDBs and IDAs can act as intermediaries between government agencies and various funds/institutions available globally, such as the Global Environment Facility (GEF), European Union (EU), which facilitates substantial funding in the sustainable mobility sector.

7.6 PUBLIC PRIVATE PARTNERSHIP

Public-Private Partnerships (PPPs) have become increasingly relevant for public infrastructure investment as an alternative to spending by governments or (privatized) infrastructure companies. One of the main difficulties in ensuring private participation is the viability gap that exists between new infrastructure projects and the need for state-financed subsidies to support a high proportion of private investment. Certain projects related to city bus services (including bus operation and maintenance, bus stops) can be considered to be implemented on PPP mode. Going forward, the Multi-Modal Integration Terminals, Bus Depots, which have great potential to exploit the real estate and advertisement value, should also be funded in this mode, besides exploring the possibility to include other types of projects by distributing the risks to the partner (public or private) who is best suited to bear that risk.

7.7 BOND- FINANCE

Bonds are financial instruments issued by a government or corporation obliging the issuer to make periodic interest payments and repay the principal on maturity. Bonds are an alternative source of capital to intermediated credit and equity financing (Hack and Close 2013). Bonds take many forms and are widely used by governments, corporations, and project sponsors to raise capital for infrastructure projects.

Bond markets provide an opportunity to bridge the gap between high domestic savings and the shortfall in infrastructure capital (although evidence suggests that this has not occurred on a significant scale). However, the weakness of infrastructure bonds is that this arrangement does not ensure active lender governance of projects.

7.7.1 Tax Exempt Bonds

Tax-exempt bonds are government-issued securities that offer investors a full or partial exemption from taxation on interest receipts. This option, though attractive for investors, is a conundrum for the government because a deduction from tax liability is an explicit transfer payment from the state to private investors to be offset by the welfare from that infrastructure. Several Indian cities (such as Ahmedabad) have issued such bonds.

7.7.2 Revenue Bonds

Revenue bonds are debt securities issued by governments to meet the cost of Greenfield infrastructure, or issued by a project's private sponsors to raise investor capital on either a project-by-project or a portfolio basis. The bonds are secured over the value of the assets and the contracts being financed.

Apart from the above, other sources can also be explored for funding urban mobility projects:

- Sovereign Wealth Funds (SWFs) (wherein various SWFs directly participates in the infrastructure building);
- Initial Public Offering (IPO) (for securitizing privately financed infrastructure projects), etc.

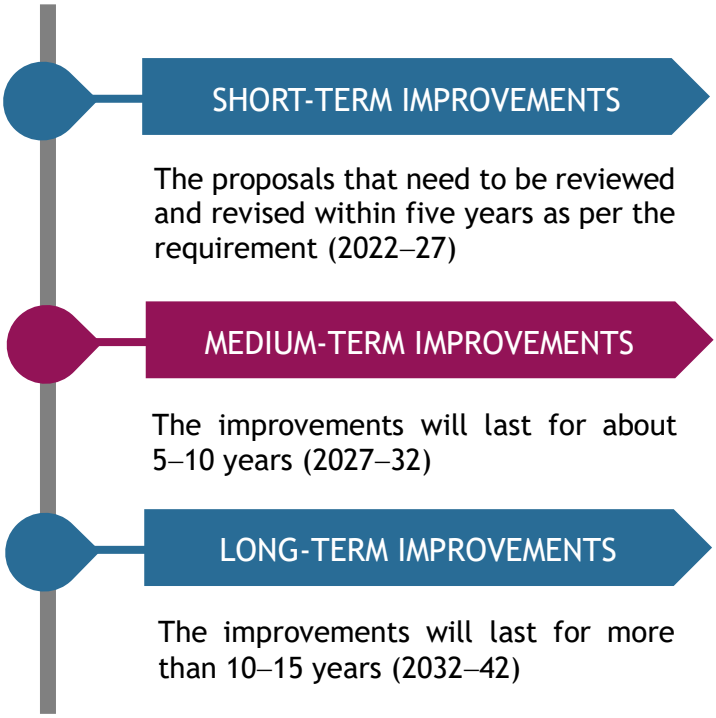
8. IMPLEMENTATION PLAN

This chapter details the costs associated with each of the proposed improvements (immediate, short, medium and long term) along with the phasing of the projects. The implementation plan also provides various financing options to be looked at towards executing the proposed projects. A suitable institutional framework is of utmost importance for the successful implementation and management of all the schemes.

8.1 PRIORITISATION OF PROJECTS

The mobility plan components discussed in the previous sections were considered in the estimation of block cost (FY2022) estimate for implementing the elements in the future. The approximate capital cost, excluding land acquisition, for implementing the mobility plan is about Rs 7792 crores.

All the proposals discussed so far can be broadly grouped under three categories as shown here. The following section gives the overall project costing.



Short Term Proposals	Medium Term Proposals	Long Term Proposals
Quickly Implementable, Not Capital Intensive	Not Very Quickly Implementable, Moderately Capital Intensive	Requires Detailed Study Before Implementation, Capital Intensive
Junction, Corridor Improvements	Upgradation of Existing Roads / Development of New Links	Development of New Links
Pedestrian Network Improvements	Flyover / ROBS / RUBS/ Canal Crossings	Upgradation of Existing Roads
Bicycles Corridors Improvements	Dedicated Cycle Tracks	Flyover / ROBS / RUBS/ Canal Crossings
Area Improvement Plans	Pedestrian Network Improvements	Dedicated PT Network
Parking Management Plan	New Bus Terminal	Truck Terminals
Improved Bus System (Fleet)	Off-Street Multi-Level Parking	
	ITS Systems	

8.2 PHASING OF PROJECTS

Detailed Phasing and Block Cost Under various strategies are discussed in the following section.

8.2.1 Block Cost - Road Network Strategy

The total block Cost under Road Network Strategy is estimated to be **606 crores**.

Table 8-1: Block Cost- Road Network Strategy

Strategy	Type	Unit	Total Quantity	Average Unit Rate in Rs	Total Cost in Cr	Total Cost in Cr Phase 1	Total Cost in Cr Phase 2	Total Cost in Cr Phase 3
Road Network Strategy	Ring Road	sqm	462000	4093	189.1	0	189.1	0
	Missing Link	sqm	103040	4093	55.07		12.9	42.2
	Widening	sqm	445200	4093	182.2	169.3	12.9	0
	River/ Rail Bridge	no	5	358810608	179.4	36	72	72
Total Cost					606	205	287	114

8.2.2 Block Cost – Public Transport Strategy

The total block Cost under Public Transport Strategy is estimated to be **2692 crores.**

Table 8-2: Block Cost- Public Transport Strategy

Strategy	Type	Unit	Quantity	Average Unit Rate in Cr	Total Cost in Cr	Total Cost in Cr Phase 1	Total Cost in Cr Phase 2	Total Cost in Cr Phase 3
Public Transport Strategy	Fleet Replacement	No	352	1.75	616	151	198	268
	Bus Shelter Numbers	No	470	0.12	57.6	0.0	28.8	28.8
	Bus Terminal/ Depot	No	5	11.82	65.0	10.7	27.2	27.2
	Mass Transit System	Km	39	50	1953	0	501	1452
Total					2692	161	754	1776

8.2.3 Block Cost – Non Motorized Transport Strategy

The total block Cost under NMT Strategy is estimated to be **112 crores.**

Table 8-3: Block Cost- NMT Strategy

Strategy	Type	Unit	Quantity in Sqm	Average Unit Rate in Rs	Total Cost in Cr	Total Cost in Cr Phase 1	Total Cost in Cr Phase 2	Total Cost in Cr Phase 3
NMT Strategy	**Footpath Proposal**	sqm	532800	1,811.00	96	96		
	Pedestrian Crossing Infrastructure	sqm	33979	2,663	9	9		
	Bicycle Tracks	sqm	30000	1,821	5	1	4	
	Pedestrian Priority Streets/ All-weather walkway	km	0.80	1,06,50,150	1	1		
	Total				112	108	4	0

8.2.4 Block Cost – Freight Management Strategy

The total block Cost under Freight Management Strategy is estimated to be **21 crores**.

Table 8-4: Block Cost- Freight Management Strategy

No	Estimated Area per Unit in Acre	Unit	Quantity in Sqm	Average Unit Rate in Rs	Total Cost of Freight Management Strategy in Crores	Total Cost in Cr Phase 1	Total Cost in Cr Phase 2	Total Cost in Cr Phase 3
5.00	3.00	per acre	per acre	17572748	21	0	5	16

8.2.5 Block Cost – Traffic Management Strategy

The total block Cost under Traffic Management Strategy is estimated to be **22 crores**.

Table 8-5: Block Cost- Traffic Management Strategy

Strategy	No	Type	Unit	Quantity in Sqm	Average Unit Rate in Rs	Total Cost of Parking Management Strategy in Crores	Total Cost in Cr Phase 1	Total Cost in Cr Phase 2	Total Cost in Cr Phase 3
Traffic Management	1	Junction Improvement	No	18	4750000	8.4	8.4	0	0
	2	Corridor Improvement	sqm	37120.00	1084.67	12.79	12.79	0	0
	3	Smart Signals	No	5	532508	0.266	0.266	0	0
	4	Road Pavement Marking	sqm	112.50	151.00	0.00	0.00	0	0
	5	Signage	No	1200	3906	0.47	0.47	0	0
		Total				22	22	0	0

8.2.6 Block Cost – Parking Management Strategy

The total block Cost under Parking Management Strategy is estimated to be **3.6 crores**.

Table 8-6: Block Cost- Parking Management Strategy

Strategy	Type	Unit	Quantity (sqm)	Unit Rate (per sqm)	Total Cost of Parking Management Strategy in Crores	Total Cost in Cr Phase 1	Total Cost in Cr Phase 2	Total Cost in Cr Phase 3
Parking Management	Off Street (4 locations)	SQM	6879.60	5325.0	3.66	0.43	2.15	1.08

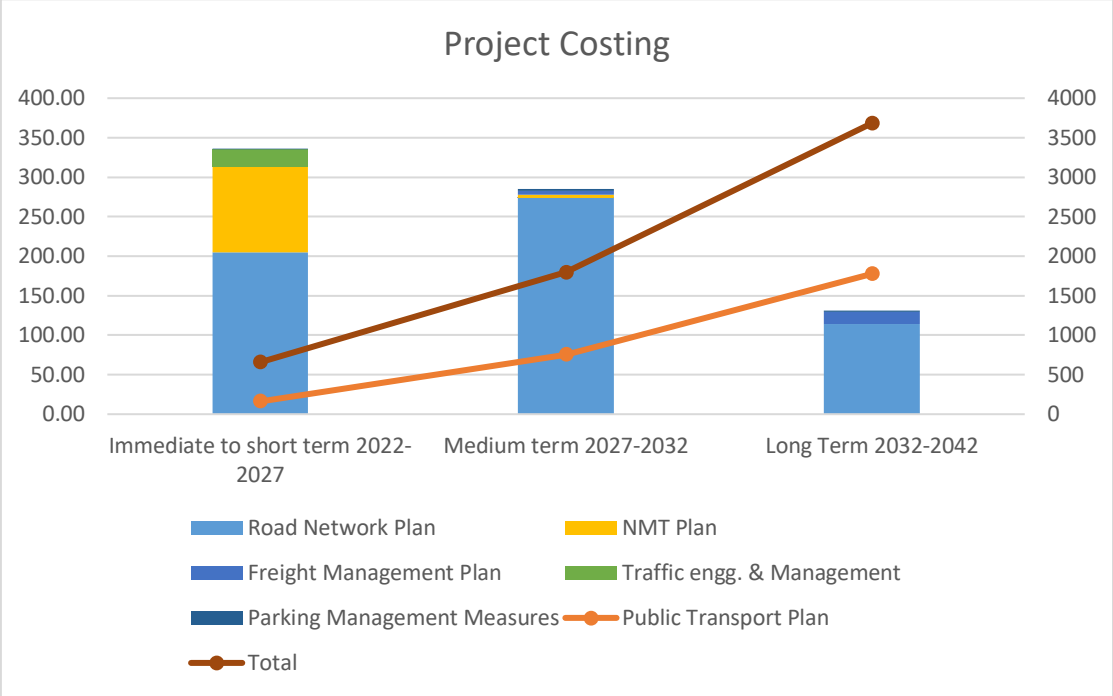
8.2.7 Block Cost – Summary

The total block Cost under all strategies is estimated to be **3443 crores**.

Table 8-7: Block Cost- Parking Management Strategy

STRATEGY	Road Network Plan	Public Transport Plan	IPT Plan	NMT Plan	Freight Management Plan	Traffic engg. & Management	Parking Management Measures	Total
Immediate to short term 2022-2027	205.21	161	0	108	0	22	0.4	497
Medium term 2027-2032	274	754	0.0085	4	5	0	2.2	1040
Long Term 2032-2042	114	1776	0	0	16	0	1.1	1907
Total Cost (in Rs. Crores)	593	2692	0	112	21	22	4	3443

Figure 8-1: Block Cost Analysis



8.3 RESPONSIBLE AGENCIES

Strategy	Responsible Agency
Land use & Transport Integration	
High density mixed land use development along transit corridors (TOD)	Tirunelveli Municipal Corporation/District Collectorate
Improving Accessibility to Public Transport	Tirunelveli Municipal Corporation
Road Network Strategy	
Development of New Roads, Bridges & Flyover	National Highways/ State Highways/ Tirunelveli Municipal Corporation
Road Widening	National Highways/ State Highways/ Tirunelveli Municipal Corporation
Road Improvement for Core City	National Highways/ State Highways/ Tirunelveli Municipal Corporation
Public Transportation Strategy	
Expansion of Intra-city bus services	TNSTC
Creation of Supporting Transport Infrastructure	TNSTC/ Tirunelveli Municipal Corporation
Dedicated High Demand PT Corridor	CMRL/Smart City/ Tirunelveli Municipal Corporation

Non-Motorized Transport	
Footpath Development	Tirunelveli Municipal Corporation
Pedestrian Crossing Infrastructure	Tirunelveli Municipal Corporation
Cycle Track Development	Tirunelveli Municipal Corporation
Freight Transport	
Freight Terminals	Tirunelveli Municipal Corporation
Consolidation Centers	Tirunelveli Municipal Corporation
Traffic Engineering & Management	
Junction Improvement	Tirunelveli Municipal Corporation
Smart Signals	Tirunelveli Municipal Corporation
Pavement Marking & Signage's	Tirunelveli Municipal Corporation
Parking Management	
Designated Parking Spaces	Tirunelveli Municipal Corporation
Smart Parking	Tirunelveli Municipal Corporation
Parking Pricing	Tirunelveli Municipal Corporation
Enforcement	Tirunelveli Municipal Corporation /Traffic Police

9 INSTITUTIONAL MECHANISM

9.1 CURRENT STATE OF URBAN TRANSPORT INSTITUTIONS IN INDIA

Urban transport is not an exclusive subject under any of the three lists given in the Indian Constitution. As a result, this has led to the enactment of various statutes by Central, State, or Local Governments to deal with certain aspects of urban transport. Various authorities/agencies have been constituted by these statutes. However, no Statute (and the Authority constituted as per the provisions of the same) covers the needs of urban transport comprehensively and, as a result, various aspects of urban transport (e.g., infrastructure, provision of public transport service) continue to be governed in a fragmented nature by a number of such statutes and corresponding agencies at various levels. These authorities/agencies widely vary in terms of their genesis (legal basis, whether through State Legislature or executive orders); jurisdiction; functions mandated; management structure, etc. More often than not, it is almost a norm that these agencies work in silos. With very little coordination among them, the level of service in urban mobility gets affected. This often leads to duplication of the same work/services because of overlapping jurisdictions. For example, often road projects are implemented in isolation without adopting the principle of 'complete street', i.e., without integrating with the adjoining land uses through the construction of footpaths, facilities for non-motorized transport, multi-modal integration facilities, etc. To ensure sustainable urban mobility, it is imperative to ensure efficient coordination with all agencies, delineate clear jurisdiction, and remove ambiguity on the roles and responsibilities of various institutions.

9.2 EXISTING INSTITUTIONAL FRAMENWORK IN TIRUNELVELI

Tirunelveli is no exception to the above-mentioned problems in existing legal and institutional arrangements that persist in almost all Indian cities. The Central, State, and Local Government Agencies that are engaged in urban transport, be it in the creation of infrastructure or provision of transport services (or in land-use planning/land development) have been depicted in a schematic diagram. It indicates the overlapping of functions and responsibilities at various levels for activities related to transportation in the city. Planning and provision of sustainable urban mobility in Tirunelveli, therefore, would depend on the effective coordination among these institutions and developing a 'win-win' strategy for all stakeholders, which is quite an onerous task. The establishment of a supportive institutional environment will hold the key. This can be facilitated through an umbrella-level organization with regulatory powers to carry out planning, monitoring, funding, implementation, and coordination tasks. The National Urban Transport Policy (NUTP), 2006 provided for setting up of the Unified Metropolitan Transport Authority (UMTA) to serve this purpose.

The establishment of **Chennai Urban Transport Authority - CUMTA** as per the CUMTA act of 2010 by the Government of Tamil Nadu can be seen as a commendable initiative towards resolving the issues related to organizational coordination. Similar strategy may be used for setting up the transport authority in rest of the ULBs in Tamil Nadu.

9.2.1 Various Agencies and their Roles and Responsibilities

PRIVATE MOTORIZED TRANSPORT

Center

Planning & Policy: MoRTH, MoHUA
Infrastructure: NHAI

State

Planning & Policy: Trasnport /Urban Department at State level
Infrastructure: Highways Department
Operations: Traffic Police
Monitoring & Evaluation: Pollution Control Board, Traffic Police

City

Planning & Policy: Municipal Corporation, DTCP
Infrastructure: Municipal Corporation, Highways Department (National & State)
Operations: Municipal Corporation
Monitoring & Evaluation: RTO, Traffic Police

INTERMEDIATE PUBLIC TRANSPORT

State

Planning & Policy: Transport Department, RTO

City

Infrastructure: Municipal Corporation, Highways Department
Operations: IPT Operators
Monitoring & Evaluation: RTO, Traffic Police

INTERCITY BUS

Center

Planning & Policy: MoRTH, MoHUA

State

Planning & Policy: TNSTC, Transport Department/ Urban Development at State Level
Operations: TNSTC
Monitoring & Evaluation: TNSTC

City

Infrastructure: Municipal Corporation, RTO, TNSTC

CITY BUS SERVICE

Center

Planning & Policy: MoHUA,

State

Planning & Policy: Transport/ Urban Department at State Level, TNSTC
Operations: TNSTC/Private Operators
Monitoring & Evaluation: TNSTC

City

Infrastructure: TNSTC, Municipal Corporation
Operations: TNSTC, Municipal/ Distric Administration
Monitoring & Evaluation: RTO, Traffic Police, TNSTC

9.3 BENEFITS OF UNIFIED MUNICIPAL TRANSPORT ATHOURITY (UMTA)

Facilitate Integrated Planning and Management of Urban Transport

UMTA is envisioned to be a unified agency to direct planning, operations, and monitoring of various transport modes in a city. This setup would ensure that decisions about transport systems including future planning of urban development are made in a holistic and integrated manner.

Facilitate Multi-Modal Integration of Transport

A vital aspect of this integration is seamless interchanges between different modes. To bring about integrated planning of facilities or systems, there is a need for rationalization of functions and ownership rights of agencies that are currently undertaking operation of multi-modal integration of transport facilities. UMTA is envisaged to be given complete control in the planning of all major transport initiatives in its jurisdictions.

Facilitate Rational Fare Structure

NUTP proposes that a regulatory authority should regulate charges for different types of public transport services. This will help in ensuring that fares charged are fair and reasonable. UMTA is expected to set up regulatory/institutional mechanisms to periodically revise fares of all public and intermediate public transport systems.

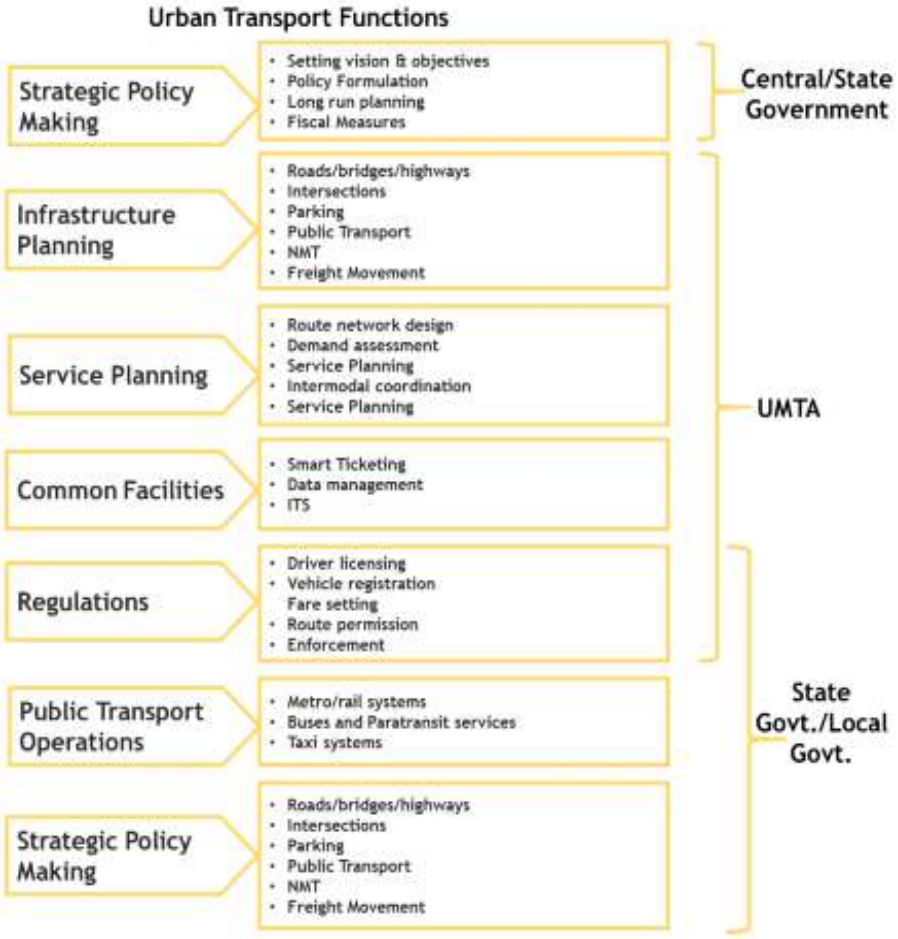
Facilitate Research Studies and Awareness

In order to make informed decisions, data and information related to the urban transport system should be made available to the agencies and the public. UMTA is expected to address the problems of urban transport through research, studies, awareness campaigns, and promotion of good practices in urban transport.

9.4 ROLES AND RESPONSIBILITIES OF UMTA

1. **Inputs in Policy Formulation**: UMTA, being a local-level government body, will have in-depth and precise knowledge about urban transport challenges that exist at the ground level. It would, thus, be in the appropriate position to advise the government on the city's current and future urban transport needs and the mechanisms for addressing challenges.
2. **Strategic Planning**: UMTA shall undertake planning functions that set the direction for the city's long-term transport planning, thereby providing a framework for transport policy and investment decisions to respond to key challenges. It would also be responsible for periodic updating of Comprehensive Mobility Plans (CMPs).
3. **Project Approval**: Funding approvals for urban transport initiatives is one such power that may be assigned to UMTA to give it the necessary authority to execute its functions. It would also be important that UMTA reviews and approves projects for which it facilitates funding in whole or in part so that it can be assured of gaining value from putting in its resources. Project approvals will be based on compliance with CMP, and other guidelines and standards prepared by higher authorities.
4. **Ensuring Project Implementation**: UMTA would be responsible for ensuring the effective implementation of plans and projects related to urban transport in the planning area through the concerned agencies.
5. **Overseeing Operation and Management**: UMTA shall be responsible for overseeing operations, maintenance, and management of transport infrastructure and public transport services.
6. **Regulation**: UMTA will not be responsible for matters such as registration and licensing of private and commercial freight vehicles and fare fixation. UMTA shall, however, provide recommendations on licensing and fare fixation of public transport vehicles operating within its jurisdiction and regulate fees and charges for other urban transport facilities and services. It is suggested that UMTA shall not get involved in inspecting vehicles' conditions, enforcing traffic laws, or managing traffic.
7. **Funding**: Urban transport reforms recommend the establishment of a UTF so that initiatives are less dependent on government budgetary allocations. As part of these reforms, it is envisaged that UMTA shall be responsible for the management, utilization, and regulation of expenditure from the UTF. In this regard, the functions of UMTA shall include:
    - Resource mobilization
    - Treasury management
    - Utilization/disbursements of funds
    - Funds management
    - Monitoring of fund utilization
8. **Research Studies and Awareness**: For achieving the desired development of urban transport, research studies need to be conducted regularly. UMTA shall be made responsible for conducting research specific to the urban mobility area, including up-gradation and extension of urban transport. It would also be made responsible for effective measures that will ensure public safety in urban transport.
9. Mobility area and provision of the same to the relevant agencies with a view to contribute to the national database on urban transport.

Figure 14-1: Functions of UMTA



9.5 PROPOSED OPTIONS FOR UMTA IN TIRUNELVELI

The proposed institutional mechanism for setting up the UMTA in Tirunelveli may be any one of the following three:

a) UMTA as a separate statutory authority; or

b) State Government Appointed Transport Agency as UMTA at the state level; or

c) UMTA is accountable to the municipal level of government.

The pros and cons of the above options are elaborated in the following sections.

9.5.1 UMTA as a Separate Statutory Authority

UMTA would have a clear status as an independent statutory authority, while its mandate would be for a specific metropolitan/municipal area.

Advantage

Independent authority would lead to lesser dependence on other departments and working more independently.

Disadvantage

A dedicated Act needs to be enacted based on the 'Unified Metropolitan Transport Authority: Operations Document' prepared by erstwhile the Ministry of Urban Development (now Ministry of Housing and Urban Affairs), Government of India in November 2016.

Greater time requirement for its formation and other legal formalities and approvals of the State government.

9.5.2 State Government Appointed Agency as UMTA at State Level

Any State Government Appointed Transport Agency as UMTA at the state level, i.e., instead of being set up through a special separate entity as stated in option 9.5.1

Advantage

- Already existing dedicated body looking after urban transport issues in the state.
- An important objective of UMTA is to promote the development of integrated systems for urban transport, including seamless transport connectivity extending beyond an urban area. The agency would not limit its functions as it would have full control of the state-level decisions or policies and also its control extends much beyond the city limits.
- Moreover, the main objective of the department is to oversee the issues of Urban Transport along with the responsibility of assessing, monitoring, controlling, and distributing Viability Gap Funding to various SPV as conceived in the scheme.
- The department is sound in Technical know-how, to be able to address the transport component.
- Apex body in urban transport having control on Urban Transport Fund (UTF), so easy allocation of funds would be possible.

Disadvantage

The Agency would only be looking after urban development system. Other departments like Metro, IPT, NMT, etc. are not under its control.

9.5.3 UMTA Reporting to the Municipal Corporation of Tirunelveli

The city is the prime beneficiary of improved urban transport, so the city should have a major say in the development and management of its urban transport. From this perspective, UMTA could be established with direct accountability to the municipal level (under its planning department) of government. Setting up of UMTA under the Developmental (Planning) Authority of Tirunelveli is a strategy similar to the setup adopted for Chennai Metropolitan Transport Authority under the CUMTA act. The pros and cons of this option include:

Advantage

- The MC is responsible for planning and managing all activities related to the city of Tirunelveli compared to state-level authorities (including a few aspects of urban transport). Hence, it has better experience in handling urban transport-related matters.
- Small team of NNM would lead to faster implementation of decisions

Disadvantage

- It may not be easy for a city-level agency, such as Municipal Corporation, without backup from the state, to coordinate with Central Government agencies such as Indian Railways and NHAI in urban transport matters, among others.
- In particular, in the context of Tirunelveli, this would be even more challenging as Municipal Corporation to date does not have any prior experience in dealing with all urban transport service provisions.
- Lack of funds in the ULBs and technical capacity would also lead to a greater challenge.
- To add to this, the jurisdiction of Municipal Corporation is much lesser than the controlled area for which the development plan is prepared. This would ultimately defeat the very purpose of UMTA. In view of these factors, this option is not recommended.

It is thus proposed that **a state government appointed transport agency, Tamil Nadu may be the apex body for all transport-related issues at the state level**. However, at the same time, the **city of Tirunelveli should set up a dedicated transport cell within the Municipal Corporation which looks after the day-to-day operations of all transport systems and issues in the city** and reports **directly to the State Level Authority**.

The dedicated cell shall constitute the following departments mentioned in Figure 10-2.

Apart from the above-mentioned members, which will form the decision-making body, it is proposed that the dedicated cell shall comprise an in-house working unit that consists of advisors, transport planners, traffic engineers, transport economists, GIS cell, etc. and shall be directly involved in the development works being planned and executed in the city.

Figure 14-2: Members of the Proposed Dedicated Cell in the Municipal Corporation