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Coimbatore Rapid

Mass rapid transit feasibility study

Institute for Transportation and Development Policy

Transport Department & Commissionerate of Municipal Administration, Government of Tamil Nadu

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Preface

Coimbatore is a prominent industrial hub and second largest city in the state of Tamil Nadu. The city has been witnessing rapid growth of vehicles especially cars and two wheelers. Due to the high vehicle volumes, there is significant traffic congestion in the inner city. Though walking and cycling account for a quarter of trips in Coimbatore, most streets lack dedicated pedestrian and cycling facilities. Even where footpaths are available, they are either narrow or encroached by utilities and parked vehicles. The existing public transport system served by TNSTC does not have adequate good quality buses and is characterised by poor frequency, longer waiting times, and poor quality bus shelters. Due to lack of high quality public transport and non-motorised facilities, the city is seeing increased dependency for personal transport for even shorter trips. Most existing efforts to reduce traffic congestion have been focused on building grade separators and widening roads—initiatives that are primarily intended to benefit users of personal motor vehicles.

To actively promote safe and accessible sustainable transport with focus on reducing vehicular increase and pollution, the Commissionerate of Municipal Administration, Tamil Nadu, in partnership with ITDP has initiated the “Sustainable Cities through Transport” process. The process helps cities like Coimbatore to identify existing transport challenges and develop proposals towards encouraging more walking and cycling; implementation of high quality public transport system, and effective parking management in the city. Now in partnership with the Transport Department, ITDP has worked with Coimbatore to study the city’s public transport needs in more detail. The outcome is this feasibility study, which identifies a 74 km network for rapid transit. This document discusses the existing transportation system challenges, and identifies four corridors to implement an affordable, accessible, flexible, and cost effective mass rapid transit system.

Contents

1. Executive summary

1.1 Background

Coimbatore, a vibrant industrial city in the western part of Tamil Nadu, is home to over 2.3 million inhabitants,[1] making it the second largest city in the state. Its population is growing quickly, but its personal motor vehicle population is growing four times as fast. Formal public transport accounts for around a third of all trips in the city. Further, the government-operated city bus service, operated by the Tamil Nadu State Transport Corporation (TNSTC), accounts for only two thirds of these trips. The remaining public transport demand is served by private buses and shared auto rickshaws. None of these are of a high quality. Buses are overcrowded during peak hours and their speed is dropping by the day due to traffic congestion. The poor quality of public transport invites people to opt for personal motor vehicles.

Daily trips in Coimbatore are likely to grow from 3.5 million presently to 6.5 million by 2031. Under a "business as usual" scenario, where higher travel demand is addressed through road widening, flyovers, and elevated roads, the mode share of personal motor vehicles will rise from 34% presently to 53% by 2031 (Figure 1). Even if all of Coimbatore's main roads have an additional layer of elevated roads, there won't be enough capacity to meet 2031 demand. The transport system will quickly reach capacity limits and Coimbatore will get entangled in unending traffic jams and deadly air pollution. Road fatalities also are expected to multiply, not to talk of significant inequity.

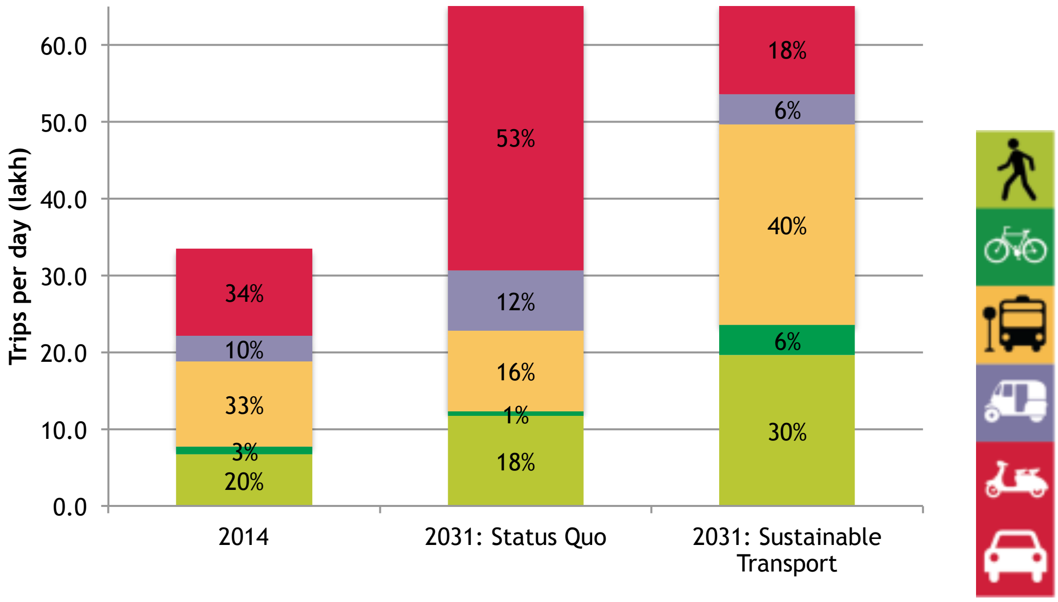


Figure 1: If existing trends continue, Coimbatore will see a doubling in the number of daily motor vehicle trips ("Status quo"). If Coimbatore invests in better public transport and non-motorised transport facilities, these trends can be reversed ("Sustainable").

[1] 21.5 lakh inhabitants as per 2011 Census

Transport planners have increasingly come to a consensus that successful cities facilitate the movement of "people, not vehicles," a goal clearly expressed in the National Urban Transport Policy (NUTP 2006). The Government of Tamil Nadu (GOTN) and Coimbatore City Municipal Corporation (CCMC) recognize that public transport and urban accessibility are drivers of growth and prerequisites for quality of life. GOTN and CCMC have chosen to create a sustainable, robust, high-capacity mass rapid transport system. Such a system must accommodate not only the anticipated demand in 2031 but have sufficient capacity to support travel demand over the following two decades.

Through strategic public transport and allied interventions, CCMC aims to achieve the following goals over the next 15 years:

- **Support Non-Motorised Transport (NMT)**. 36% of all trips by cycling and walking
- **Improve public transport**. 40% of all trips by public transport and 6% by paratransit mode
- **Public transport accessibility**. 75% of residents within a 5 min walk of formal public transport
- **Improve safety**. Zero fatalities per year from traffic crashes or public transport accidents
- **Keep Coimbatore air healthy**. Zero nonattainment days for PM and NO_x emissions

Coimbatore stands at a crossroad in its history and development. With suitable urban interventions at this stage, it can avoid the pitfalls of cities of similar characteristics and can set high standards for other cities to follow. Known as the "Manchester of South India," Coimbatore has the potential of becoming an IT based and global commercial centre after Chennai that affords its citizens immense benefits in the form of jobs, opportunities, and improved quality of life. For this opportunity to become a reality, the city will have to develop adequate infrastructure and services to facilitate development and improve the quality of life of all its citizens, both rich and poor.

1.2 MRTS mode selection

Public transport mode choice is driven by the potential passenger market for public transport, the trip patterns of prospective users, and other socio-economic criteria. ITDP recommends implementing a high quality Bus Rapid Transit (BRT) system as a critical step toward improving the overall public transport system. In Coimbatore, ITDP strongly favours BRT over other systems such as monorail and metro for the following reasons:

- Ability to meet existing passenger demand and scale up to meet future demand;
- Ability to provide flexible services, and change service design for increase in capacity;
- Adaptable designs to accommodate narrow streets;
- Low implementation cost; and,
- Rapid implementation timeline.

BRT is a high capacity rapid transport system that provides safe, comfortable, efficient, and economical services to millions of transit customers worldwide. BRT includes the following:

- High quality, frequent service that is proven to attract users from personal vehicles.
- High quality stations with platform that match the level of the bus so that passengers can enter and exit quickly and easily without climbing steps.

- Specially designed buses that operate in exclusive lanes in the centre of the street.
- Special bus fleet that is electronically monitored from a control centre to ensure reliability and provide real-time information to passengers.
- Smart ticketing at stations enhances passenger convenience and improves efficiency.

BRT systems offer the following advantages over other forms of rapid transit (monorail, metro, etc.):

- Not bound to a track, bus routes can be easily adjusted and consist of a combination of corridors.
- Buses can also exit the track and serve nearby areas, thus providing direct connectivity.
- BRT can be built in a short period of time (under 18 months) and at a fraction of the cost of rail systems (i.e., Rs 20 crores / km of BRT vs. Rs 150 to Rs 450 crores / km for rail-based systems).
- At grade, low-impact BRT stations are quick and easy for customers to access.
- BRT systems have the potential to provide a capacity over 20,000 pphpd (matching metro performance) using passing lanes and articulated vehicles.
- BRT operations plans can include multiple services per corridor and express services.

Table 1: Key Features of Bus Rapid Transit

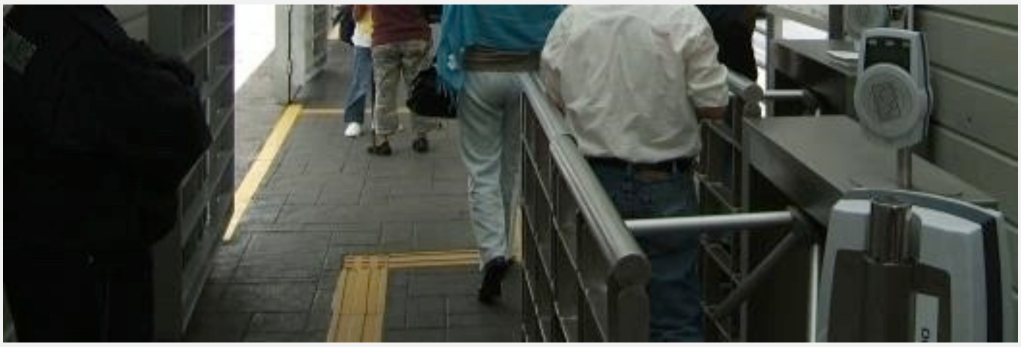
MEDIAN BUS LANES

Physically segregated median bus lanes ensure that buses are not stuck in traffic. They also reduce conflicts between buses and slower moving traffic at the edge of the carriageway.

STEPLESS BOARDING

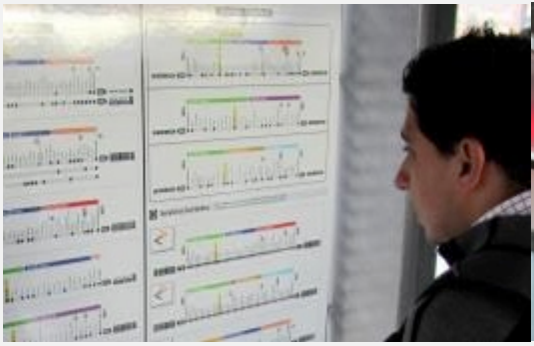
Level boarding ensures that the system is universally accessible and helps reduce bus dwell times.

OFF-BOARD FARE COLLECTION



Off-board fare collection with electronic smart cards is convenient and reduces revenue leakage.

CUSTOMER INFORMATION



Real-time passenger information keeps customers up to date on bus destinations and departure times. Clear schedules and maps summarize system information.

High capacity BRT systems are successfully operating in many large cities across the world including Bogotá (Colombia), Mexico City (Mexico), Seoul (Korea) and Guangzhou (China), often integrated with rail systems and providing complementary services. Many developed countries like USA and France are exploring BRT solutions to provide high-quality, cost-effective rapid transportation to manage the demand for private vehicle travel.

1.3 BRT for Coimbatore

The Mass Transport Feasibility Study finds that BRT is feasible and immediately required in Coimbatore. Simple improvement of bus service may not be a viable option, as measures to control the use of private vehicles are extremely limited. The appropriate solution for Coimbatore is a full-featured BRT system that pairs significant improvements in bus performance with other elements, such as a dedicated right-of-way for buses that is segregated from general traffic (Figure 2).

Figure 2: Proposed BRT station on Mettupalayam road.

1.4 Corridor selection

ITDP mapped shared autorickshaw and TNSTC routes, and also conducted multiple surveys—traffic volume counts, bus and shareed auto frequency-occupancy counts, and parking surveys—across the city to get a better understanding of the existing conditions. Interviews with key agencies, including CCMC, TNSTC, the Regional Transport Office, and the Traffic Police, were completed as part of analysis.

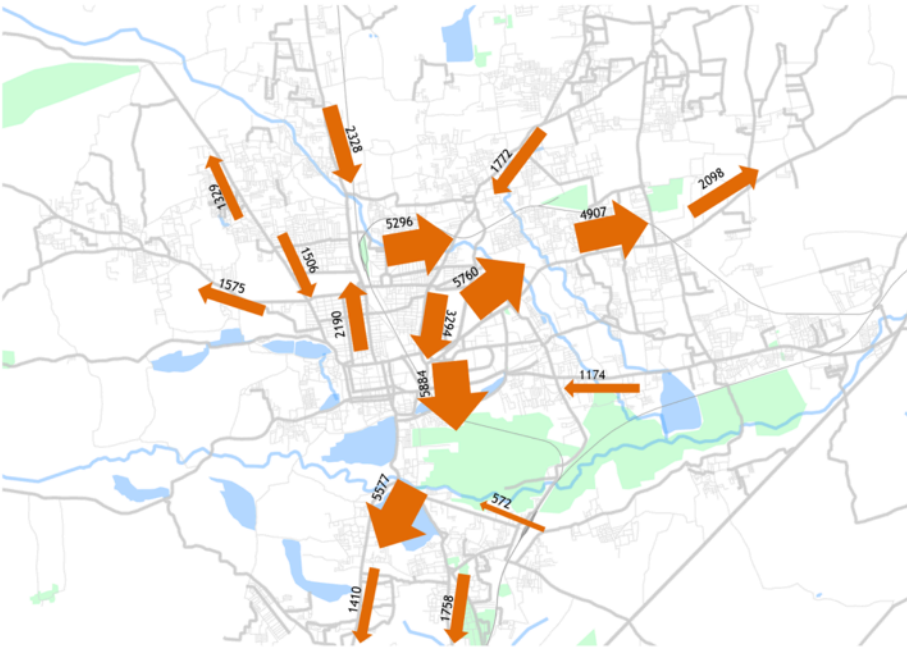


Figure 3: Key TNSTC routes (left) and observed peak period passenger volumes (pphpd).

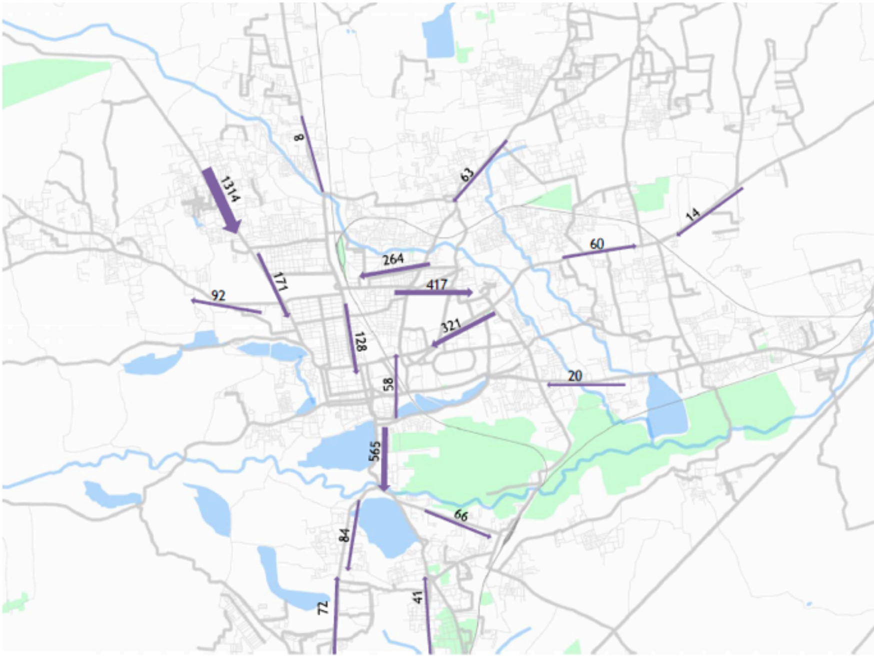


Figure 4: Observed peak period passenger volumes (pphpd).

The proposed Phase 1 BRT network comprises 74 km of dedicated BRT corridors and serves a large portion of the Coimbatore Metropolitan Region. Corridors were selected based on the following basic criteria:

- Current demand for travel based on existing TNSTC bus and shared auto rickshaw networks.
- Potential for future growth per Coimbatore's development plans. Need to connect high growth areas in the fringe to the city centre with high quality public transport.
- Opportunity to integrate with other existing modes of public transport.
- Existing public rights-of-way (ROW) for ease of implementation.

The Coimbatore BRT will be a closed system with a dedicated fleet. The following services will be provided:

- Trunk services. Operating entirely in dedicated BRT lanes.
- Trunk services with limited stops. Operating entirely in dedicated BRT lanes with increased spacing between stations
- Direct services. Operating in mixed traffic and then extended up to 3 km beyond the trunk corridor to provide better connectivity and attract ridership.
- Feeder services. Operating in mixed traffic, bringing passengers to terminals and stations on BRT trunk corridors.

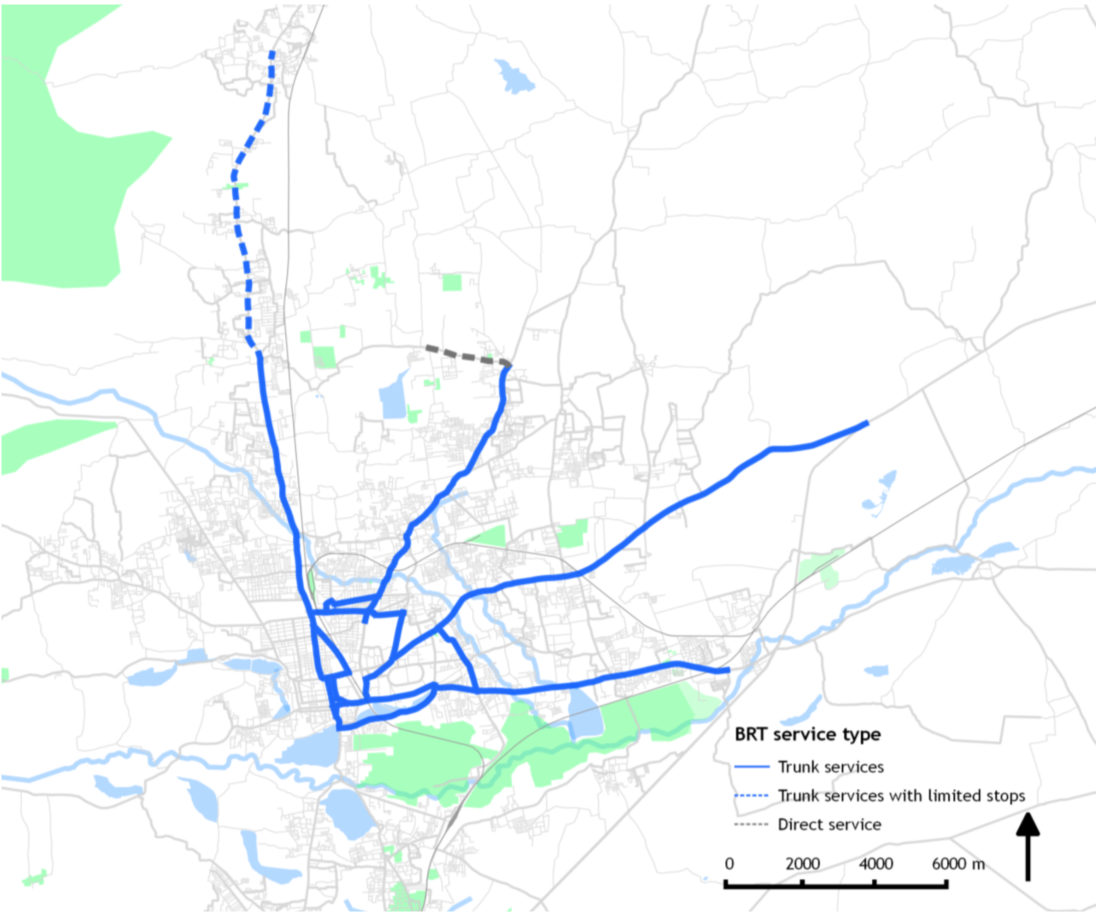


Figure 5: Proposed Phase 1 BRT alignment.

Considering the current demand and potential growth, the Phase 1 includes the following corridors:

- Mettupalayam Road from Ukkadam to Narasimhanaickenpalayam (23 km)
- Avinashi Road from Ukkadam to Nelambur (20 km).
- Sathyamangalam Road from Gandhipuram bus stand to Saravanampatty (15.6 km) with an extension to KCT Tech Park (1.6 km).
- Tiruchi Road from Ukkadam to Ondipur (15 km).

Phase 1 also includes feeder routes serving Ganapathy, Sanganoor, Saibaba colony, Vilankurichi, Sowripalayam, Venkittapuram, and R. S. Puram. A detailed service plan should be carried out to determine the precise routes and schedules. The Feasibility Study also identifies 41 km for Phase 2 BRT network by extending BRT service to Marudhumalai, Uppilipalayam, Eachanari, Thadagam Road, Palghat Road and other remaining corridors with considerable public transport demand.

1.5 Corridor designs

Conceptual corridor design, with cross-sections and plans, are provided in the full report. Figure 6 illustrates typical cross sections of the BRT corridors.

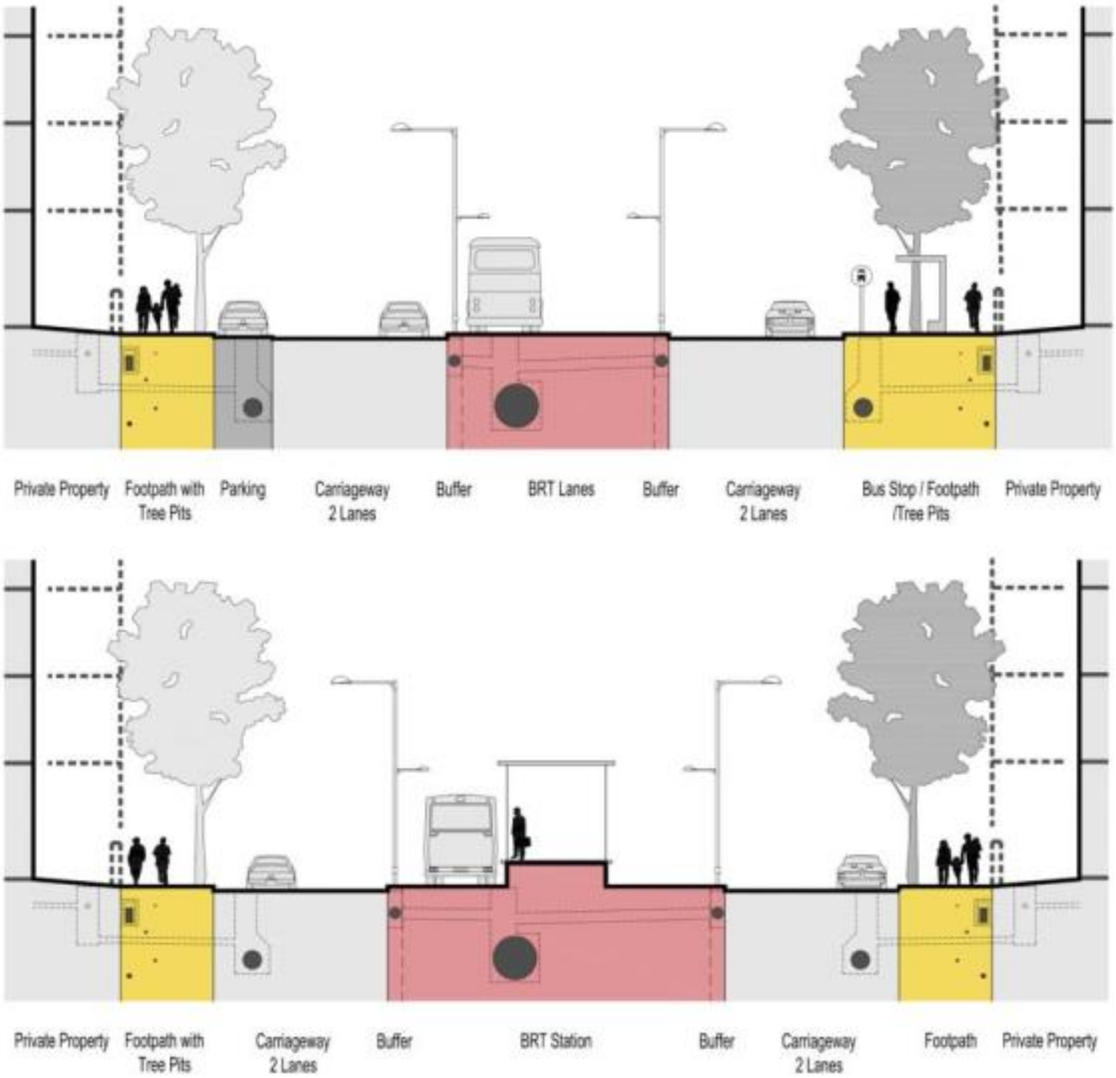


Figure 6: Typical 30 m BRT corridor sections: midblock (top) and station area (bottom).

The arterials roads of Coimbatore have varying ROW of 8 m to 30 m. Wherever the ROW is 30 m or above, it becomes easy to accommodate infrastructure such as: dedicated BRT lanes, BRT stations, protected footpaths, cycle parking, street furniture, landscaping and trees for shade, lighting, and storm water drainage without any land acquisition. In case of narrow widths, it will be possible to accommodate dedicated BRT lanes and stations with suitable designs provided.

The Coimbatore BRT will feature centrally located island stations that serve two-directional bus movement. The stations and buses both will have a floor height of 650 mm, allowing for step-less boarding. For Phase 1, the BRT fleet will consist of around 420 trunk buses (passenger capacity of 72 and 140) and 40 feeder buses (capacity of 60). The 12 m trunk buses will have doors on both sides, including two right-side doors providing level boarding at stations and two left side doors for stepped access to kerbside stops on the BRT extensions. The feeder and microbuses will have a low floor height (380 mm). The entire fleet will be air-conditioned. Given high passenger volume, Avinashi Road and Mettupalayam Road will need to introduce 18 m articulated buses in the first year. Stations, terminals, and depots should be designed to accommodate articulated buses without major structural modification.

1.6 Capital and operating cost

The total cost of implementing Phase 1 of the Coimbatore BRT is Rs 1,220 crores. This expenditure will be made over a period of 3 years. An initial allocation of Rs. 10 crores is required in FY 2015-2016 for creation of the SPV and hiring consultants for detailed design and public outreach. The remaining expenditure will be spread equally between the three subsequent financial years. Expenditure accounts include infrastructure creation, project monitoring, and outreach.

Table 2: Capital cost for the Coimbatore BRT

Component	Cost (cr Rs)
Corridors	920
BRT stations	63
Terminals and depots	75
ITS & control centre	40
Automatic doors	33
Consultancy	110
Total	1,220

1.7 Institutional arrangement

A BRT implementing agency, known as a "special purpose vehicle" (SPV) should be formed to oversee implementation. The SPV will plan, manage, and monitor BRT operations. Headed by the state Transport Department, the SPV will be executing body to supervise the implementation of BRT corridors and will have to enter into agreements for infrastructure construction with the line agencies that own each stretch of corridor (such as CCMC, the state Highways Department, and the National Highways Authority of India). The SPV also will have to coordinate with TNSTC, RTO, and Traffic Police.

Specific services like bus fleet operations and maintenance, IT services, and electronic fare collection would be procured by the SPV from amongst experienced service providers to ensure that service of the highest quality can be maintained at the lowest cost to the government. The SPV needs qualified, professional staff and the independence to make swift decisions during the implementation process. An IAS officer should serve as the CEO of the SPV and a Managing Director to oversee the daily operations and management. S/he will be supported by a competent team with specializations in the areas shown in Figure 7. A board chaired by the CCMC Commissioner will include Mayor, Standing Committee Chairman, and the Deputy Commissioner of Police for Traffic, the Regional Transport Officer, and a representative of the Urban Development Department to oversee the SPV.

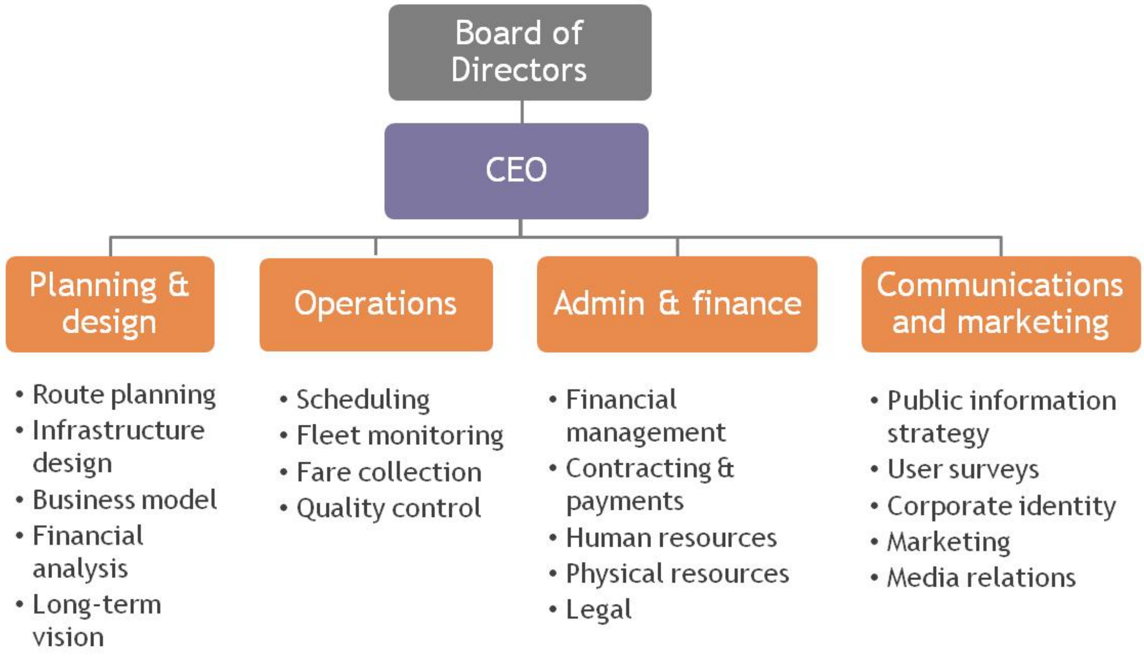


Figure 7: Structure for the special purpose vehicle for Coimbatore BRT.

1.8 Implementation timeline

BRT systems can be implemented in a short time period. Many systems take under three years from concept planning to start of operations. Since the detailed feasibility study has already been completed, it is possible to start the operations on the first two lines of the Coimbatore BRT system in three years and six months.

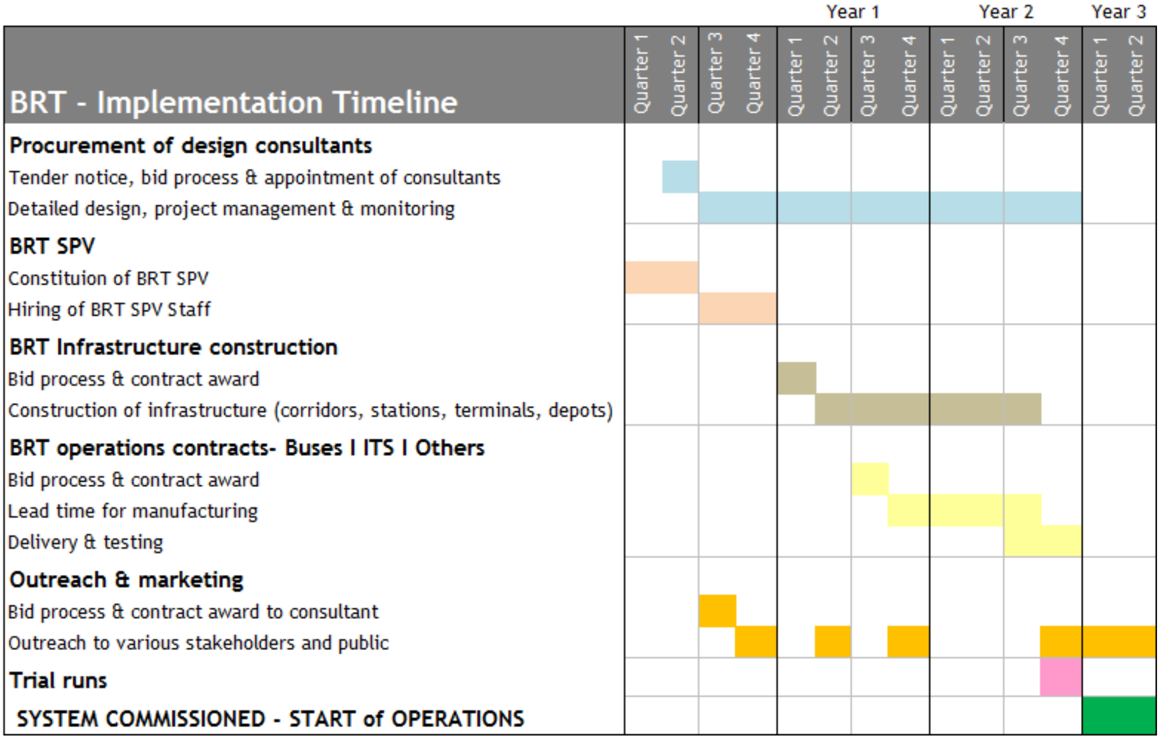


Figure 8: Suggested implementation timeline for Coimbatore BRT.

For implementing Coimbatore BRT, the following key steps will need to be taken up immediately in the first year:

- Hire consultants to developed detailed infrastructure designs (corridors, depots, terminal, etc.) and oversee project monitoring.
- A project monitoring committee is to be setup immediately for reviewing detailed designs, operational planning and implementation of BRT system. In due course of time, the committee shall be reconstituted to form a SPV under State Transport department for BRT operations.

2. Introduction

This mass transport feasibility study aims to provide answers for Coimbatore's sustainable development—to provide a development strategy that meets the needs of present Coimbatore without compromising the ability of the city's future generations to meet their own needs. Coimbatore stands at a crossroad of history and development. It has the potential to become a commercial and cultural centre and afford its citizens the possibility to reap immense benefits in the form of jobs, opportunities and improved quality of life. However, for this possibility to become a reality, Coimbatore will need to develop adequate infrastructure and services to facilitate the development and improve the quality of life of all citizens—rich and poor alike.

2.1 The path to sustainable mobility

Transport touches the life of people daily. A good transport system connects people and boosts the economy. It is sustainable—socially, economically, and environmentally. If not properly addressed, transport can become a nightmare, with traffic jams and long travel times leading to frustration and reduced productivity. Citizens are exposed to high levels of pollution, leading to poor health, and lack of vitality.

Too often, transport planning has tended to concentrate on infrastructure, traffic, costs, and benefits, with environmental factors limited to engineering consideration. Transport planners increasingly believe that mobility planning should focus the movement of "people, not vehicles," a goal clearly expressed in the National Urban Transport Policy (NUTP).[2] The Ministry of Urban Development (MOUD), Government of India, supports this approach, which is a major departure from the emphasis on personal motorised modes in traditional traffic and transport studies.

Figure 9: Much of Coimbatore's transport infrastructure prioritises private motor vehicles and does not provide adequate facilities for other road users. Transport planning should provide safe and efficient mobility to all—not just for personal motor vehicle users.

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[2] Ministry of Urban Development (2006), "National Urban Transport Policy," <http://www.urbanindia.nic.in/policies/TransportPolicy.pdf>.

To meet the above aims and objectives, this study emphasizes a development path for Coimbatore that follows a set of widely accepted principles of integrated land use and transport, collectively known as transit-oriented development (TOD). At its core, TOD recognizes that successful transport systems cannot be planned separately from the land use context. The following principles describe the key ideas behind TOD: [3]

- **Walk**: Promote walking through the provision of high quality, continuous walkways and improve the safety of the public realm through active building frontage.
- **Cycle**: provide continuous networks of dedicated facilities to improve the safety and convenience of travel by cycle and cycle rickshaw.
- **Connect**: create dense networks of streets and paths that reduce walking distances.
- **Public transport**: locate development near high-quality public transport.
- **Mix**: plan for a vertical and horizontal mix of uses to reduce trip lengths.
- **Densify**: match density and public transport capacity.
- **Compact**: ensure that the majority of development can happen within walking distance of high quality public transport rather than in peripheral locations.

When addressed together, these urban development principles foster efficient spatial configurations that enable high-quality, and car-independent lifestyles. The focus of transportation policy is increasingly on reducing greenhouse gas emissions, air pollution, traffic congestion, injuries and deaths from vehicle crashes. The potential for TOD is to reduce the volume of total travel, measured as vehicle-kilometres travelled (VKT). TOD often results in replacing motorised vehicle trips by encouraging shifting travel modes to walking, cycling and public transport. Thus, these developments mean safer journeys, reduced air pollution, less congestion, and less time wasted in traffic.

[3] http://www.todstandard.org

Figure 10: Elements of transit-oriented development (TOD)

2.2 About this report

Under a Memorandum of Understanding with Commissionerate of Municipal Administration, Government of Tamil Nadu, the Institute for Transportation and Development Policy (ITDP) is assisting the former on planning and implementation of sustainable transport systems and best urban development practices in Coimbatore. This report aims to provide a clear analysis of Coimbatore's potential for implementing a high-capacity mass rapid transport system. It will provide a detailed description of how high quality transport systems can play a key role in meeting existing and future transport demand in the city. The ultimate goal of the report is to be a useful reference for decision-makers to serve as the basis for applying for central government funding for advancing Coimbatore's urban development.

2.3 About the Institute for Transportation and Development Policy

ITDP is an international non-profit organization that promotes sustainable and equitable transportation worldwide. ITDP is acknowledged as an expert in the field of sustainable urban transport planning. ITDP has been collaborating with state and city governments to improve urban mobility through creation of high quality public transport systems, complete streets that prioritise non-motorised transport, and travel demand management. ITDP has been closely involved in the development of many BRT systems worldwide, most recently in Ahmedabad (India), Guangzhou (China), and Johannesburg (South Africa), that are regarded as best practice examples of BRT implementation and operations.

3. Transport in Coimbatore

3.1 City overview

Coimbatore, popularly known as the “Manchester of South India,” is the second largest city in the Indian state of Tamil Nadu. The City is the district headquarters and is well known for its textile and automobile industries. The city is also an emerging hub for information technology-related industries. Due to its close proximity to the Western Ghats, Coimbatore has pleasant climate throughout the year.

Coimbatore is well connected to other parts of the state by road, railways, and air. The city is well positioned at the junction of major roads from Tamil Nadu, Kerala, and Karnataka. Three National Highways pass through the city: NH-47 (Kanyakumari-Salem), NH-67 (Coimbatore-Nagapattinam), and NH-209 (Bengaluru-Dindigul). The hill station Ooty is only 90 km from the city and is easy to reach by road and mountain rail service throughout the year.

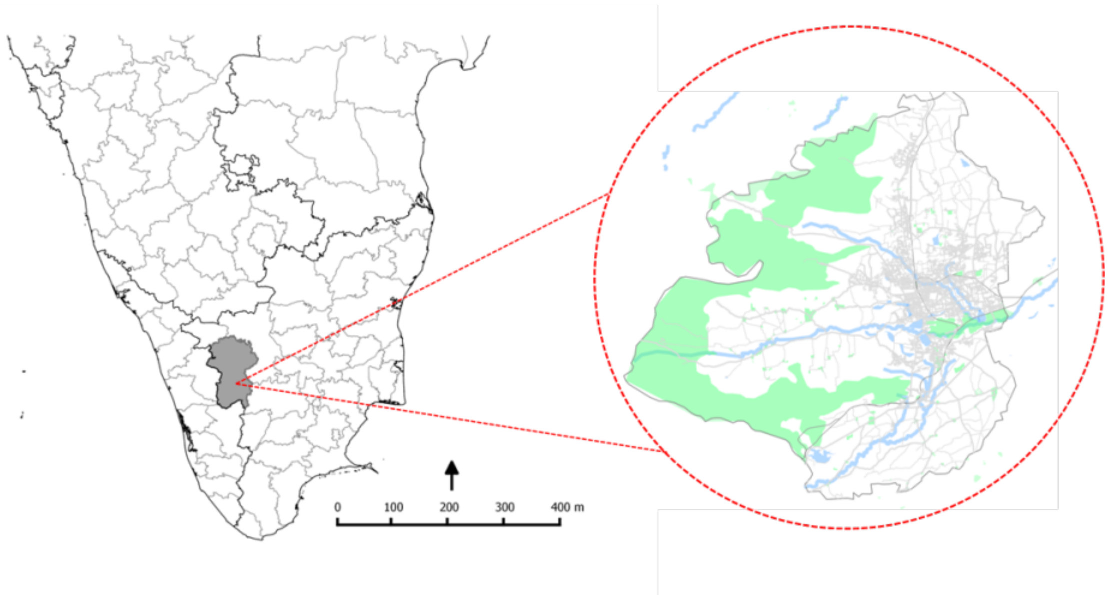

Figure 11: Tamil Nadu including Coimbatore District (left) and the Coimbatore Local Planning Area boundary (right).

According to the 2011 census, Coimbatore metropolitan area had a population of 2.2 million.[4] Coimbatore’s population is set to grow to nearly 3.8 million by 2031.[5] With increasing population, the city is witnessing rapid motorisation, increased congestion and pollution. With suitable interventions at this stage, it can avoid the pitfalls of cities of similar characteristics and can set high standards for other cities to follow. Coimbatore has a population density of only 34 persons per hectare, indicating that there is potential to increase densities and achieve a more compact city form as the city grows. [6]

The Coimbatore Municipal Corporation (CCMC) is the authority responsible for planning and service provision in the city. Headed by a Municipal Commissioner, CCMC utilises eleven departments to

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[4] http://www.census2011.co.in/census/city/492-coimbatore.html
[5] Assuming a growth rate of 2.95 per cent per year.
[6] The area of the metropolitan region is 64,212 ha. Source: http://en.wikipedia.org/wiki/Coimbatore

carry out civic operations. CCMC's Engineering Department is responsible for maintenance of Coimbatore's 2,376 km of roads as well as its schools, public toilets, community temples, and health clubs.[7] The Town Planning Department is responsible for the planning activities, including sanctioning plots for construction, identifying encroachments based on complaints, sanctioning Transfers of Development Rights, and preparing survey maps. Town Planning manages the reserved buildings and land, and is the decision making body regarding how land is allocated for various purposes.

3.2 Current transport conditions

3.2.1 Walking and cycling

Coimbatore has some moderate quality footpaths on streets including T. V. Swamy Road and D. B. Road. In addition, there is a high quality walkway along the Race Course. However, footpaths are narrow or completely absent on most streets in the city. Where present, footpaths are often encroached by electrical boxes, poles, and parking. Busy market streets, such as NSR Road and the Town Hall road, as well as major public transport corridors, such as Trichy Road and Avinashi Rd, lack safe and continuous footpaths, cycling tracks, and pedestrian crossings.

Figure 12: Existing footpaths are narrow and obstructed (left). In the absence of dedicated cycle tracks, cyclists are forced to travel in mixed traffic (right).

3.2.2 Public transport

Presently, most public transport in Coimbatore comprises bus services operated by the Tamil Nadu State Road Transportation Corporation (TNSTC) and privately owned bus operators. The remaining trips are made via privately owned and operated shared auto-rickshaws. TNSTC reports a current fleet size of 632 buses with 619 services, supplemented by a fleet of 300 privately owned buses.[8] Together, these buses ply on 322 routes.[9] With growing congestion, buses are no longer fast or reliable in areas like Town Hall, Tiruchi Road, and Gandhipuram. Some areas, such as Kamaraj Road, are underserved by the existing buses, while corridors such as Tiruchi Road are not sufficiently interlinked with other parts of the city.

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[7] http://www.coimbatore.tn.nic.in/pdf/SHB043.pdf
[8] TNSTC data 2013
[9] http://tellmyroute.com/Coimbatore/Directions/Saravanampatti/Gandhipuram#Gandhipuram

Figure 13: Bus services and facilities are poorly organised and the aging bus fleet suffers from inadequate maintenance.

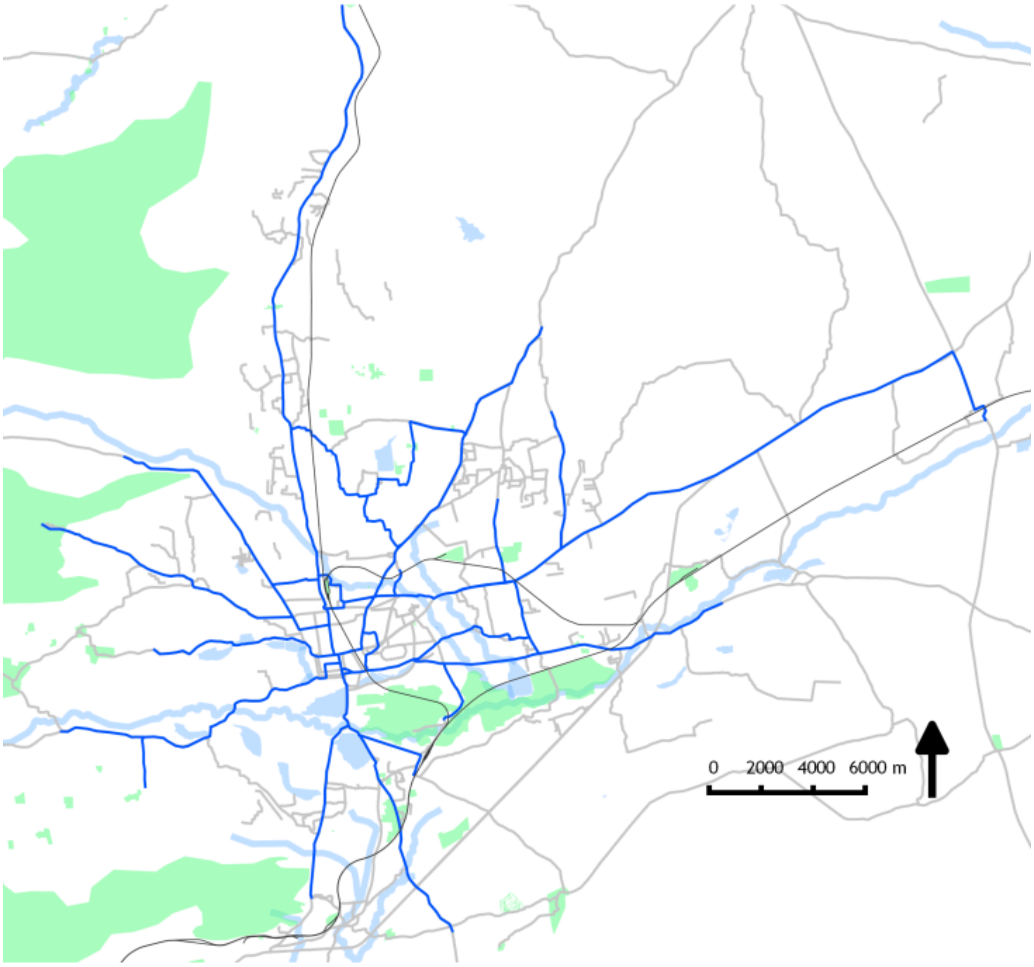

Figure 14: Existing city bus routes in Coimbatore.

The bus services generally operate efficiently but get very crowded at times due to poor frequency. Major parts of the bus network, including stretches of Avinashi Rd, Sathyamangalam Rd, and

Mettupalayam Rd, suffer from slow speeds of under 18 km/h, with even slower speeds in the core area including Town Hall, Big Bazaar, and Oppanakara Street (Figure 15).

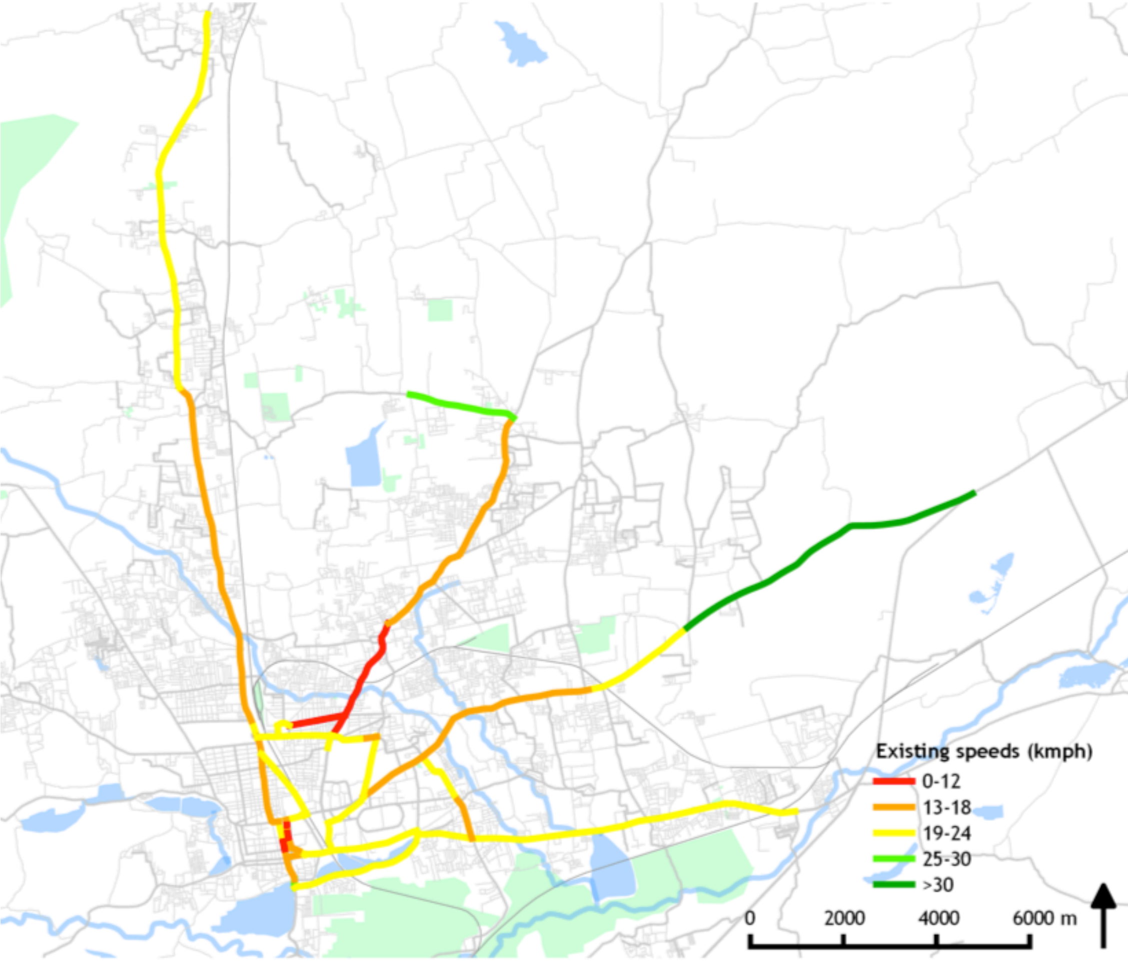

Figure 15: Existing speeds for public transport.

As seen in **Error! Reference source not found.**, nearly 204 buses are more than six years old and are in poor condition. These buses need to be replaced with new buses.

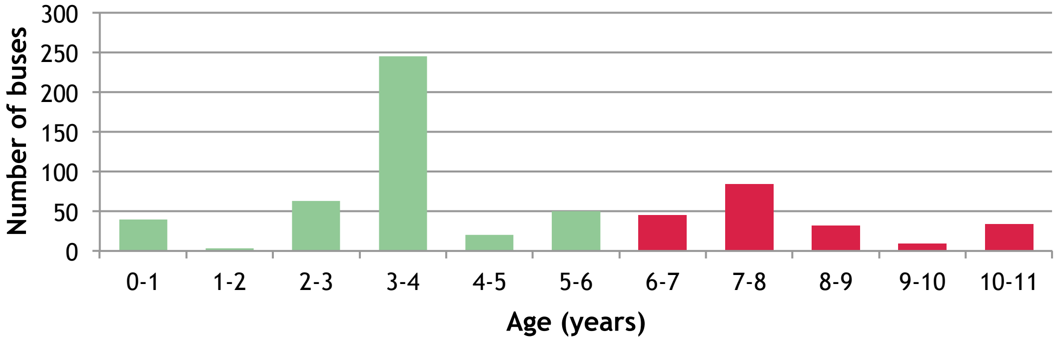

Figure 16: Age of TNSTC buses in 2013.[10]

The fare for TNSTC city buses starts at a minimum of Rs. 3 and increases to a maximum of Rs. 25. There are two service types, ordinary and deluxe. Ordinary services are operated with high floor buses, while deluxe services are operated with semi-low floor buses and have a higher fare. Both types of buses are inaccessible to persons with disabilities. Due to the low fares in ordinary services, these buses are typically overcrowded during peak hours, resulting in delays.

3.2.3 Parking

The supply of parking plays an important and unique role in the demand for travel as well as the basic functioning of transport system. Free parking in particular has adverse effects on public transport as it facilitates more and more usage of personal vehicles. Free parking or pricing below market rates is the leading cause of parking shortages, haphazard parking, pollution, and congestion due to extra driving in search of parking space. It is very necessary that local administrative bodies take control of public street space by managing parking as a service that comes with a price.

Free on-street parking is the norm in Coimbatore. Double parking is common despite the presence of no parking zones in busy commercial areas such as Raja Street, N. H. Road, and Town Hall. Parked vehicles often occupy one or more lanes of the carriageway. This reduction in effective width results in congestion and traffic jams. Congestion from poorly managed parked vehicles not only reduces carriageway widths, but it also hampers the mobility of all vehicles (especially public transport), increasing travel times and emissions secondary to vehicle idling. Traffic police in Coimbatore do not have sufficient vehicles or personnel to enforce parking restrictions.

[10] TNSTC data, 2013.

Figure 17: Free, unorganised on-street parking in Coimbatore: D.B.Road (left) and T.V.Swamy Street (right).

3.3 Prior studies

A Comprehensive Mobility Plan (CMP) was carried out in 2007 for Coimbatore to identify transport interventions for the city. The CMP conducted surveys of 15 per cent of households and traffic volume counts at 34 locations. The CMP found that non-motorised and public transport modes are the dominant means of transport in the city. However, the CMP estimated that there would be a 34 per cent reduction in public transport trips by 2031 under a business-as-usual scenario.

The CMP identified the following issues concerning Coimbatore's transport system:

- Poor pedestrian infrastructure.
- Limited public transport services and low public transport mode share.
- Lack of effective parking management mechanisms.
- Environment deterioration due to motorised traffic.

In response to these issues, the CMP proposes some measures to prioritise public transport, NMT modes, and travel demand management. However, the bulk of the recommendations in the CMP consist of road improvements and flyovers in the short and medium terms, while mass rapid transit is only proposed for subsequent phases. CMP has proposed the following improvement measures, categorised broadly into three phases for Coimbatore:

- Short term
    - Traffic management measures
    - Junction improvements at 10 locations
    - Roadway improvements on 19 streets with footpath upgrades on 9 streets
- Medium term
    - Missing links connectivity to improve bus transport coverage, better circulation on 12 roads.
    - Flyovers at 5 intersections
    - Road over bridges at 5 locations
    - Pedestrian subways at 18 locations

- Road widening schemes on 9 major roads.
- Long term
  - Ring roads, both inner and outer.
  - Multi-level parking facilities at 14 locations
  - Bus terminals at 4 potential locations
  - Truck terminals at 6 locations
  - Mass rapid transit solutions such as BRT, metro rail, and monorail.

The CMP recommends continuous and safe paths, facilities for safe crossing, and segregated cycle lanes, but the investment plan focuses on grade-separated facilities.

As part of the long-term plan, the CMP recommends mass rapid transit solutions, including BRT in the first phase. The CMP identifies a 17.6 km corridor from Avinashi Road to Mettupalayam through 100 Feet Road. Depending on road width, the CMP proposes a combination of both at grade and elevated corridors (Figure 18).

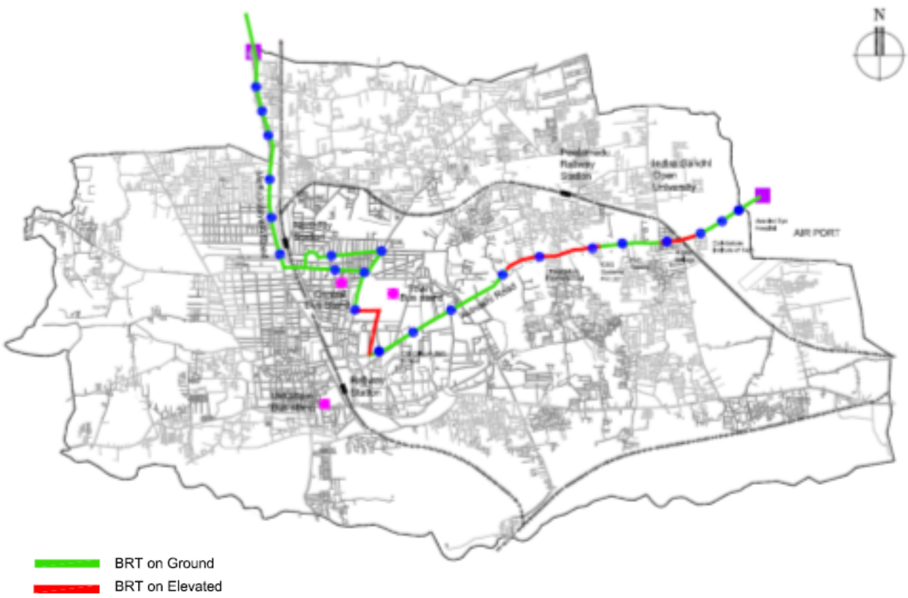

Figure 18: BRT corridors proposed in the Coimbatore CMP

It should be noted that the CMP uses vehicle counts as the primary criterion—not existing public transport and paratransit passenger volumes—to evaluate the corridors for BRT. Documenting existing public transport passenger volumes per corridor is the primary information required to assess the public transport demand during peak hour. These are considered critical because they determine the size of the infrastructure that is required to prevent overcrowding when the system experiences highest demand.

The CMP recommended 66 buses to provide BRT services along the identified corridor with a headway of 1 minute during peak hours. Feeder routes were identified where smaller vehicles such as minivans and taxis will provide service. The CMP also recommends integration of BRT with pedestrian and cycling facilities, paratransit, buses, and trains. The total cost estimated for phase 1 is Rs. 383 crores (excluding the purchase costs of buses).

Since most of the project corridors belong to highways department, the CMP recommends a committee to be formed for project implementation. However, the CMP does not identify the government agencies involved and their respective responsibilities to implement, operate, and manage a BRT system.

In addition, the study also recommends the following corridors for phase 2 MRT

- Trichy Road
- Sathyamangalam Road
- Sanganur Drain
- Proposed Ring Road

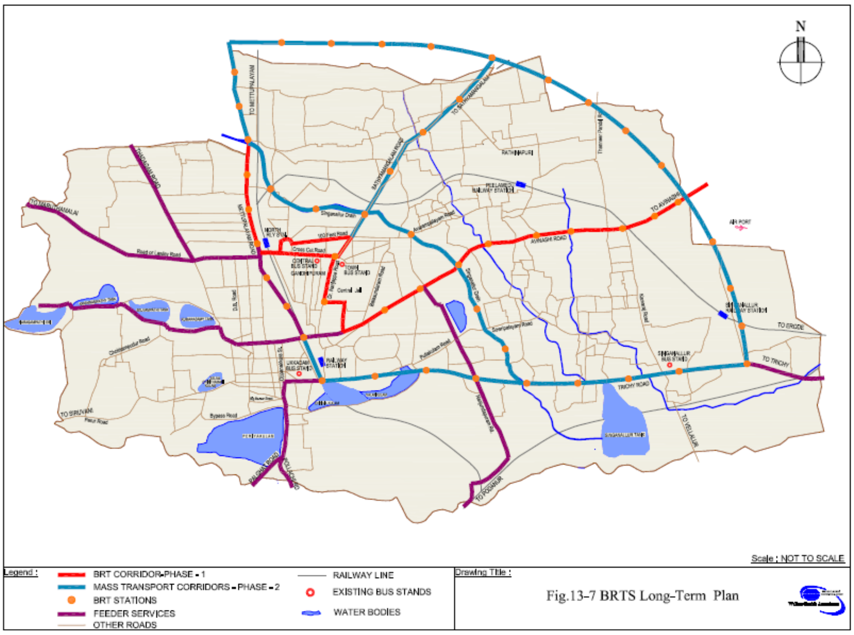

Figure 19: Proposed phase 1 and 2 rapid transit corridors.

Other rapid transit options such as metro rail and monorail are also being considered in Coimbatore. The Government of Tamil Nadu announced an effort to prepare a feasibility study for monorail, and the Indian Chamber of Commerce and Industry, Coimbatore, along with Resident Awareness Association of Coimbatore have consulted former Delhi Metro Rail Corporation head E. Shreedharan to discuss the potential for implementing a metro in Coimbatore. [11,12]

At the time of writing the feasibility report, a new CMP is being prepared for Coimbatore's extended LPA boundary.

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[11] http://timesofindia.indiatimes.com/city/coimbatore/Coimbatore-takes-a-step-towards-monorail/articleshow/27316694.cms
[12] http://www.thehindubusinessline.com/news/states/indian-chamber-pitches-for-infra-development-projects-for-coimbatore/article6271866.ece

4. On-going projects

Several on-going transport projects in Coimbatore, mostly led by CCMC, seek to promote the use of sustainable transport modes in the city. Key initiatives include the Model Roads Programme, the pedestrianisation of Big Bazar Street, IT-based parking management, and greenways.

4.1 Model Roads Programme

CCMC seeks to implement a network of streets with high quality walking and cycling facilities, improved access to public transport, organised parking, and streamlined junctions under the Model Roads Programme. The objective of the Model Roads Programme is to ensure equitable allocation of road space to walking and cycling—collectively known as “non-motorised transport” (NMT). In the first phase, CCMC plans to redevelop seven streets with a combined length of 9.1 km (Table 3:).

Table 3: Streets identified for phase 1 of the Model Roads Programme

Street name	From	To	Length (km)	Width (m)
Raju Naidu Street	Power House Road	Sastha Infotech	1.2	> 20
V.K.K Menon Road	Kerala State Road Transport Corporation	P.N Palayam Junction	1.0	≤ 20
Diwan Bahadur Road	Forest College Quarters	Gandhi park/Kaliamman kovil	1.6	≤ 20
TV Swamy St	Thadagam Rd (RS Puram)	Mettupalayam Road	1.1	≤ 20
Alagesan Road	Thadagam Road	Murugan Mills bus stop	1.6	≤ 20
Kamarajar Road	6th Street	Apex Roller Mills/Eru Company BS	0.7	≤ 20
NSR Road	Venkittapuram	Saibaba Kovil	1.8	≤ 20

Figure 20: D. B. Road, part of the Model Roads Programme: existing (left) and proposed (right).

4.2 Parking management

4.2.1 On-street parking management

CMC proposes to implement a modern parking system to improve parking operations, optimise usage of the available parking supply, and enhance the overall functioning of streets in the city. The new parking system will employ information technology (IT) elements as a backbone to facilitate greater transparency and efficiency in the collection of parking fees and enforcement operations. In phase 1, CCMC has identified five parking zones covering around 33 km of roads for paid parking (Figure 21:).

Figure 21: On-street parking management zones.

4.2.2 Multi-level parking facilities

CCMC plans to construct off-street parking facilities at three locations. Detailed reports have been prepared for constructing multilevel parking facilities at Town Hall, D. B. Road and Cross Cut Road, but construction is yet to commence. Since two of these facilities fall on proposed BRT corridor, they will provide an opportunity to accommodate displaced vehicles from on-street to off-street parking locations, thereby freeing up road space for NMT facilities such as footpaths and cycle tracks.

4.3 Greenways

Coimbatore city has around three-dozen lakes, including Perur Lake, Periya Kulam, Kurichi Lake and Valan Kulam. [13] Besides these, there are two major river channels called Sanganurpallam and Noyal, which traverses from north to south. Under present conditions, some of the lakes like Ukkadam and

[13] http://timesofindia.indiatimes.com/city/coimbatore/A-slow-death-for-Coimbatore-lakes/articleshow/18298073.cms

Kurichi at the verge of destruction due to encroachments by illegal housing and other activities. Similarly, the river canals are polluted by inlet of sewage water and garbage regularly.

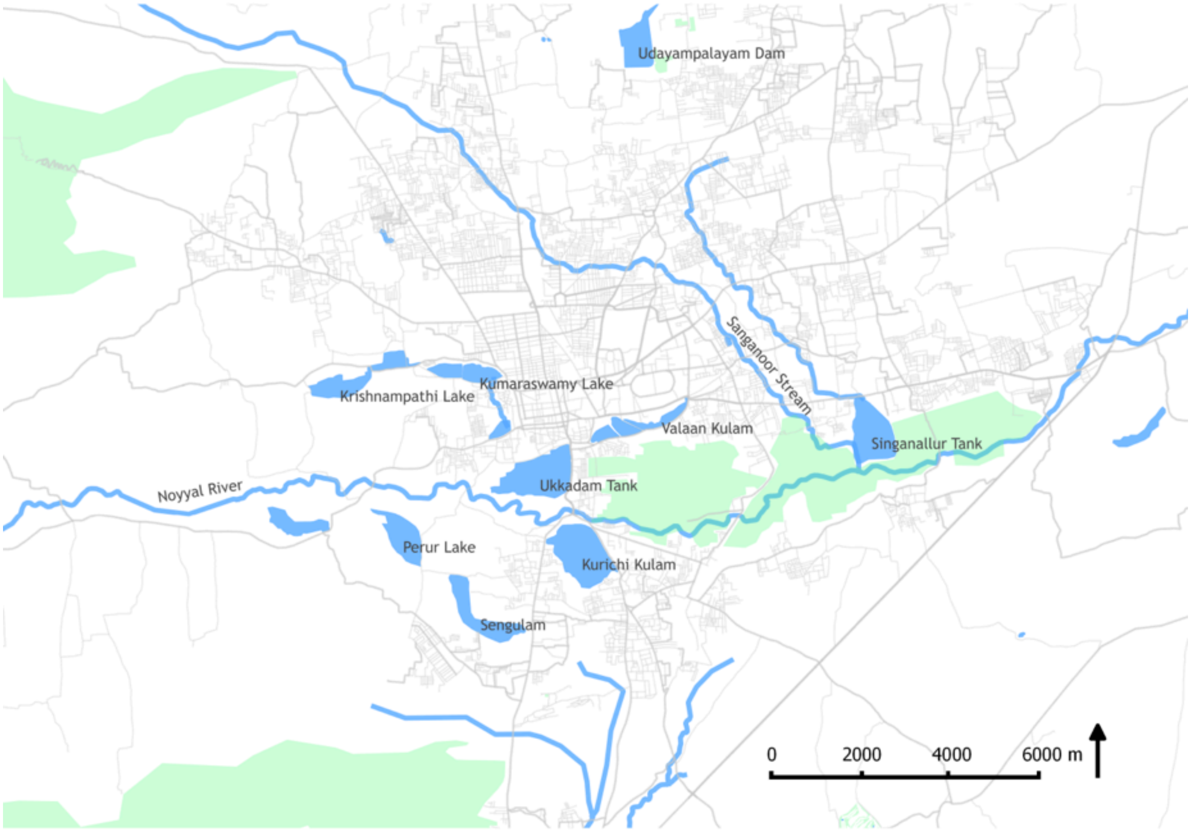


Figure 22: Major lakes and water bodies in Coimbatore.

To restore these lakes and waterways, CCMC had assumed responsibility for eight lakes from the Public Works Department. Of these lakes, six lakes along with Sanganoor stream were identified for a greenway proposal as a means to preserve and prevent further encroachments (Figure 23). These greenways provide an opportunity for creating recreational spaces and improve mobility for all NMT users. The greenways along the river are appropriately proposed to act as feeder routes to the BRT corridor.

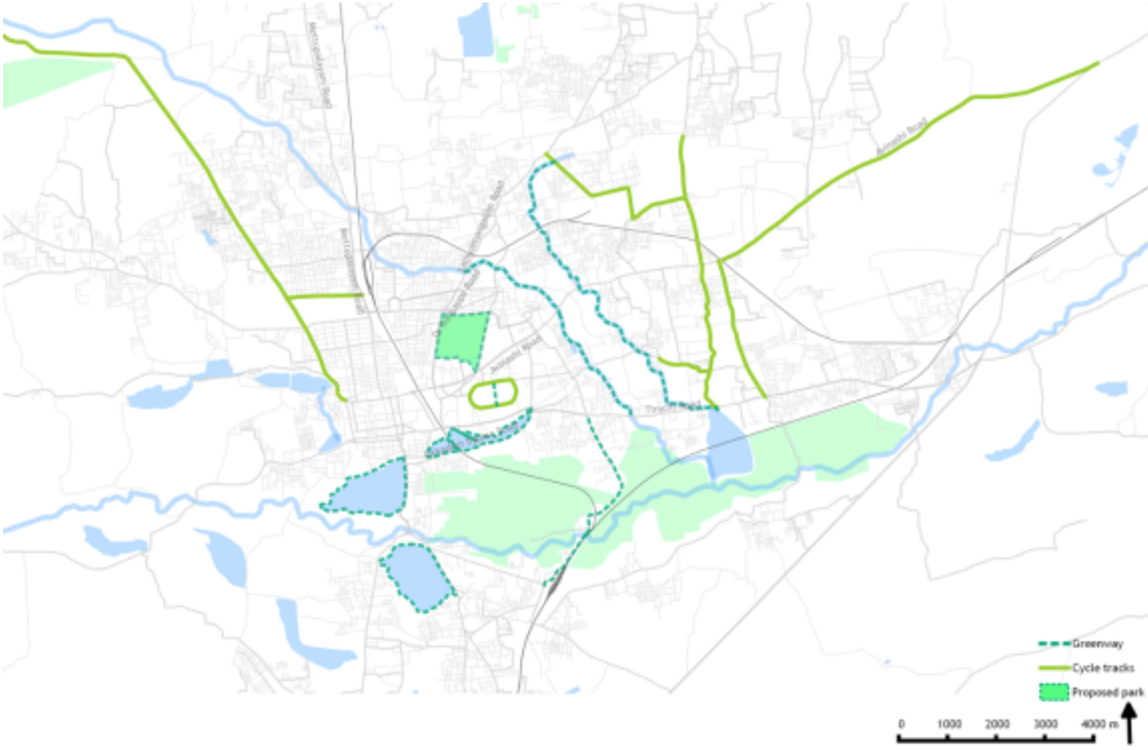


Figure 23: Proposed 37 km of greenway for Coimbatore.

Figure 24: Greenway on the bank of Perur Lake: existing (top) and proposed (bottom).

5. Vision and goals

5.1 Transport scenarios for Coimbatore

In partnership with ITDP, the Commissionerate of Municipal Administration (CMA) launched the Sustainable Cities through Transport (SCTT) programme to address the mobility issues in tier-2 cities like Coimbatore. In view of the NUTP's goal of moving people, not vehicles, SCTT participants identified ways to improve public transport, support walking and cycling, improve safety, enhance public transport accessibility and improve air quality.

It is important to recognise the trajectories of Coimbatore's population and vehicle ownership. While the current population is about 3.3 million, the city is expected to grow to nearly 6.5 million by 2031. This increase in population will have a significant effect on mobility of people in Coimbatore. The number of personal motor vehicles is growing at a brisk pace of 10 per cent per annum. If this growth continues, ITDP estimates that the number of trips made by personal motorised modes will increase by 19 per cent over the next 15 years. This scenario also assumes that Coimbatore's existing public transport fleet is not expanded and that pedestrians and cycle mode shares continue to decline. Accommodating the anticipated increase in personal motor vehicle use will pose the challenge of managing increased congestion, pollution levels, and fatalities from traffic collisions.

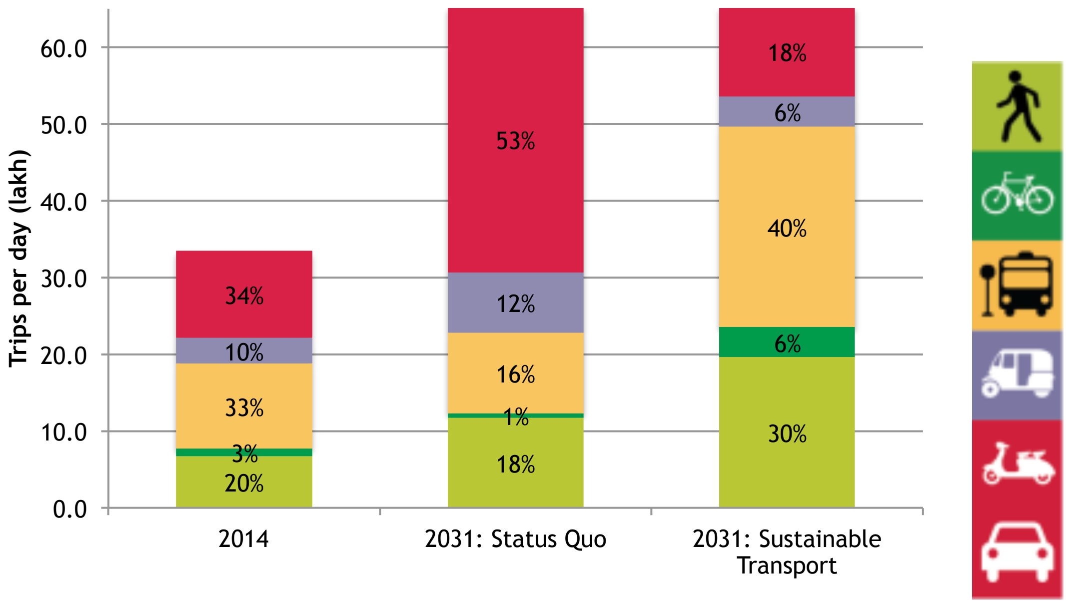


Figure 25: If existing trends continue, Coimbatore will see a doubling in the number of daily motor vehicle trips ("Status quo"). If Coimbatore invests in better public transport and non-motorised transport facilities, these trends can be reversed ("Sustainable").

Sustainability is defined as meeting the needs of the present without compromising the ability of future generations to meet their own needs. To meet that end, it is important to invest in transportation alternatives that move large numbers of people efficiently, at a low cost, and with low environmental externalities. Per ITDP's calculations, even if all of Coimbatore's main roads are transformed to include elevated corridors on top, there will not be enough capacity to meet the anticipate 2031 demand.

Participants in the SCTT process felt that better way to accommodate anticipated demand is to invest in a robust, high-capacity, mass rapid transport (MRT) system. Under the sustainable scenario, the city implements an MRT mode, bus rapid transit (BRT), to meet future transport needs. With increased investment in public transport two outcomes are likely: (A) an increase in the public transport mode share, and (B) a reduction in mode shares for paratransit and private motor vehicles. These simple calculations are very helpful in understanding the potential impacts of transport investment priorities. BRT meets projected 2031 demand and offers the possibility of future expansion to accommodate further increases in travel demand. The following diagram (Figure 26) illustrates the differences of capacity and cost between the status quo and sustainable scenarios.

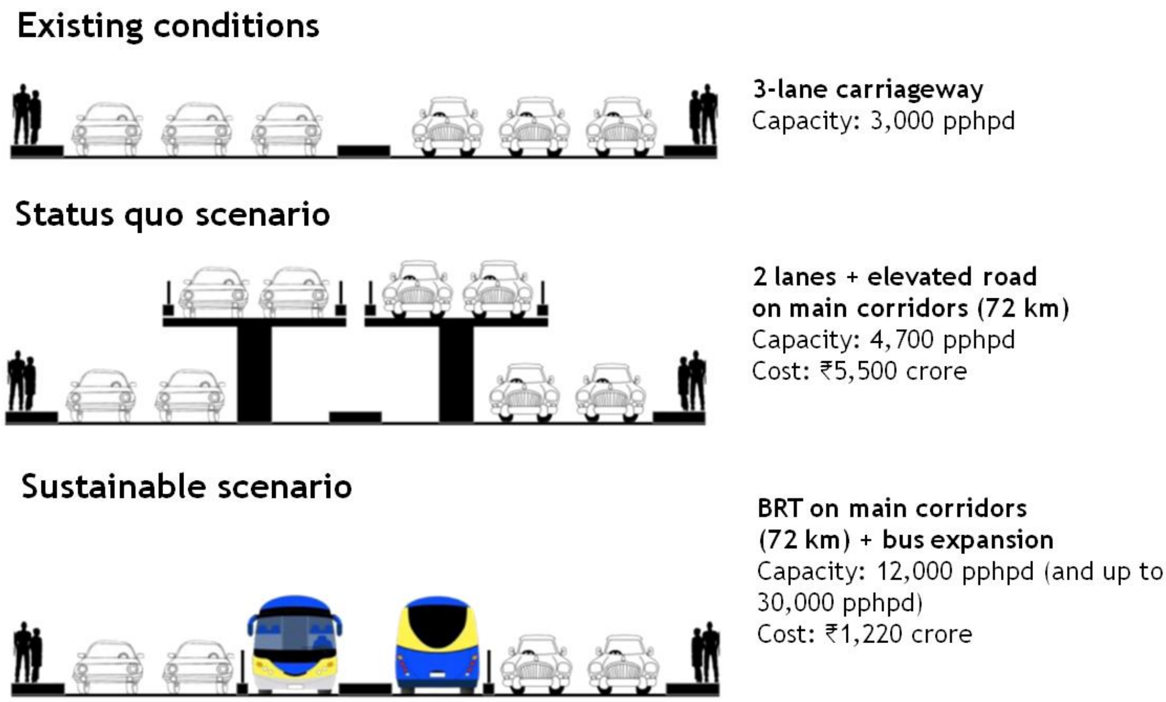


Figure 26: Accommodating increased demand—can we just expand the roads?

Returning to SCTT participants' adopted goal of moving people, not vehicles, the sustainable scenario provides an appropriate way to move forward as it has significant advantages over the status quo in both capacity and cost effectiveness. Table 4 displays the mode shares under the two possible scenarios.

Table 4. Mode share shift under alternate scenarios in 2031

Mode	2014	2031: Status quo	2031: Sustainable
Walk	20 %	18 %	30 %
Cycle	3 %	1 %	6 %
Bus	33 %	16 %	40 %
Paratransit	10 %	12 %	6 %
Private vehicles	34 %	53 %	18 %

SCTT participants agreed on specific goals to help the city achieve the sustainable scenario outlined in the previous table. The following benchmarks should be achieved by 2031:

- **Support Non-Motorised Transport (NMT)**. 36% of all trips by cycling and walking
- **Improve public transport**. 40% of all trips by public transport and 6% by paratransit mode
- **Public transport accessibility**. 75% of residents within a 5 min walk of formal public transport
- **Improve safety**. Zero fatalities per year from traffic crashes or public transport accidents
- **Keep Coimbatore air healthy**. Zero nonattainment days for PM and NO_x emissions

Achieving these goals will require a detailed planning process along with regular monitoring and evaluation to determine whether Coimbatore is on target to meet these benchmarks. Any effort to implement a mass transport system for the city must include a vigorous regime of data collection and performance measurement, so that operations and planning efforts are supported by quantifiable outcomes. Such performance-based planning efforts provide a robust structure to support system improvements and corrections.

6. Planning for mass rapid transit

6.1 MRT background

Mass rapid transit (MRT) is defined as publicly accessible transport in urban areas that can transport a large number of people from one place to another. The selection of appropriate MRT modes is driven by factors such as the potential passenger market for public transport, the trip patterns of prospective users, and other socio-economic criteria. When a planning body has to make decisions regarding which mode should be utilised to serve a community, it must base this decision on the following criteria:

- Ability of the mode to meet demand;
- Implementation cost;
- Environmental impact;
- Social equity impact;
- Cost to user;
- Journey time;
- Travel safety;
- Factors of comfort and convenience including the number of interchanges and system Accessibility
- Flexibility
- Reliability; and
- Degree of implementation complexity and technical sophistication.

Ultimately, the right choice of public transport solution is governed by local circumstances requiring comprehensive examination of alternatives on an objective basis.

6.2 Coimbatore corridor demand

To assess potential demand for MRT service in Coimbatore, ITDP completed a detailed analysis of travel patterns in Coimbatore. First, the key routes and public transport passenger volumes were mapped to determine existing patterns of use and travel demand (Figure 14). Frequency-occupancy surveys of TNSTC bus and shared auto rickshaw passengers were conducted at twenty locations during the morning peak period to estimate passenger volumes on major corridors (Table 5, Figure 27). While the TNSTC data illustrate key corridors and high demand services, the full transport network is only revealed when patterns and passenger volumes of paratransit are considered.

Passengers on buses and auto-rickshaws constitute most of the potential users of an MRT system. In addition, some motorised two-wheeler and car users are likely to switch to public transport in the short term if presented with an improved service, but these passengers will represent a limited fraction of total MRT ridership. Based on the experiences of BRT systems in Ahmedabad and other cities, it is estimated that at least 10 per cent of BRT passengers are likely to come from private modes. Therefore, ridership patterns of buses and paratransit can provide a fairly robust starting point for planning corridors and services on the proposed MRT system.

Table 5: Survey locations for frequency occupancy counts

Road name	Locations
Avinashi Road	Hope college bus stop Lakshmi mills bus stop Coimbatore Rly junction
Mettupalayam Road	Kavundampalayam bus stop TVS Gate Poo market
Tiruchi Road	Olymbus bus stop Rajalakshmi mills bus stop
Sathyamangalam Road	Ganapathy bus stop
100 Ft Road	Gandhipuram bus terminal Near Power house
Thadagam Road	Lawley road bus stop St John Britto church TNAU gate Gandhi park
Ukkadam	Ukkadam city bus stop Ukkadam bus stand
Palghat road	Anandhas bus stop Shadi Mahal bus stop
Palakkad road	Bus stop near RKV school

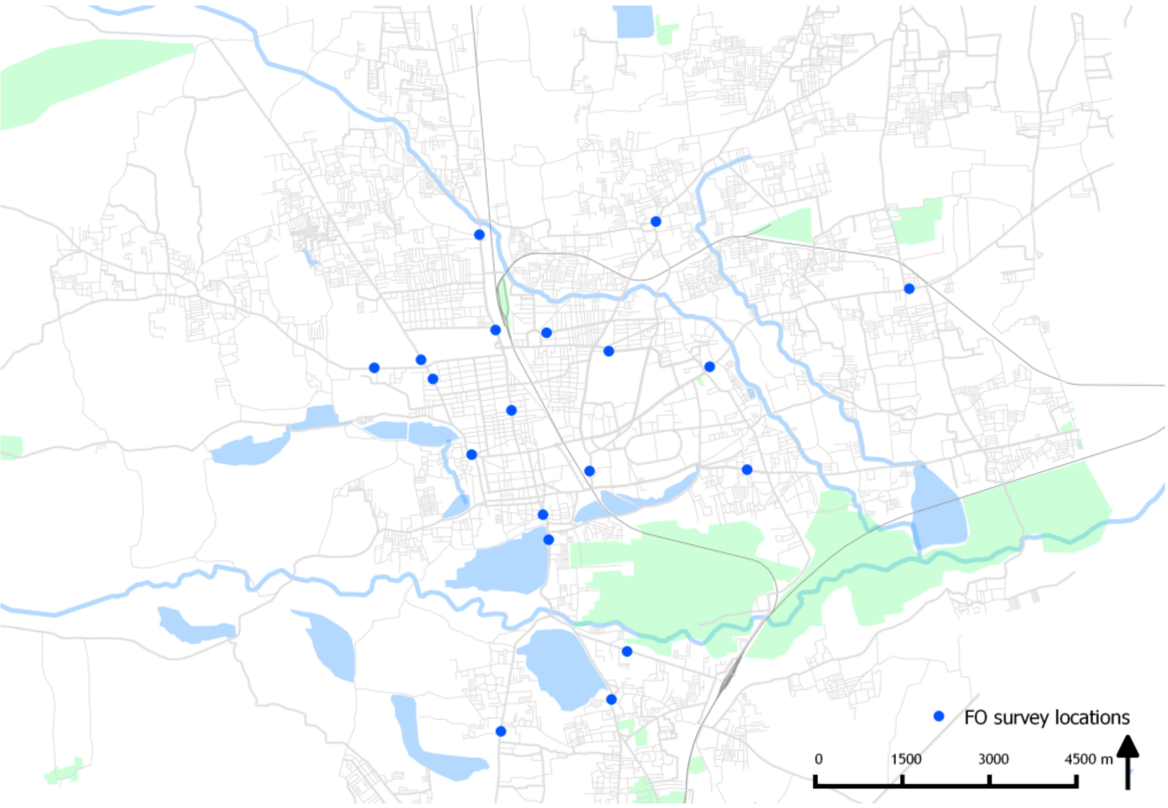


Figure 27: Locations of ITDP frequency-occupancy count surveys.

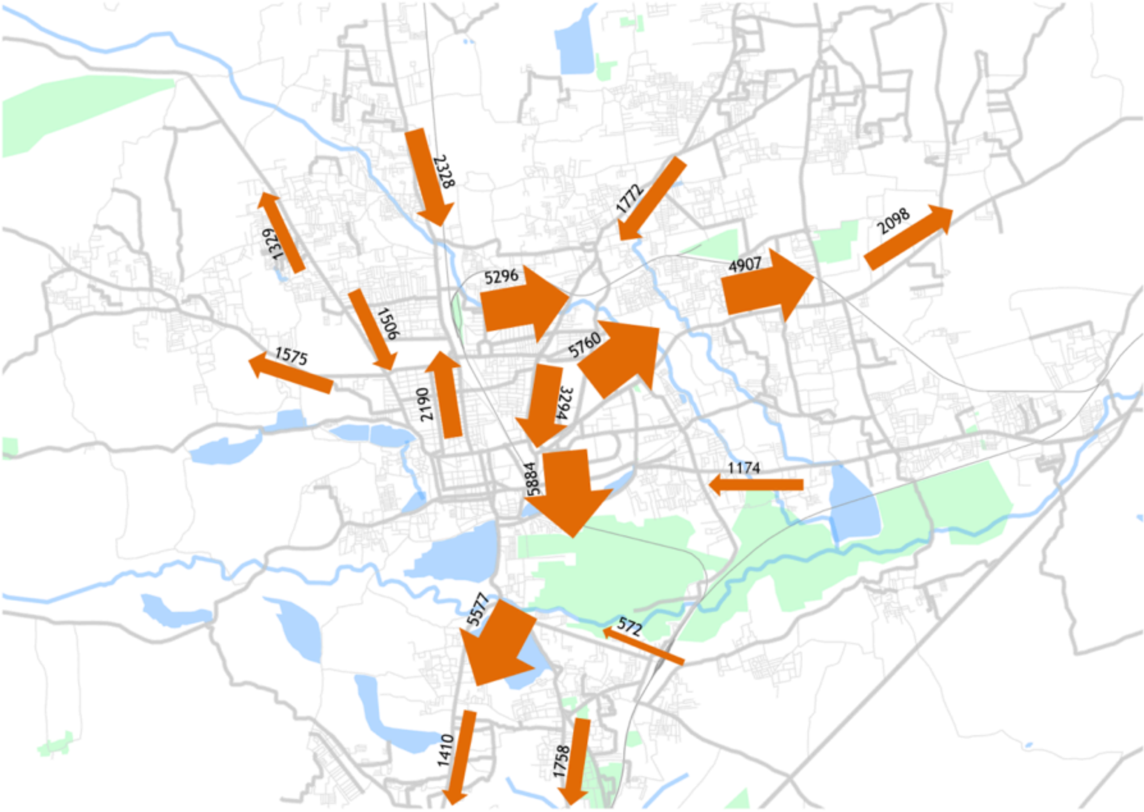


Figure 28: Observed peak hour passenger volumes.

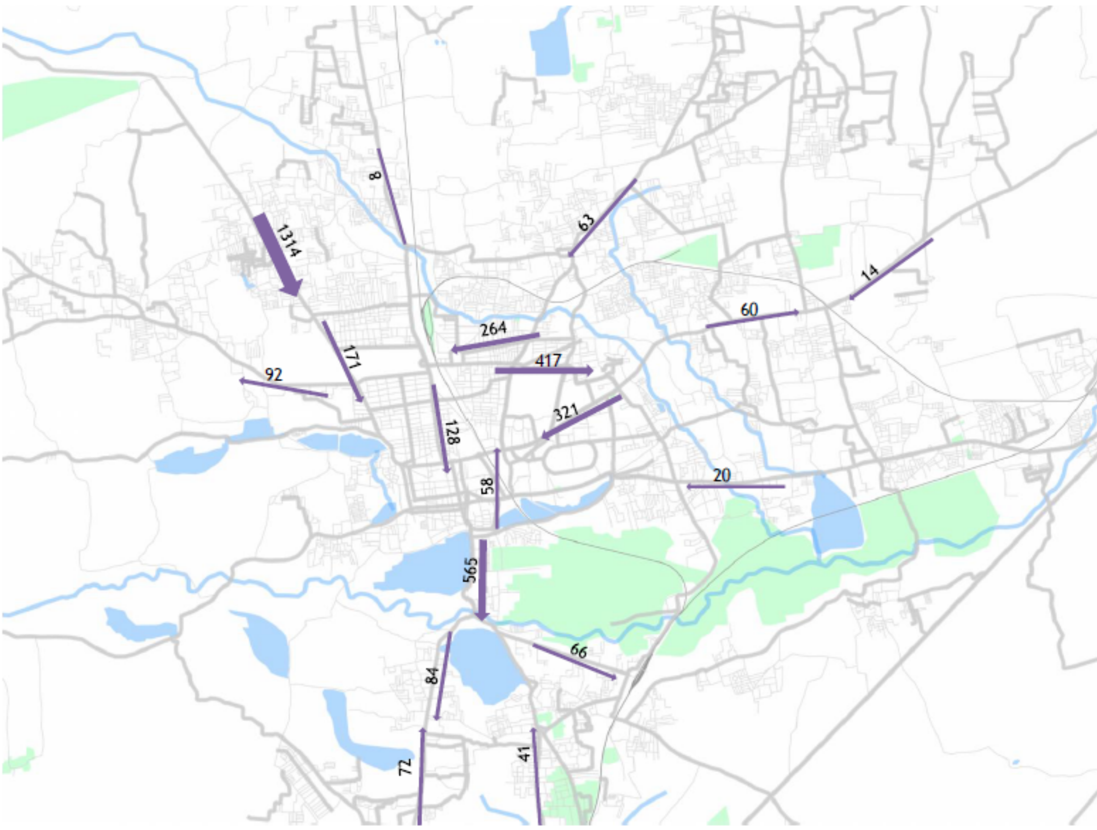


Figure 29: Observed paratransit peak hour passenger volumes.

After reviewing the TNSTC and shared auto data, the four corridors shown in Figure 30 and listed in Table 6 were identified as potential corridors for implementing MRT. The demand estimates are derived from existing bus and auto-rickshaw passengers plus private vehicles passengers who are likely to shift to a high quality MRT service.

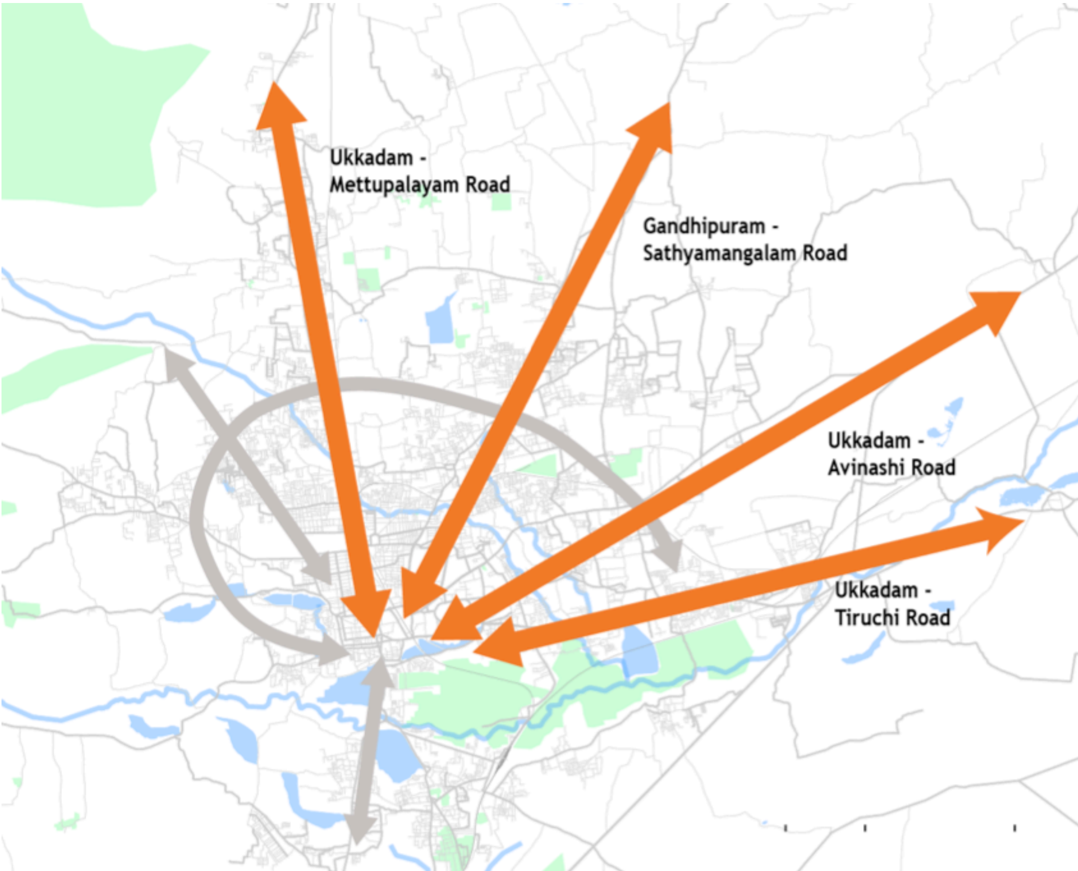


Figure 30: Potential MRT corridors (Phase 1 in orange and Phase 2 in grey).

Table 6: Potential MRT corridors

ID	Corridor	Demand (pphpd)
1	Avinashi road from Ukkadam to Nelambur	6,400
2	Sathyamangalam road from Gandhipuram bus stand to Saravanampatty- KCT tech park	5,400
3	Tiruchi road from Ukkadam to Ondipur	6,600
4	Mettupalayam road from Ukkadam to Narasimhanaickenpalayam	6,000

The selected corridors cover important neighbourhoods, landmarks, public transport hubs, educational institutions, and local businesses. Most importantly, Ukkadam is taken as start point, with majority of city buses originating from this point and passing through key corridors of the central business district (CBD) including Town Hall, NH Road, Oppanakara Street, and Raja Street. Mettupalayam Road and

Avinashi Road provide access to bus terminals, local markets, businesses, and educational institutions such as PSG, KCT, G. K. Naidu, and Stanes schools (Figure 30:).

6.3 Choosing the right MRT mode

Having identified key corridors in the city where a high capacity MRT system is required, we now turn to the choice of MRT technologies for these corridors. Common MRT technologies include:

- **Bus Rapid Transit (BRT)**: An bus-based MRT system typically operating at-grade with dedicated bus lanes, with a range of capacities depending on the station design, bus configuration, and presence of passing lanes.
- **Light rail transit (LRT)**: A rail-based MRT system typically operating at-grade on low- to moderate-demand corridors.
- **Monorail**: A grade-separated MRT system with coaches that run on a single track, typically employed on used for low-demand corridors.
- **Metro**: A grade-separated, rail-based MRT system for corridors with very high demand.

Successful rapid transit systems attract ridership by offering a high level of affordability, efficiency, safety, and convenience to their customers. To achieve these qualities, rapid transit systems combine a minimum set of design features, including dedicated lanes; stepless boarding, electronic fare payment, and real-time passenger information (see Table 7). These features are common to all MRT technologies, whether rail- or bus-based, and should be part of any future MRT system in Coimbatore. Together, they ensure that service is fast, comfortable, and convenient—qualities that help attract riders from personal motor vehicles.

Table 7: Key features of high quality rapid transit systems.

	BRT	Metro	LRT	Monorail
Dedicated ROW	Yes	Yes	Yes	Yes
Stepless boarding	Yes	Yes	Yes	Yes
Electronic fare payment	Yes	Yes	Yes	Yes
Real-time passenger information	Yes	Yes	Yes	Yes
High quality service that can attract users from personal vehicles	Yes	Yes	Yes	Yes

Beyond these common features, MRT technologies have important distinguishing characteristics that impact the choice of the best technology for a particular context:

- **Capacity**: An appropriate technology must have sufficient capacity— typically expressed in terms of the number of passengers per hour per direction (pphpd)—to handle existing demand and should also be able to accommodate future growth. Current passenger demand in Coimbatore is in the range of 5,000 to 7,000 pphpd. At-grade systems such as BRT and LRT typically accommodate up to 12,000 pphpd with a single lane or track per direction. Monorails are lower capacity systems, handling around 8,000 pphpd on the busiest known system. To achieve higher capacities, two approaches are typically employed: grade separation in the case of rail-based systems, and passing lanes in the case of BRT. With passing lanes, BRT can carry up to 45,000 pphpd, the capacity of Bogotá's Transmilenio.

Grade separated metros can achieve volumes upwards of 60,000 pphpd. These values are compared in Figure 31.

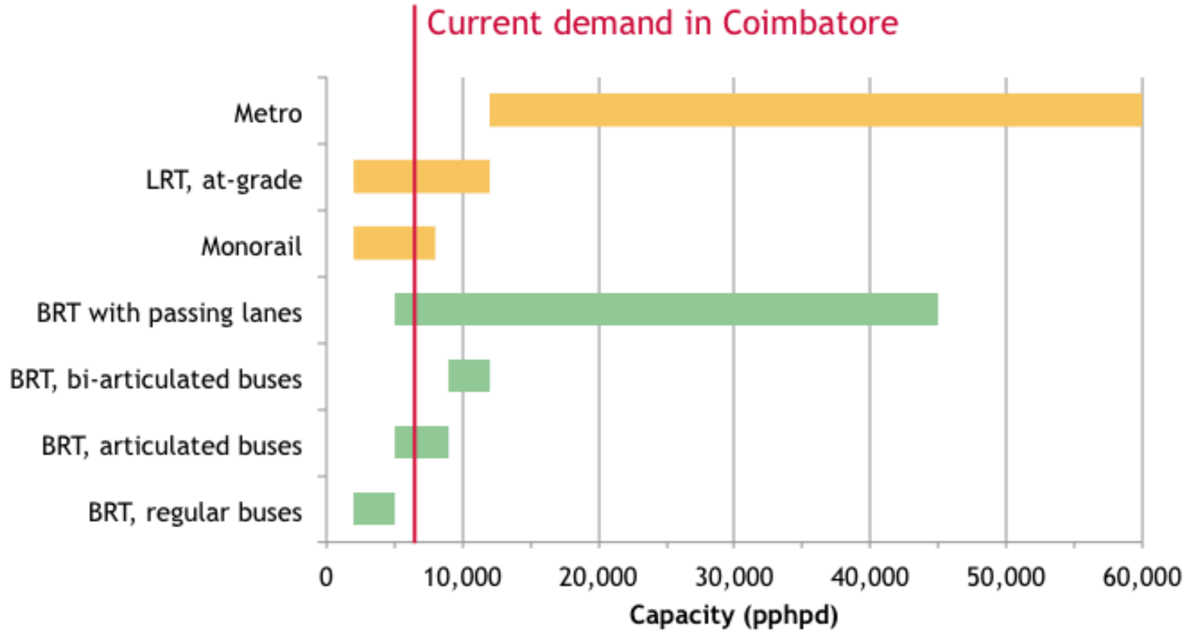
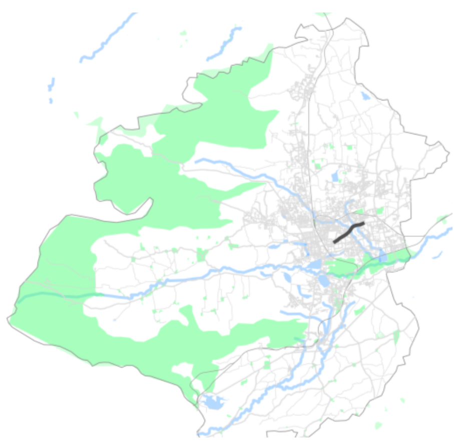
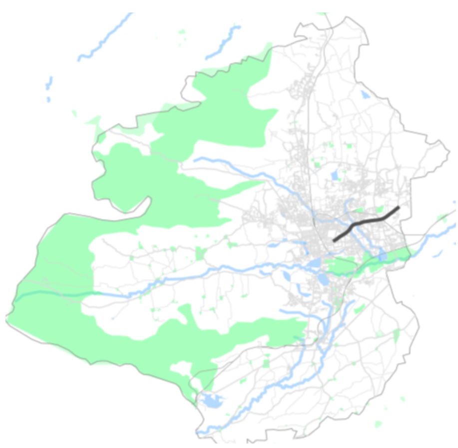


Figure 31: Typical capacity of MRT systems.

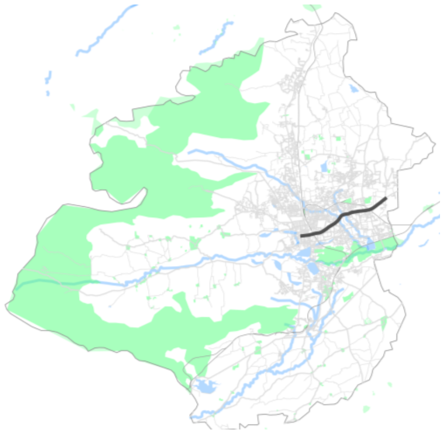
- **Implementation cost**. Capital costs vary considerably among MRT technologies, ranging from around Rs 20 per km for BRT to upwards of Rs 400 crore for underground metro. Given the cost differential, it is advisable to choose the least expensive mode that adequately meets the travel demand requirements of the city. Figure 32 draws a sharp comparison related to the implementation costs by posing the question: "What can be accomplished with Rs 1,500 crore?" in a city like Coimbatore. While this investment can contribute the implementation of a single corridor for a rail-based technology, it can establish a network across the whole city in the case of BRT.



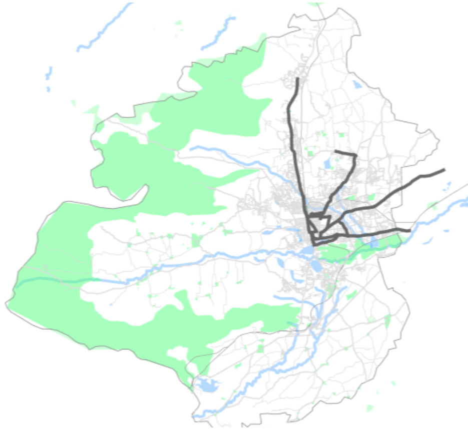
Underground metro: 3.8 km



Elevated metro: 7.5 km



Monorail: 10 km



BRT: 74 km

Figure 32: What can be accomplished for approximately Rs 1,500 crore?

- **Convenient station access**: Stations should be easy to access, particularly for passengers with disabilities. Stations of a BRT system or LRT (provided it is at-grade) are easier to access compared to the elevated or underground stations of a grade separated monorail or metro system.
- **Flexibility and reduced need for transfers**: BRT is unique as an MRT system in terms of its flexibility with routing options. Unlike rail-based systems, BRT bus itself can turn from one corridor to another, allowing passengers to stay on the same vehicle all the way to their destination rather than taking multiple transfers. Since buses can move freely among multiple corridors, direct services can be provided for all of the major origin-destination pairs in the system, resulting in significant savings in waiting time for passengers. With buses of the right specification, the BRT routes can go beyond the network of dedicated corridors where needed, as described below.
- **Integration with existing bus-based public transport**. In cities around the world, buses are the main form of public transport. This is true even in cities with extensive rail systems, including London, Mexico City, Hong Kong, and Singapore. Similarly, city buses form the backbone of Coimbatore's public transport network and will remain so even after an MRT system is implemented. Therefore, it is important to evaluate how easily the MRT system can be integrated with the city bus system. In this respect, BRT has a definite advantage over rail-based systems. Not only can the system provide cross-platform transfers between BRT and non-BRT services at integrated terminals, but BRT services themselves can leave the corridors to reach closer to passenger destinations. Such "direct services" bring the system closer to the user's doorstep, eliminating the need for transfers to intermediate modes or feeder buses. In the Guangzhou BRT system, all but one of the 40 BRT routes provides direct service outside the segregated corridor.[14]
- **Rapid implementation time**: Implementation time is another critical factor in the decision among competing MRT technologies. The longer it takes to implement MRT corridors, the longer the city has to wait to present a compelling public transport option to customers. In the

[14] http://www.chinabrt.org/en/cities/guangzhou.aspx

absence of any improvements, more and more public transport and NMT users will switch to personal motor vehicles. Once they do so, it is more difficult to convince them to return to using public transport. Given adequate political support, BRT can be implemented in under three years, from the planning stages through to construction and operations. The Janmarg system in Ahmedabad demonstrates how fast a BRT system can become the backbone of a city's transport network. What began as a 12.5 km pilot corridor in 2009 has expanded to 82 km, providing cross-city connections. Some of the world's most successful BRT systems, including those in Bogotá, Rio de Janeiro, and Mexico City, have been implemented in 2 to 3 years. Rail-based systems can take upwards of 8 years to plan and construct. Some of India's major metro rail projects, such as those in Bangalore and Chennai, are expected to take up to a decade fully implement their first phases.

- **Safety**: Because the dedicated corridor segregates buses from smaller vehicles, minor as well as major accidents come down dramatically. With appropriately spaced pedestrian refuges, conflict between BRT buses and pedestrians crossing the street reduces dramatically. Extensive safety measures need to be incorporated in case of elevated and underground rail systems, whether it is metro-rail, LRT or monorail. Catwalks are required in case of emergencies so that passengers are not stranded up in air. BRT systems do not have such complications. In case of an emergency, passengers are easily evacuated.
- **Smaller maintenance facilities**: Since buses are flexible, greater freedom is available in locating maintenance and parking facilities. These depots are also much smaller than rail system depots and thus need smaller land resource to place them. Average BRT depot holds 100-300 buses and requires a space of 5-12 acres. A system of 1,000 buses, which can serve around 1.5 million passenger trips daily, can be managed out of 6-8 facilities spread across town. This reduces the number of dead kilometres (i.e. nonrevenue earning km). The system can serve a larger distributed network.

Table 8: Contrasting elements of MRT systems.

	BRT	Metro	LRT	Monorail
Sufficient capacity to meet projected corridor demand in Coimbatore	Yes	Yes	Yes	No
Investment cost for Coimbatore MRT network (cr Rs)	1,500	29,000 (elevated)	7,800 (at-grade)	10,800
Easy-to-access stations	Yes	No	Yes, if at-grade	No
Flexibility in route planning	Yes	No	No	No
Integration with bus-based transport	Yes	Limited	Limited	Limited
Implementation time (years)	2-3	6-8	6-8	6-8

6.4 BRT: The right mode for Coimbatore

Taking into account the increasing demand for a better quality transport system, Coimbatore has the potentiality of implementing MRTS system. Coimbatore has high public transport volumes on major corridors and adequate availability of ROW towards creating a substantial demand for the system. A bus based system is more appropriate for the city where it is easy, cost effective and quick to implement the full system. ITDP specifically recommends BRT over other systems such as metro, LRT, or monorail based on the following advantages:

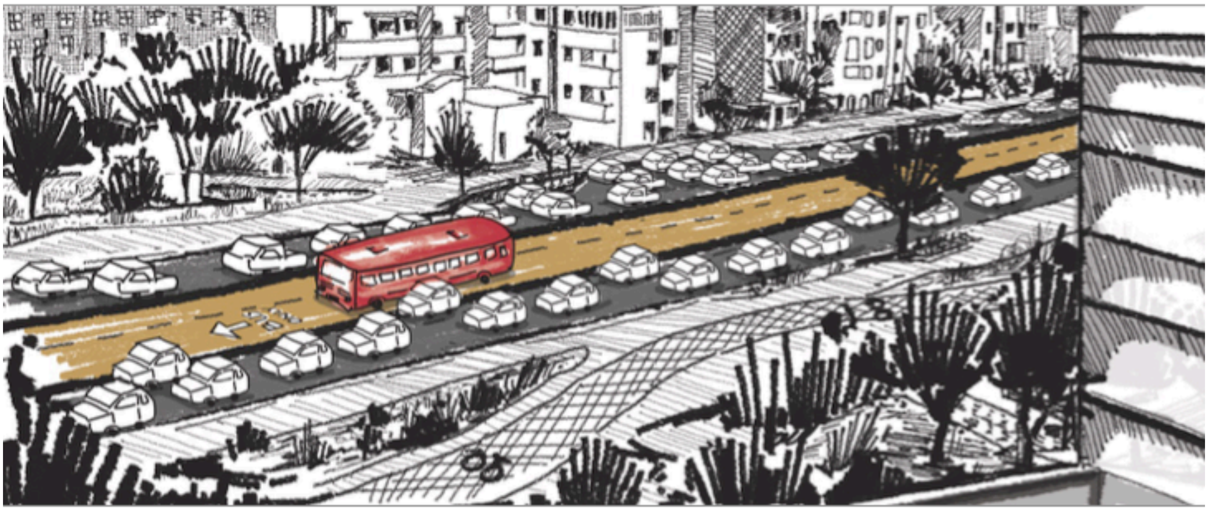
- Ability to meet existing passenger demand and scale up to meet future demand;
- Ability to provide flexible services, and change service design for increase in capacity;
- Adaptability for narrow streets; and
- Low implementation cost.

Taking into account the corridors with high public transport demand and areas with low to moderate demand, a comprehensive network of BRT corridors was identified to be implemented in two phases.

6.5 Summary of key features of BRT

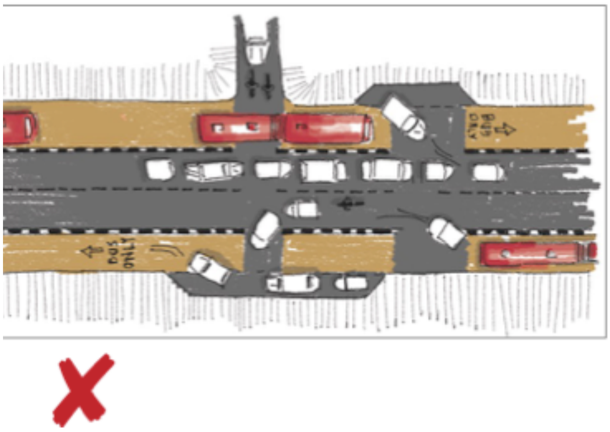
The following key features will help ensure that the Coimbatore BRT system provides a high level of customer service. These features comprise part of the BRT Standard, a BRT implementation checklist developed by experts from around the world.[15]

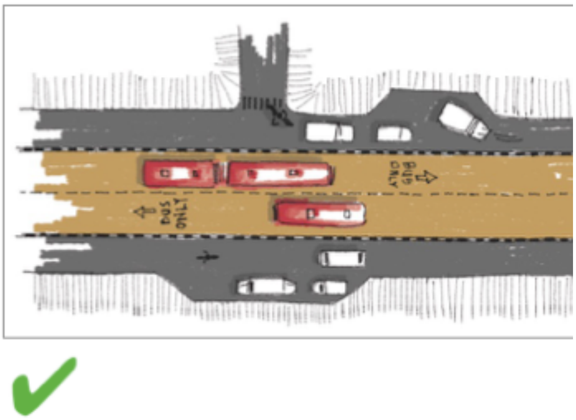
Figure 33: The BRT Basics



Dedicated right-of-way. A dedicated right of way is essential to ensure that buses can move quickly and uninterrupted by traffic movement. It allows for BRT buses to move at higher speed and minimises the conflict between mixed traffic and busway movement. The separated right-of-way should be segregated from mixed traffic lanes with physical delineators.

[15] http://www.brtstandard.org

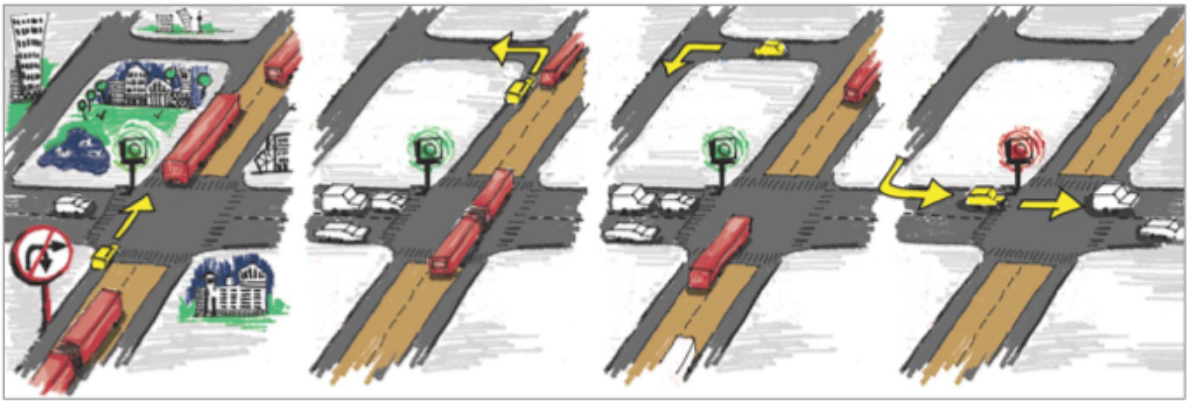




Busway alignment. The busway should be located where there is minimum conflict with mixed traffic, turning movement, on-street parking and property entrances. The central verge alignment is recommended as it remains free of obstructions, reduces turning conflicts, delay and increases the speed and capacity for most part of the corridor.

At-level boarding. Having the bus-station platform level with the bus floor is one of the important ways to reduce the boarding and alighting times at station. The platform should be at the same level with minimum or no gap between the vehicles and platform. Level boarding makes the system accessible to seniors, disabled, and people with luggage.

Off-board fare collection. Off-board fare collection reduces travel time, improves the customer experiences, and prevents revenue leakage. A barrier-controlled system with turnstiles allows access when a user taps his/her smart card.



Intersection treatments. Intersection treatment is another important element for ensuring bus speeds in the bus lanes. Forbidding turns across the bus lane, minimizing the number of traffic signal phases and activation of signal priority (wherever possible) are some of the ways to reduce the delay and increase bus speeds.

7. System operations

MRT systems are designed to address specific transit customer needs. A customer may attach value to a wide variety of system characteristics: economic affordability, reliability, system aesthetics and attractiveness, travel time saving, ease of accessibility, and comfort level. The operational design and planning of the system determines how effectively these valued characteristics are prioritised and implemented. It is especially important that the system avoid increasing the number of transfers that customers are required to make, or financially burden the operations cost by primarily planning for direct services. The latter point refers to destinations that are outside a BRT system. Thus, the service plan must balance various factors, including customer service and cost efficiency.

7.1 BRT services

BRT for Coimbatore must address the mass transit need of the city along the major corridors carrying high volumes of peak passenger demand. Therefore we recommend that Coimbatore BRT be a closed system with a dedicated bus fleet. In a closed system, access to use the dedicated BRT corridor is limited to specially designed BRT vehicles. For example, high-quality BRT systems such as Bogotá's Transmilenio and Ahmedabad's Janmarg maintain high performance by ensuring that all BRT services are provided by designated BRT vehicles.

The Coimbatore BRT system will consist of the following services (Figure 34):

- Trunk services: Operate entirely in dedicated BRT lanes.
- Trunk services with limited stops: Operating entirely in dedicated BRT lanes.
- Direct services (BRT Extensions): Operate in dedicated BRT lanes and then extended up to 3 km beyond the trunk corridor to provide better connectivity and attract ridership.
- Feeder services: Operate in mixed traffic, bringing passengers to terminals and stations on BRT trunk corridors.

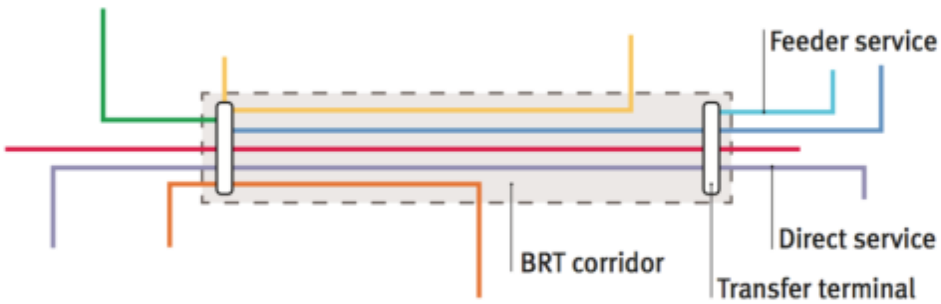


Figure 34: The Coimbatore BRT will provide trunk, direct, and feeder services.

Most trunk corridors in the Coimbatore BRT will comprise two-way dedicated median bus corridors with central stations (for more details on physical designs, please see chapter 8).

The proposed BRT corridors will be implemented in two sub phases, Phases 1A and 1B (see Figure 35: Proposed BRT Phase 1 corridor types.). In Phase 1A, Avinashi Road (northeast) and Mettupalayam Road (north) have been proposed due to high travel demand and greater accessibility to rapidly growing areas like Peelamedu. Secondly, the important educational institutions, IT Park, and local businesses on located on these two corridors will be connected with high quality public transport. The other two corridors with medium travel demand are proposed for BRT Phase 1on Sathyamangalam and Tiruchi Road. These corridors are surrounded by industrial uses and light commercial activities and have adequate width (20 m or more) and make it easy to implement BRT.

Coimbatore city is characterised by wider road widths in the immediate neighbourhoods and outlying areas and narrow streets in the core area. Despite width constraints in the core area, it is possible to implement BRT on narrow streets, as many cities across the world have demonstrated. However, creating a BRT where there is high demand as well as adequate street width will help demonstrate the viability of BRT system. It will have sufficient ridership to make it successful. It can achieve financial sustainability from the outset.

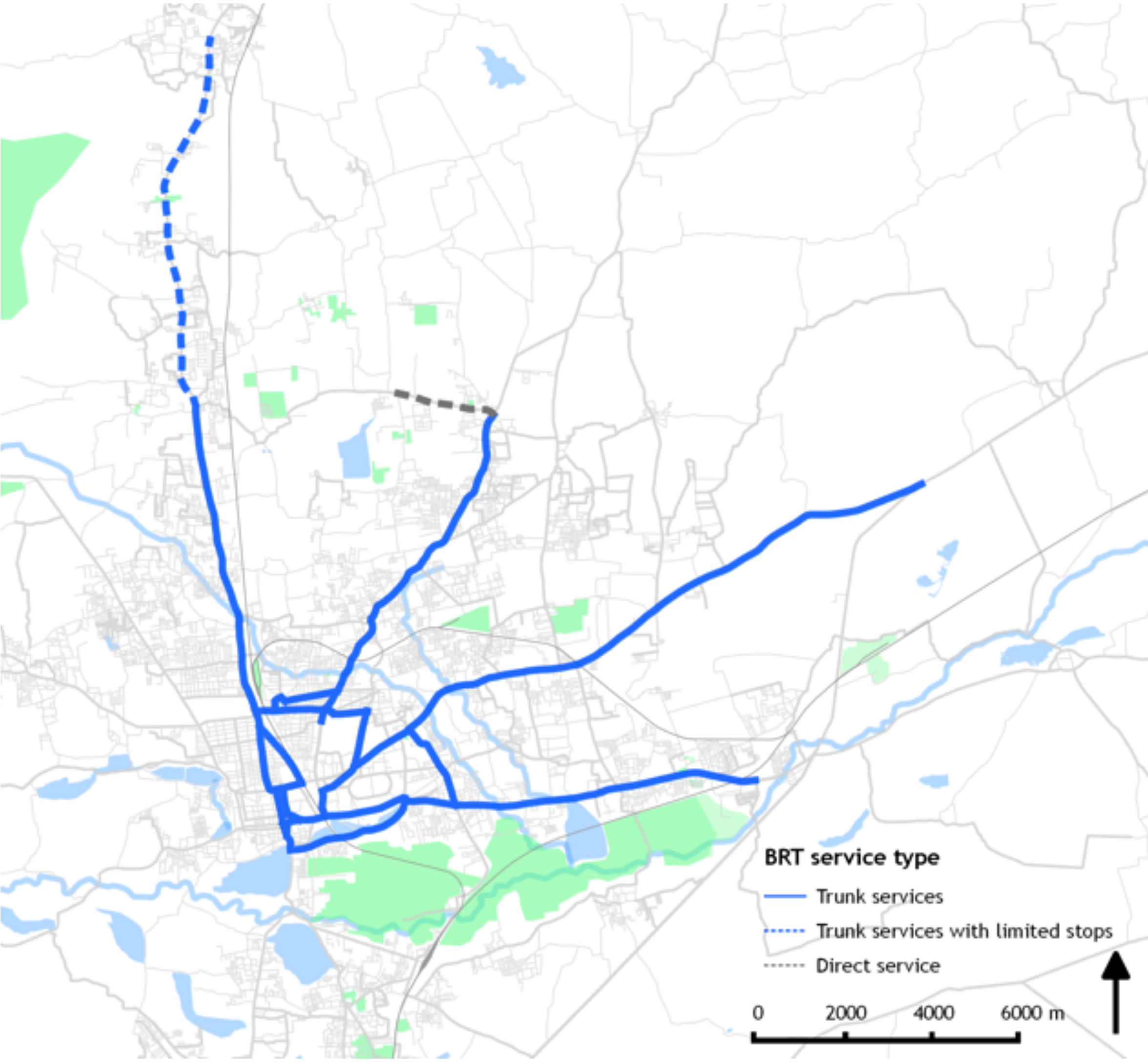


Figure 35: Proposed BRT Phase 1 corridor types.

The term “direct service” refers to services in which BRT buses travel a short distance outside the dedicated BRT corridors to reach important destinations. In Coimbatore, direct service is proposed on Sathyamangalam Road where it will operate as BRT service extension from Saravanampatti terminal to IT Park (Figure 35).

As part of this study, approximate fleet sizes were calculated. It is estimated that the corridors above will experience the following peak period customer demand and require the following service frequencies (Table 9).

Table 9: BRT Demand frequency and length

Corridors	Length (km)	Peak customer demand (pphpd)	Frequency, 12 m (buses / hr)	Frequency, 18 m (buses / hr)	Fleet size, 12 m	Fleet size, 18 m
Mettupalayam road	23.0	6,800	28	34	59	70
Avinashi road	20.0	7,300	20	41	37	76
Tiruchi road	15.0	7,400	21	42	29	60
Sathyamangalam road	15.6	6,100	25	31	37	45
Total	**73.6**					**414**

Peak hour passenger volumes justify the use of 18 m articulated buses (with a capacity of approximately 140 customers) on most corridors in Coimbatore. Based on rudimentary assumptions regarding the likely orientation of BRT services, it is estimated that the services will require vehicle fleet of 414 buses. Following a detailed service planning process, it may make sense to operate some services that have limited demand with regular 12 m buses (with a capacity of 72 passengers). The detailed service plan should ensure that these services do not increase overall corridor loads beyond a combined frequency of 60 buses per hour.

Figure 36 present a representative arrangement of services within the Phase 1 corridors. Once the framework for BRT corridors is finalised, detailed service plans and route schedules must be created based on expected passenger demand. This includes addressing not just existing traffic, but creating BRT service schedules that are harmonized with the city's key origins, destinations and municipal services / attractions. Then, specific fleet sizes can be estimated for each service.

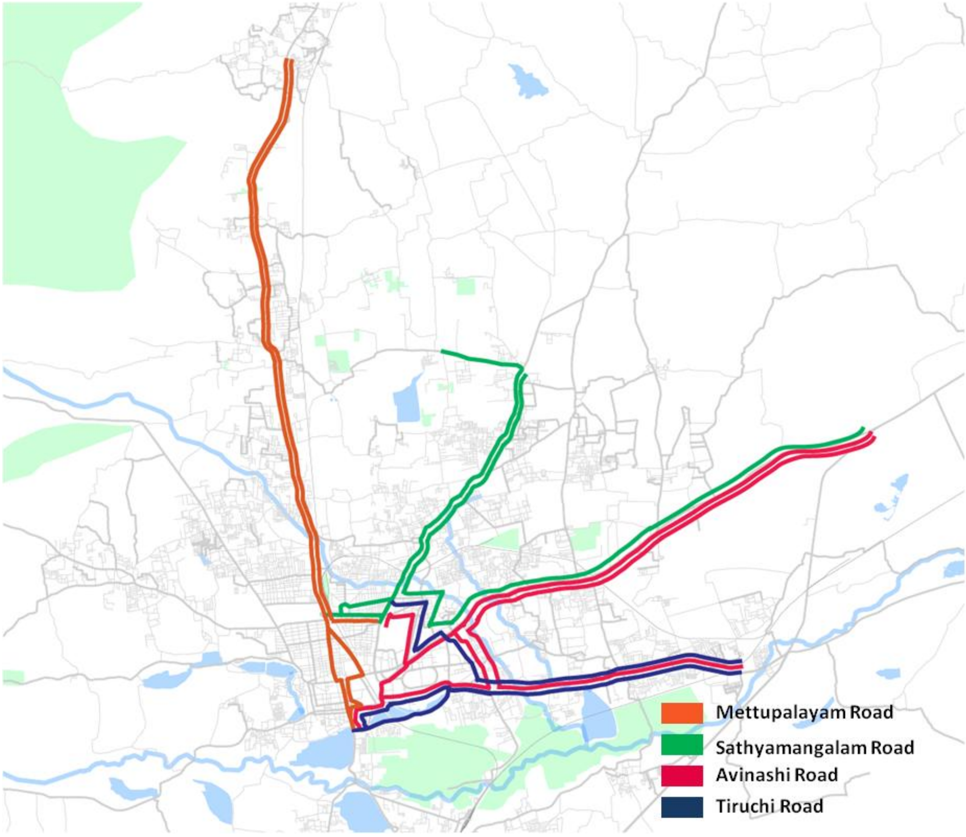


Figure 36: Representative services for Phase 1.

The BRT service phasing for each route is generally not restricted to one corridor or terminal. For instance, one BRT service route from Mettupalayam road with start point at Ukkadam passes through Oppanakara Street while another one could start at Ukkadam and pass through Balasundaram road. While small extensions are possible, and advised, to provide direct service outside BRT corridor network, it is okay to extend BRT services way outside corridor network as long as there is no significant traffic congestion. Yet it should be ensured that route extension outside BRT corridor network shall not reduce the effectiveness and reliability of BRT system.

It is essential that feeder services be planned and integrated to support (but not compete with) any MRT system. Therefore, developing and supporting an efficient network of feeder routes will be an important task of implementing the Coimbatore BRT.

Taking into consideration the corridors with high transit demand and the underserved areas of existing city bus routes, the feeder routes have been selected to form a comprehensive network. Because feeder services are typically operated no differently than fixed-route public transport, a wide variety of options may be considered. The existing TNSTC city bus system and paratransit services (e.g. private and shared autorickshaws) may be restructured to serve as feeders to the BRT services. All of these services will have important roles to play as the BRT system is being planned and implemented.

Five feeder services are proposed for Phase 1 (Figure 38):

- Mettupalayam Road via NSR Road to Cowley brown Road (7.7 km)
- T. V. Samy to Ukkadam (7.2 km)
- Avinashi Road via Vilankurichi to Sathy Road (5.1 km)

- Mettupalayam Road via Sivanandha colony- Ganapathy to Sanganoor (5.8 km)
- Avinashi loop from Signaller to Avinashi road (7.2 km)

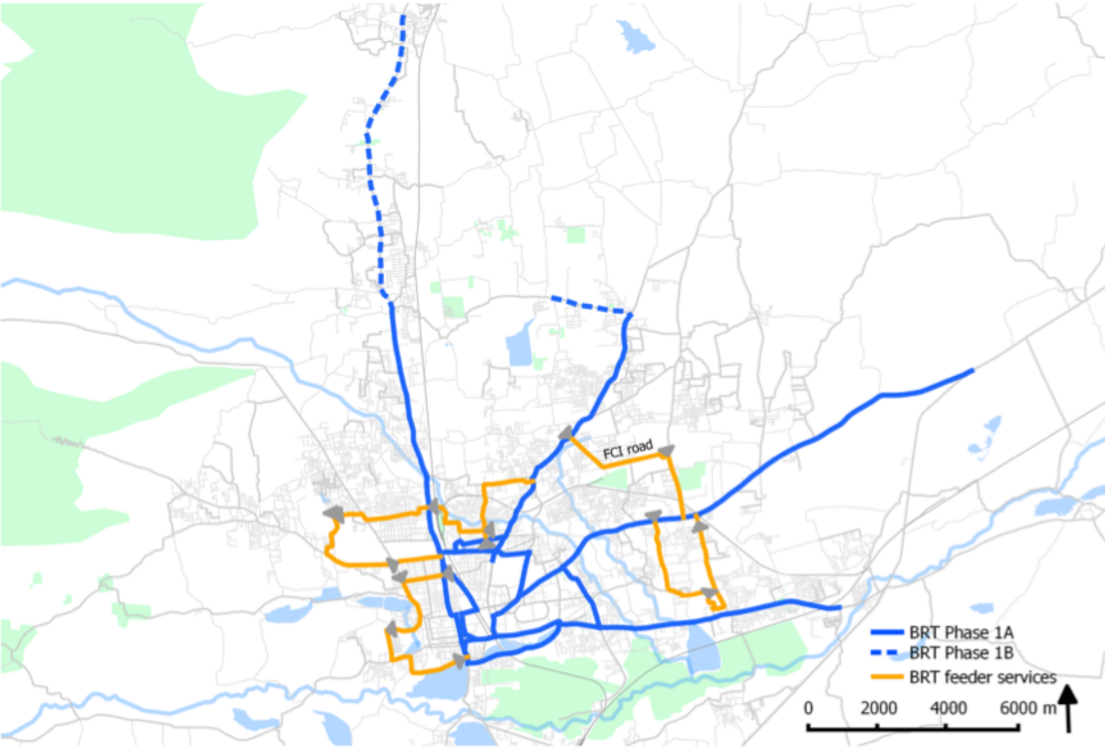
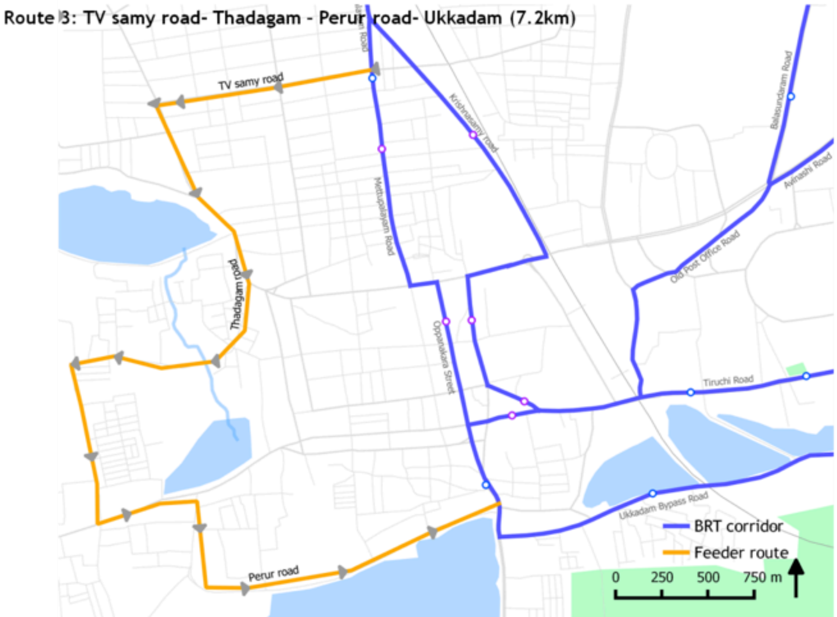


Figure 37: Phase 1 BRT feeder services.


Route 2: Sathy road -Sanganoor road - Sivanandha colony-MTP road(5.8km)
Sanganoor road
Sathyamangalam Road
Sakthi Main Road
Mettupalayam Road
Sivanandha colony
100 Feet Road
Cross Cut Road
BRT corridor
Feeder route
0 250 500 750 m


Route 3: TV samy road- Thadagam - Perur road- Ukkadam (7.2km)
TV samy road
Thadagam road
Perur road
Mettupalayam Road
Krishnasamy road
Balasundaram Road
Avinashi Road
Old Post Office Road
Tiruchi Road
Ukkadam Bypass Road
BRT corridor
Feeder route
0 250 500 750 m

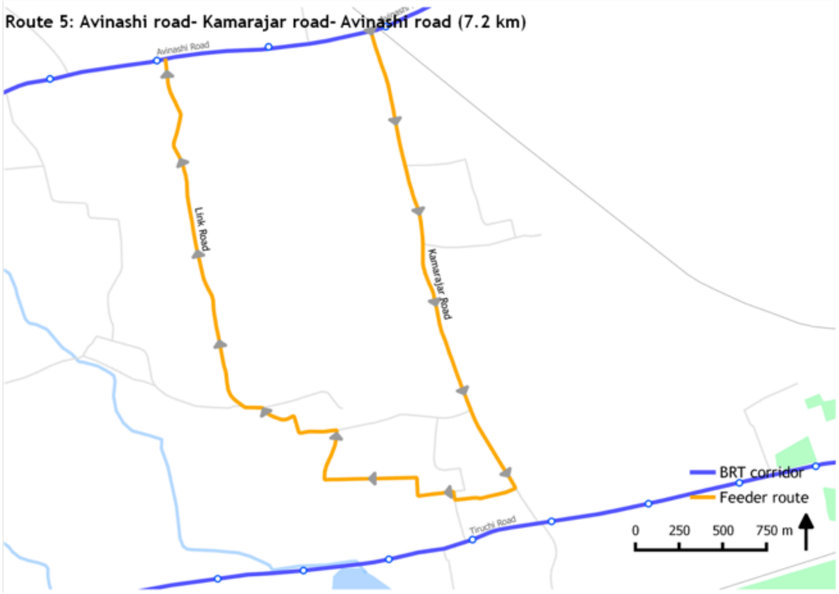


Figure 38: Feeder routes in detail for BRT phase 1

Based on the estimated demand and proposed route alignment ROWs, the feeder services may be operated using 9 m long low floor buses with a capacity of approximately 50 customers. The Avinashi road loop and Mettupalayam Road to Sanganoor route will require smaller vehicles due to narrow widths and the low demand. It is recommended that these routes utilise low floor microbuses with wide sliding doors that allow simultaneous boarding and alighting and seating for approximately 20 passengers (see Section 8.7).

Table 10: BRT feeder services.

Route	Length (km)	Frequency (buses / hr)	Fleet size
Mettupalayam-NSR Road-Cowley brown Road	7.1	10	8

T. V. Samy to Ukkadam	7.2	10	8
Avinashi Road -Vilankurichi to Sathy road	5.1	10	6
Mettupalayam Road-Sivanandha colony-Sanganoor	5.8	10	7
Avinashi road – Singanallur – Avinashi road	7.2	10	8
Total			**35**

7.1 Ridership estimate

Using data on TNSTC services and the location of bus stops extracted from Google satellite imagery, the fleet of TNSTC and private buses serving each proposed BRT corridor. A representative estimate of BRT ridership was obtained by multiplying the prorated fleet size by the system-wide ratio of 1,200 passengers per day per bus, with factors added to represent additional boardings from mode switching and induced travel. The trunk services are expected to handle around 9.4 lakh boardings per day.

Table 11: Estimated ridership on proposed BRT corridors.

	Length (km)	Bus stops	City bus fleet	BRT fleet, 12 m	BRT fleet, 18 m	BRT ridership
Mettupalayam Road	23	32	144	59	70	3,30,000
Sathyamangalam Road	16	21	61	37	76	1,40,000
Avinashi Road	20	21	109	29	60	2,30,000
Tiruchi Road	15	34	100	37	45	2,50,000
Total						9,50,000

7.2 Future system planning

To ensure that future streets are planned with public transport, the following corridors have been identified where BRT can be implemented in the future. Where Phase 1 is concerned with connecting four major corridors in the northern and eastern side, Phase 2 takes the service to the next high demand arterial corridors to form an inner BRT network. Phase 2 also adds additional reach and connectivity to the western side. The Phase 2 network comprises 41 km of dedicated BRT corridors:

- **Mardhumalai Road** from Mettupalayam Road to Mardhumalai Road via Koundampalayam Road.
- **Thadagam Road** from Sukrawarpettai Road to Vadavalli- Edayarpalayam Road.
- **Nallampalayam Road** from Mettupalayam Road to Sathyamangalam Road via Nallampalayam and Bharathiar Road
- **Vilankurichi Road** from Sakthi main Road to Avinashi Road via FCI road, and Vilankurichi.
- **Kamaraj Road** from Avinashi Road to Tiruchi Road via Kamaraj Road.

- **Palghat Road** from Ukkadam to Chettipalayam Pirivu.

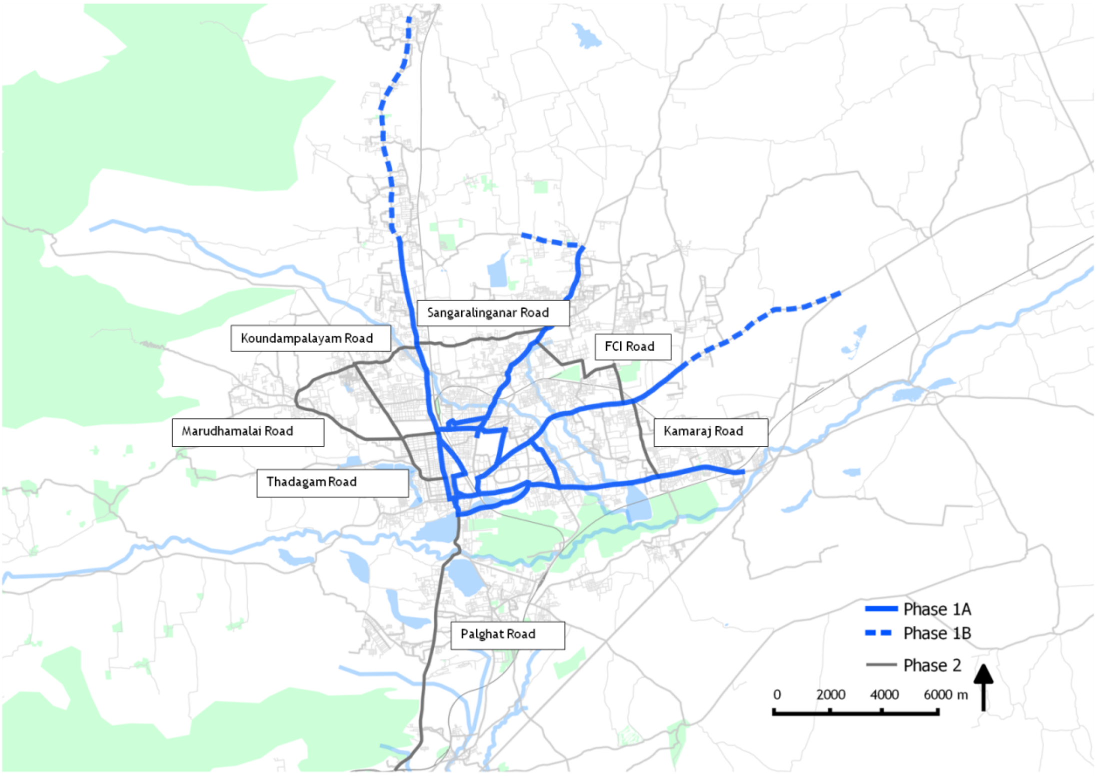


Figure 39: Proposed network of Phase 1 and Phase 2.

It is essential that all current and future BRT corridors be included in the current Coimbatore Development Plan (DP). Space must be reserved in the median lanes on designated BRT corridors. Also, space for future terminals and depots must be reserved and specifically included in the DP.

7.3 Fare collection

Fare collection is an essential component of BRT service planning. It is important that the proposed BRT system must utilize off-board fare collection system using electronic smart cards. Smart cards use embedded microchips to electronically store data. This technology enables payments to be tracked, and also monitors the ticket's validity and use. Off-board collection of fares facilitates quicker boarding times, keeps the buses on a consistent time schedule, and makes the system simpler and easier for customers to use.

Electronic ticketing and fare media are especially important tools to reduce revenue leakage, reduce operational cost, simplify customer transactions, as well as monitor system performance to adjust operations and inform future planning decisions. Comprehensive IT systems will be necessary to effectively manage these fare collection techniques.

For Coimbatore, a pre-paid smart card system should be designed in such a manner that they may be used in multiple transport services and essentially function as a common mobility card across whole region. This would offer functionality similar to London's Oyster card, or Hong Kong's Octopus card.

Oyster Card - London

Operating Agency: Transport for London
Single card used across trains, buses, ferry, parking, etc.

Octopus Card - Hong Kong

Operating Agency: Hong Kong Mass Transit Railway
Single card used across trains, buses, ferry, parking, etc.

Figure 40: Two successful smart card / integrated ticketing systems

Ahmedabad's Janmarg uses an automatic fare gate and flap barrier type of system for smart card passengers.

Figure 41: Janmarg stations with flap barriers and passengers using smart cards

The following details describe how fare collection technologies will be incorporated into different BRT services in Coimbatore:

- **BRT trunk stations:** BRT trunk stations and terminals will have fare collection cabins wherein customers will be issued smart token and smart card media after paying journey fare. Customers will use smart cards, to activate controlled barriers inside the stations after deduction of appropriate fare at those barriers. All these fare payment data must be transmitted to a system centralized control facility via station servers.
- **BRT Service Extensions:** Out of the BRT trunk routes that use station access gates to control entry to the system, buses will utilize conductors. Conductors will issue *smart tokens*[16]and receipt that are assigned value from hand held electronic ticketing machines (ETMs) with smart media reader / encoder. The ETM must be able to read, deduct the appropriate fares, and add value to smart cards. With any cash payment received from customers, the conductor must provide a receipt via the ETM's printer. At the end of each shift, conductors must submit their ETMs and unused token stock at the end terminal - where they will also deposit

[16] Smart tokens are contactless electronic media that is coded with the fare for a *single journey only*. These tokens allow customer to access the system without having to purchase a smart card.

any cash that was collected. Data from the ETM is extracted and compiled to a terminal server from where it is transmitted to the centralized control facility. Incoming cash from conductors must be immediately reconciled against ETM data.

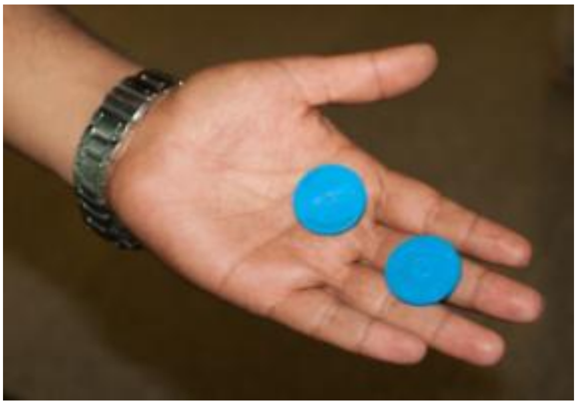


Figure 42: Smart tokens from the Delhi Metro (left), and hand held media reader / encoder with printer (right)

It is important to outline how the customer pays their fare and how the agency has assurance that the customer has paid for each possible journey. As the proposed network is closed with service extensions, the following fare payment / journey scenarios are possible**:**

- **In to In:** Journey between BRT trunk stations
- **In to Out:** Journey originating from BRT trunk stations and finishing on the BRT service extension
- **Out to In:** Journey originating from the BRT service extensions and finishing at a BRT trunk station
- **Out to Out:** Journey between points on the BRT service extensions

Table 12 provides a detailed description of the fare payment and collection steps required for each type of journey.

Table 12. Fare payment / Journey scenarios

Journey type	Occasional users (smart token)	Frequent users (smart card)
In to In (BRT trunk only)	• Customer buys smart token that is coded with his origin and destination and is given a receipt of the transaction. • Customer uses token to enter system at BRT station. • Upon exit the token is deposited into the exiting fare gate. • If the amount of the token purchased is less than the amount of the customer's journey, then customer is asked to add value to the token in order to exit the station.	• Customer with smart card taps the card on the card reader. • The maximum system fare is deducted from the smart card account. • If the maximum fare amount can be deducted from the account, then the fare gate (such as a turnstile or flap barrier) opens. • Upon exit, the customer tags his/her smart card at exit flap barrier and the difference between the maximum system fare and the amount of the trip distance (per fare

		chart) is credited to his/her account.
In to Out (BRT Trunk to Extension)	• Customer buys smart token from ticket window that is coded with his origin and destination. • Customer uses token to enter system at BRT station. • Conductor boards the bus once the BRT bus is outside the trunk corridor, to perform random checks and issue receipt • Customer will return the token and given a receipt of transaction with value as per requested trip to continue on the service extension.	• Customer with smart card taps the card on the card reader. • The maximum system fare is deducted from the smart card account. • If the maximum fare amount can be deducted from the account, then the fare gate (such as a turnstile or flap barrier) opens. • Upon exit, the customer tags their smart card to card reader at the bus exit. • The difference between the maximum system fare and the amount of the trip distance (per fare chart) is credited to the customer's account.
Out to In (BRT Extension to Trunk)	• Customer boards the bus, buys token from conductor on board, and is given a receipt of the transaction. • Conductor uses ETM to encode token with value of the customer's requested trip. • Upon exit the token is deposited into the exiting fare gate. • If the amount of the token purchased is less than the amount of the customer's journey, then customer is asked to add value to the token in order to exit the station.	• Customer boards bus and taps smart card-to-card reader at either bus entrance. • The maximum system fare is deducted from the smart card account. • If the maximum fare amount cannot be deducted from the account an error message will alert the conductor so that customer may purchase a token. • Upon exit, the customer tags the smart card at exit flap barrier and the difference between the maximum system fare and the amount of the trip distance (per fare chart) is credited to their account.
Out to Out (BRT Extension only)	• Customer boards the bus, buys token from conductor on board, and is given a receipt of the transaction. • Conductor uses ETM to encode token with value of the customer's requested trip. • Prior to leaving the vehicle, the customer is required to deposit the token with Conductor	• Customer boards bus and taps smart card-to-card reader at either bus door. • The maximum system fare is deducted from the smart card account. • If the maximum fare amount cannot be deducted from the account an error message will alert the conductor so that customer may purchase a token. • Upon exit, the customer tags their smart card-to-card reader at the bus exit. • The difference between the maximum system fare and the amount of the trip distance (per fare chart) is credited to the customer's account.

As the smart tokens are an important component, managing non-coded (uncharged), smart token stock is essential. All tokens are single journey tokens that are valid only for a one way journey, so having an appropriate supply for BRT stations as well as for conductors on the extension services will be a complex and time-sensitive task. Stock amounts must be monitored, and dedicated personnel will be required to collect completed journey tokens from buses and BRT stations, and then maintain the supply. This task takes on greater importance during peak periods, where the token supply for each station (and conductor) must be updated to meet the high demands.

The operational burden of the smart token system should not be understated. Therefore it is important that Coimbatore BRT strive to maximise the number of customers who use multi-trip smart cards to pay their fare. Smart cards have many advantages for the efficiency of the system, so incentive systems for customers must be put in place. It is important that the customer fare structure indicate a significant discount for smart card holders. Fares must be reasonable, but higher for token users. BRT fares will be fixed by the BRT agency and should be integrated with fare systems across various transport modes including city buses.

At the end of the day, a bank representative will collect the cash from all stations and depots, and deposit it in the BRT system operator's account. All the data of customer trip details and fare transactions will be received and stored on station or depot server, then immediately shared with centralized control facility via communication link.

7.3.1 Passenger information services (PIS)

At present, the lack of information on existing public transit routes and their timings discourages the use of public transport. Such information is usually only gathered from fellow passengers waiting at public transport stops or from commuting on a daily basis along the same route.

Keeping the passenger informed at all times is crucial to making public transportation user friendly and desirable. Therefore, Coimbatore BRT must create robust systems to expand access to information. Coimbatore BRT must offer clear route maps, schedules, and other forms of passenger information, just like those provided on most metro systems. It must also provide all the necessary information that can be given to a BRT customer by means of audio announcements and visual displays. Bilingual information is particularly useful in reaching out to a larger populace.

Real-time information is especially important, as it creates a bridge between a passenger and the system administration and establishes reliability in operations management. Inside stations, electronic displays inform waiting passengers when the next bus will arrive. On the buses, displays and audio announcements indicate the upcoming stop. Effective customer information systems help make the system accessible to all users, particularly people who are new to public transport. The information included as a part of the PIS can be enlisted as:

- **Route information**: Origin and Destination points of the route, Route numbers
- **Journey details**: Announcement/display of approaching stations inside the bus and ETA (expected time of arrival) of next bus at stations
- **General messages**: Cautionary, warning, directive and informative messages for users like “Smoking prohibited,” “The doors will open to your right,” and “Mind the gap” at stations and inside the bus.

In addition to the real-time information, the following static information must be provided:

- **At stations**: Route map, fare chart, directions, system map and station locations, area map with surrounding landmarks, real time passenger information of next bus etc.
- **On buses**: Route diagrams.
- **At terminals and interchange / transfer stations**: System map, route information and schedules, area map, fare chart, directions, real time information of vehicle arrivals.

Figure 43: Real-time passenger information keeps customers up to date on bus destinations and departure times. Clear schedules and maps summarize system information.

It is recommended that Coimbatore BRT provide the following customer information services remotely:

- **Call Centre**: A customer information call centre is an essential tool for instantly putting system information, real-time travel planning data and emergency announcements within easy reach of all customers.[17]
- **SMS system alerts:** Customers should be able to subscribe to Coimbatore BRT's emergency announcements feed that will push specific information to subscribers. This ensures that the customer receives timely data, such as service delays, emergency situations, and temporary service changes before s/he embarks on his or her journey.
- **SMS based route information:** The customer should be able to send a text inquiry from personal mobile number to an automated transport authority system that provides bus schedules, or route numbers from specific origin point and time.
- **Web based Information:** The webpage of the transport authority can allow users to access the bus routes database, time tables, bus schedules, system map and station locations. Users should be able to access and easily navigate the information they want to plan their journey. This service should also allow the information centre to receive digital images to help document and resolve issues.
- **Mobile applications:** Transport authority to its own mobile applications which allow users of smartphones to access and browse through the basic information like bus routes, station locations, bus schedules, ETA, etc.

It is important that all services allow customers to make staff commendations, present suggestions for improvements, and lodge complaints (i.e., errors in system, unclean bus and bus stations, improper

[17] Not just those with smartphones or access to the Internet.

staff behaviour, rash driving, over speeding, areas of concern or requiring focus, etc.). Customers must be able to immediately report a problem and receive feedback from Coimbatore public transport agency regarding the resolution of their particular comments.

To coordinate multimodal trips, the PIS systems should develop an up-to-date central knowledge base with information from all transport services available in the city. Information gathered as part of this project will be an excellent planning resource internally, but must also be made available to the public to facilitate the development of innovative services by third party developers. It is also important that Coimbatore BRT follow the Open311 standard[18] to allow private software developers to create innovative products with the transport data that the organization collects.

Figure 44: Regional transport customer information centre offered by Transport for London.

A model to follow for the web-based portal is Transport for London's integrated customer website (Figure 44). The TfL site provides functions as a one-stop-shop for information on public transport (including bus and rail), the congestion charge, and cycle sharing. The site offers a multimodal trip planning solution for public transport and cycling routes. It also provides information on London's electronic fare payment system, the Oyster Card. The program's robust data collection system, developed to support better regional traveller information, is also a valuable regional resource used by public and private sector partners.

It is possible that similar to advertising contracts for bus stops, that Coimbatore BRT can underwrite a percentage of the customer information services operating and capital costs through paid online advertisements.

[18] For more information see open311.org.

7.3.2 Branding and marketing

In this day and age, people are acutely concerned about lifestyle and image. Being efficient and utilitarian is not sufficient. Attractive branding and constant outreach is essential for the successful adoption and patronage of a new public transport system, especially by the growing middle class. As prosperity rises, public aspires to be associated with products and services that exude style and class. The marketing team needs to create a buzz that BRT is more than just another bus.

The following components of effective branding are recommended for Coimbatore BRT (from the handbook, "From Here to There"[19]):

- "Build consistent system image." All BRT Stations must have a consistent visual aesthetic to build a consistent system image and brand identity.
- "Building a strong brand." The brand communicates the system's values. A modern BRT system needs a modern-looking logo, colour scheme, and graphic style. The brand should reference local values and sensibilities. In systems such as Ahmedabad's Janmarg, a local-language name helps people connect.

Figure 45: In Los Angeles, distinctive bus colours convey information about services (e.g. local vs. express) and contribute to the identity of the system.

- "Sell your values." Agency employees are all brand ambassadors, so it is critical that they understand and internalize what the system stands for. In Ahmedabad, drivers underwent two-month training upon them that they would need to adopt more courteous driving style than they might have practiced in previous posts in the city's Municipal Transport Service or as private freight transporters.
- "Get started early." Outreach can begin well before the official launch of the system. In Bogotá, representatives of Transmilenio distributed rider information door-to-door in neighbourhoods along the BRT corridor. Ahmedabad's Janmarg offered free rides for the first three months to entice new users to try out the system. This trial period was followed up with active outreach to introduce various communities to the BRT.
- "Systematise your information." Present customer information in an easy-to-use format. Signage and information graphics need to be straightforward and concise.
- "Know what riders want." Advertising and outreach campaigns should be tailored to the specific needs and interests of different user groups.

[19] Embarq (2011). From Here to There: A creative guide to making public transport the way to go, <http://www.embarq.org/sites/default/files/ EMB2011_From%20Here%20to%20There_web. pdf>.

- “Control the narrative.” While officials are often leery of divulging too much information to the media, it is better to have a proactive approach to media outreach. The Ahmedabad Municipal Corporation fed information about the Janmarg BRT to the press on a regular basis, resulting in extensive coverage of the project before its opening.
- “Be responsive to riders.” Periodic user surveys can gather information on passenger perceptions of service quality, and this feedback can inform operational plans and the design of subsequent corridors.

Figure 46: Distinctive logos add to the identity of BRT systems (from left to right: Metrobus, Mexico City; Rea Vaya, Johannesburg; MyCiti, Cape Town; Metropolitano, Lima; Transjakarta, Jakarta).

7.4 Information management system

IT systems are necessary to manage the large amount of bus operations and financial transactions data is that generated through every day activities. For Coimbatore BRT operations reporting and performance assessment, developing a robust information management system (IMS) is critical. The primary output of the system is generating reports for various levels of BRT system managers. The broad categories in which the IMS reports can be classified are:

- **Staff and duty schedule reports**: Public transport operations involve a tremendous number of staff and manpower. Staff duty and schedule reports are required to be maintained in order to effectively plan for systems operations and management.
- **Bus operation reports**: These reports provide important output data to improve the bus operations and monitor system performance.
- **Financial reports**: Reports generated by analysing financial data are especially necessary during matters of arbitration and civic complaints, grievance redressal, track daily financial status, assess systems overall financial performance, address areas of serious concern, maintain proof towards payments made and that received.

Developing a comprehensive IMS will minimize the workload, reduce labour, optimize the required manpower and facilitate performance improvements. IMS enabled reporting eases the decision making process of transport authority at various levels. It is also necessary to effectively maintain safety, assess bus operations performance and improve overall system efficiency and service delivery (all of which attract customers).

Coimbatore public transport IT service provider must develop a graphical dashboard which will give output of real time information pertaining to bus operations and financial transactions. The dashboard should be adjustable to display key real-time operational details (summary of real time passenger boardings at various stations, tickets issued, buses on road, live bus tracking, bus speeds, etc.) visible to senior officers of transport authority and management staff at the centralised control facility.

While some of the data can be immediately shared with the customer information portal, access to key operational statistics and summary reports will be controlled by secure login ID and passwords. The dashboard can be integrated with the web portal of the public transport managing body. Guest users can be allowed to log in the dashboard to access a limited number of summary reports.

7.5 Corridor management

The primary goal of BRT systems is to give priority to the mode that is moving the greatest number of people. Therefore, intersections along BRT corridors must be designed so that they don't create unnecessary congestion (see Chapter 8). As important as physical corridor design, is traffic management. It is critical that traffic along the corridor be monitored and controlled in such a way that BRT operations are not impacted by non-BRT traffic (of any and all modes).

Effective corridor management will require close coordination with Coimbatore Traffic Police and THE BRT IMPLEMENTING AGENCY, as well as dedicated traffic management personnel employed by responsible to the BRT operating body. Such BRT-focused traffic police must ensure that junctions are not blocked by traffic regardless of signal activation or intersection design. BRT-junction guards are key gatekeepers to the system, and must be vigilant to prevent private vehicles, pedestrians, animals, and others from accidentally entering the busway.

Corridor management also includes a detailed assessment and review of the existing legal framework for traffic management and the existing capacity of the Traffic Police and THE BRT IMPLEMENTING AGENCY. The BRT operating body must be fluent in traffic management policies and systems including (but is not limited to) the following:

- Existing schedule of fines for traffic violations
- Existing schedule of fines for parking infractions
- Schedule of fines for bus / BRT lane violation
- Number of traffic police and BRT corridor management staff, including the strength assigned to specific areas such as intersection management and parking enforcement
- Number of personnel that have received training in traffic management / preventative measures / real causes of crashes and injuries
- Traffic accident data (types, frequency, locations, high risk areas, high risk times, etc.) that are collected. Methods and the degree to which this data is disseminated to department and to the general public.
- Department plan for strategically partnering with municipal organizations and with the general public. Role of community outreach and public advisory road safety committees to disseminate information on traffic safety and collect feedback from the public.

7.5.1 Intersection performance

Corridor management should be responsible for an initial and on-going assessment of intersection performance. A series of surveys must be completed to determine travel patterns and intersection performance along the corridor. With the intersection data, corridor management will work with strategic partners (Traffic Police, civil society, etc.) to develop a BRT corridor intersection improvement plan that prioritizes movement of sustainable transport modes (walking, cycling public transport) and access for people with disabilities.

Corridor management also includes implementing simplified signal timing schemes to reduce the waiting time for buses and mixed traffic. It is essential that signal timing take into account pedestrian movements, so that incoming customers (especially seniors and people with disabilities) who are crossing the corridor to reach the median stations are able to do so safely and conveniently. The simplification of signal cycles through the elimination of turning movements can help reduce delay at intersections, particularly along BRT corridors. BRT must have priority over other traffic movements. Right-hand turning movements of traffic across BRT corridors are especially detrimental to the safety and efficiency of BRT operations. Therefore, it is necessary to avoid right turns along the BRT corridor.

Signal cycles also can be simplified through changes at the network level. For example, a right turn can be substituted by three left turns (Figure 47). Vehicles can still make the right turn at the circled junction by turning left three times and then crossing perpendicular to the corridor. Two additional options are indicated below. In the diagram at left, the turn is accomplished through a left turn followed by a U-turn. In the diagram at right, vehicles make two right turns at less critical junctions away from the BRT corridor.

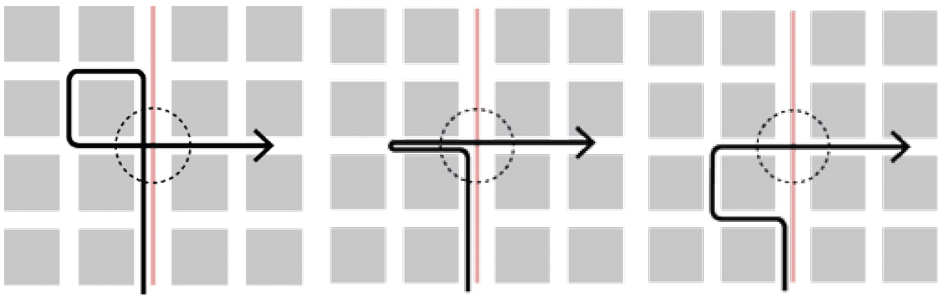


Figure 47: Alternatives to right turns across BRT lanes (red) at the circled intersection.

Another approach to reduce the length of signal cycles is the use of "squareabouts" that combine straight and turning movements, allowing for a two-phase cycle (see Section 8.11).

During the initial phase of BRT operations, in order to sensitise vehicle users and prevent the BRT corridors from being encroached personal motor vehicles, it is recommended that each opening of BRT corridor have security guards to ensure bus corridor safety and ensure bus priority at junctions. The primary duty of these guards will be to keep motorised vehicles from entering the corridor and ensuring that vehicles give priority to BRT buses at intersections. Even at present, Traffic Police presence is required to enforce discipline of traffic signals in Coimbatore; hence for BRT operations traffic management manpower must be strengthened.

8. Physical design

Physical design not only includes infrastructure construction but also requires careful planning towards addressing accessibility for passengers, traffic management, integration with other infrastructure, and provision for public utilities and landscaping.

Figure 48: Physical planning includes the careful integration of buses, stations, street elements, and intersections designs.

While planning for roadway improvements or grade separators, it is utmost important to consider BRT or any transit mode on all potential corridors. Following which, cost of land acquisition, road widening and relocation of utilities can be avoided.

8.1 Relationship between vehicles, stations and corridors

BRT is not just about physically separated busways. BRT system design is an act of balancing the needs of three different components: vehicles, stations and corridors. The design must consider the needs of each component so that each can optimally serve the goals of providing sustainable transport for Coimbatore people by 2031 (25 per cent of all trips by public transport; maintain existing share of all trips by cycling and walking of 40 per cent; zero fatalities per year from traffic crashes; 75 per cent of residents within a 5 min walk of formal public transport; zero nonattainment days for PM and NO_X emissions).

The design of stations, corridors and buses must be well coordinated to ensure that level boarding is provided for all customers. This means that important vehicle characteristics such as interior floor height and vehicle width must be identified and verified as the station is being designed. Similarly, station platform dimensions must be determined well in advance of the bus fleet procurement to ensure that the floor levels of bus and station platform are sympathetic. Construction error tolerance is equally important, and must be vigilantly monitored so that the detailed project designs are appropriately implemented. Finally, once the system is operational, all vehicles must be consistently maintained so that tire-pressure and vehicle suspension performance do not create gaps between the vehicle floor height and the boarding platform level.

Figure 49: The design of the stations and buses must be coordinated to ensure that floor heights match.

8.2 BRT lanes

What distinguishes BRT from other bus systems are the dedicated bus lanes, which are physically segregated from mixed traffic lanes. The bus lanes are usually placed in the middle of the roadway, flanked by regular traffic lanes, in order to reduce conflicts with left-turning vehicles and to avoid parking encroachments in the bus lane. The dedicated busways are separated from other modes to allow for high-frequency schedules as well as a smoother ride without stops in traffic. In peak hours, buses can arrive at stations every couple of minutes, or even every minute, and can carry passengers much faster than any other form of motor transport; this dramatically reduces travelling time.

Dedicated lanes offer a significant operational advantage for bus systems. Increased travel speeds mean that a public transport provider can provide service at a given frequency with fewer vehicles. Busways also reduce bus interaction with other traffic, reducing the potential for accidents or damage from day-to-day operations. This means reduced resources are required to keep the bus fleet maintained and in top service. Operating buses in median lanes also eliminates the conflicts between buses and non-motorised transport vehicles that occur in systems where buses are required to access bus stops at the left side of the carriageway.

Figure 50: Examples of segregated bus lanes in Medellín (left) and Ahmedabad (right).

8.3 Stations

BRT station design requires including basic aspects like platforms, transition areas and integration infrastructure to access stations. The station design and size can vary based on demand.

In general, BRT station design is largely a function of user requirements:

- **Comfort**: Sitting places, comfortable movement
- **Safety**: Adequate lighting, safe to travel
- **Accessibility**: Minimal level differences and ramped access from street level
- **Aesthetics**: Attracting to passengers, giving a sense of ownership
- **Provision of customer information**: Both static and real-time

High performance BRT systems utilise a single centrally located common station for both directions (like a typical railway platform) rather than having two bus stops, one for each direction. Such stations are positioned in the verge between the two directions of movement and offer access to buses moving in both directions. To access these stations, BRT buses with doors on the right side and no steps are required. More details on the vehicles are provided below (See Section 8.7).

There are many advantages of central stations:

- **Cheaper to construct and maintain**: Central stations are smaller and are up to 40 per cent cheaper to build and operate than two bus stations on either side of the central bus lanes.
- **Optimal use of street space**: Central stations require a single entry area and single set of turnstiles; whereas the two bilateral stations each require their own entry.
- **Easier customer transfer between routes:** Central stations make it easier for customers to transfer from one bus route to another without having to exit the station and cross a street, irrespective of the direction of the two routes.
- **Facilitates two-way bus access**: Platforms in each direction allow two buses to dock simultaneously at any given time.

ITDP recommends that Coimbatore BRT stations be centrally located in the median of the BRT corridors (Figure 51).

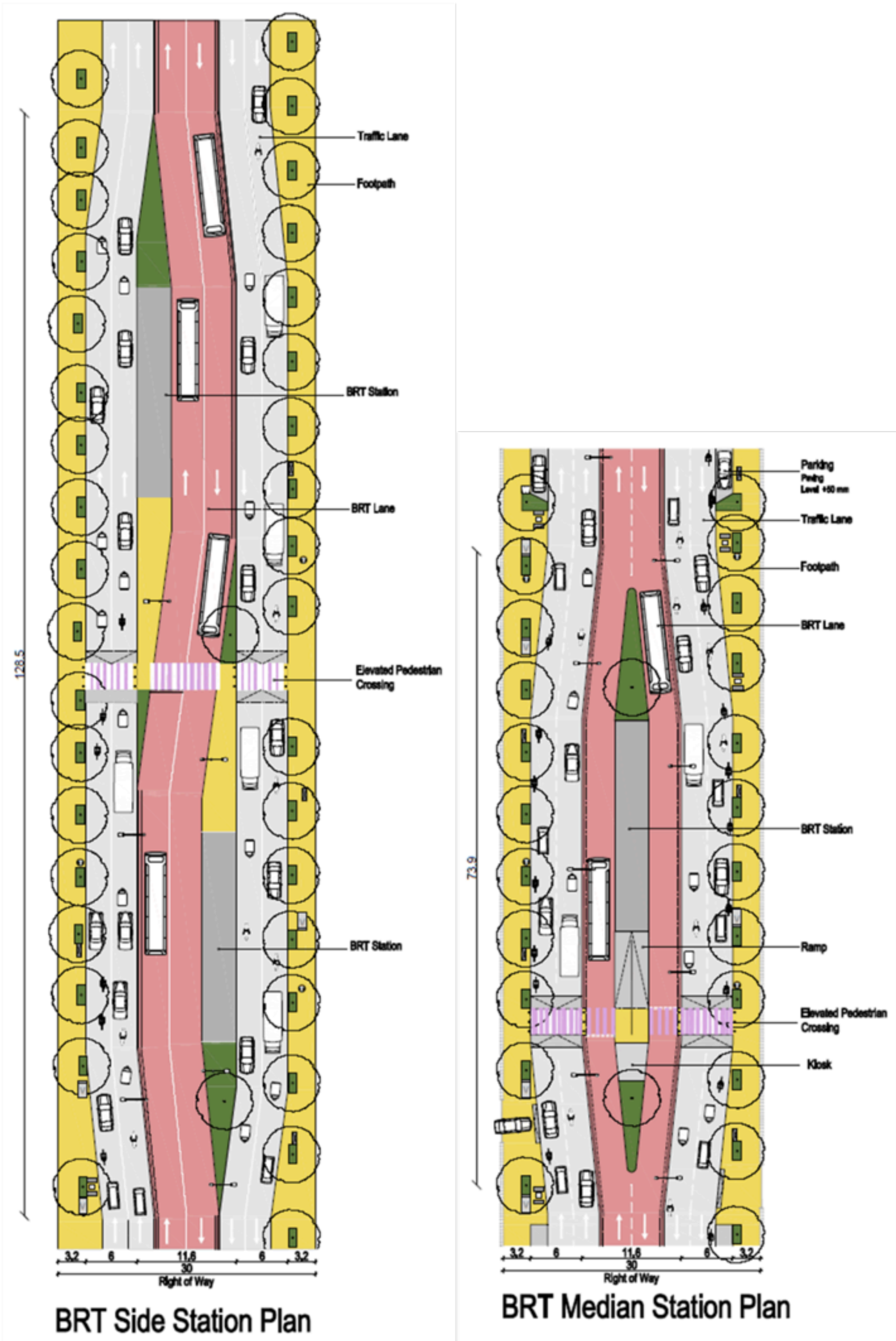


Figure 51. Curb aligned stations split for each direction takes away more ROW (left). Median station serving both directions makes transfers easier and tends to reduce both construction cost and ROW (right).

Station sizing will largely be a function of peak passenger load expected for the future years their circulation area requirements. A simple BRT station has a single stop per direction and no overtaking lane. A station with slightly higher demand may have two docking spots per direction, one behind the other, but no overtaking lane. A high capacity BRT station has multiple docking spots, called sub-stops. Each of the sub-stops may be independently accessed from the overtaking lane, without being obstructed by a bus docked at an earlier sub-stop.

Thus, depending upon the location and peak passenger demand, the length of stations, width and number of boarding platforms will vary. To allow greater flexibility, BRT stations are typically designed in such a way that new modules can be added as passenger demand increases. Extra space should be reserved in the median for adding additional modules in the future. Modules of 4.8 m x 4 m are the most appropriate to accommodate both 12 m and 18 m buses. A conceptual station layout is shown below (Figure 52. Conceptual diagram for 3 m and 4 m wide stations). Out of the 74 stations in Phase 1, 40 stations will have one module with 2 docking positions per direction for 12 m buses. The four stations are designated interchange stations that provide connectivity between BRT corridors or between BRT and feeder services. These stations may require additional modules to handle expected passenger demand. The sizing of these stations will be determined after a detailed service plan is prepared.

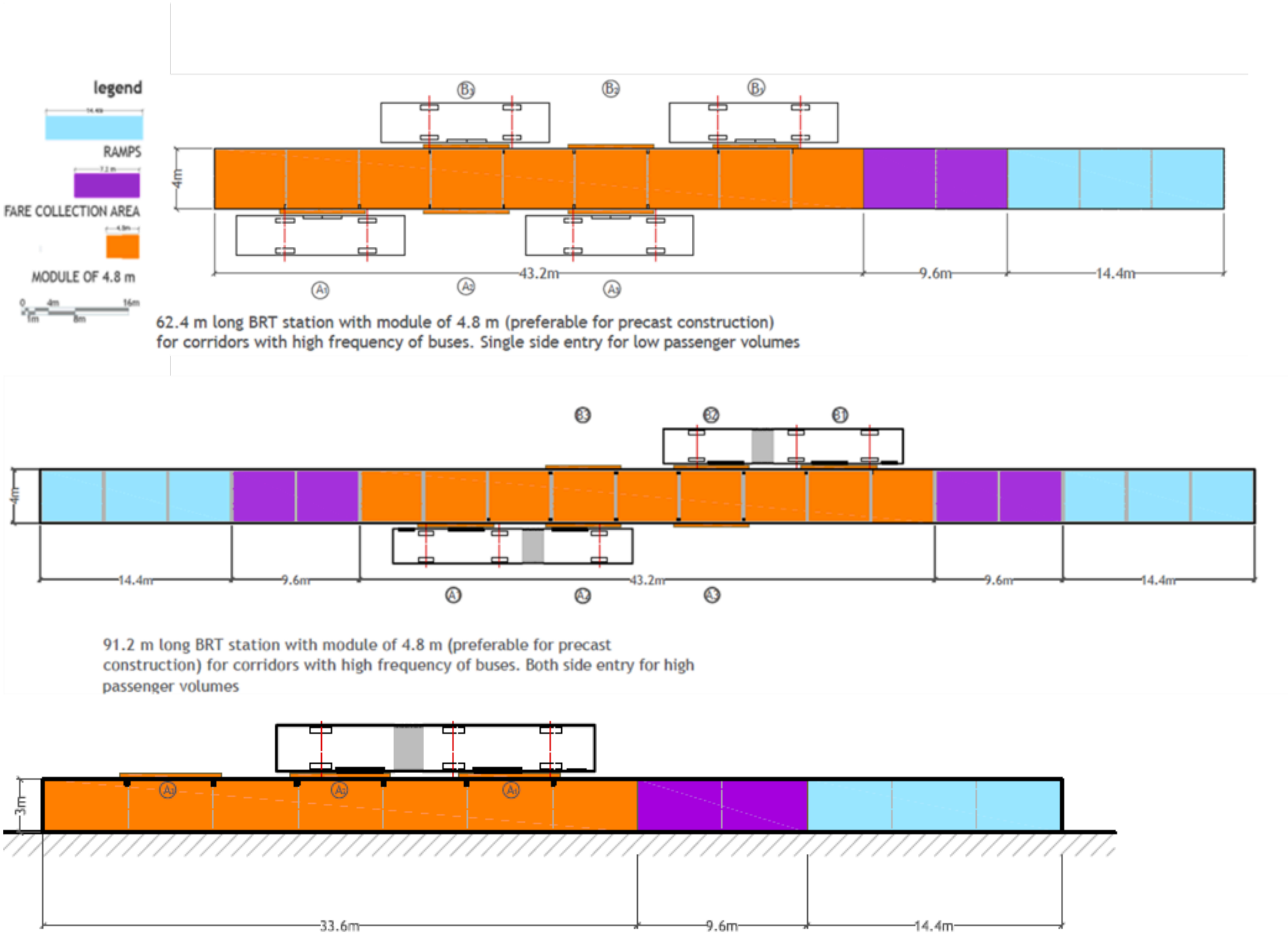


Figure 52. Conceptual diagram for 3 m and 4 m wide stations

Since Coimbatore will have 12 m and 18 m articulated buses on proposed corridors, the recommended station width shall be 60 m to 100 m with three main components: an access area (with wheelchair accessible ramps), a fare collection area, and a passenger circulation / boarding / alighting module. This requires that the station have at least two docking bays per direction for docking regular (12 m) and if it is 18 m bus then stations should be designed with extra doors to allow boarding and alighting simultaneously into the front and rear coaches of the articulated buses. Doors A1, A3 and B1, B3 will be used for docking two regular BRT vehicles in the opposite direction at the same time. Doors A1, A2 and B1, B2 will be used to allow simultaneous, opposite direction docking of articulated vehicles (Figure 52).

It is recommended that stations be at least 4 m wide to provide room for waiting and circulation. In case of a single direction or one-way BRT lane, the station should have minimum width of 3 m and the station length depends on the number of docking bays and bus type. Key to the effectiveness of this station design is the staggered nature of the boarding areas. This maximizes the use of interior space and prevents customer congestion that may occur when vehicles travelling in opposite directions arrive at the station at the same time.

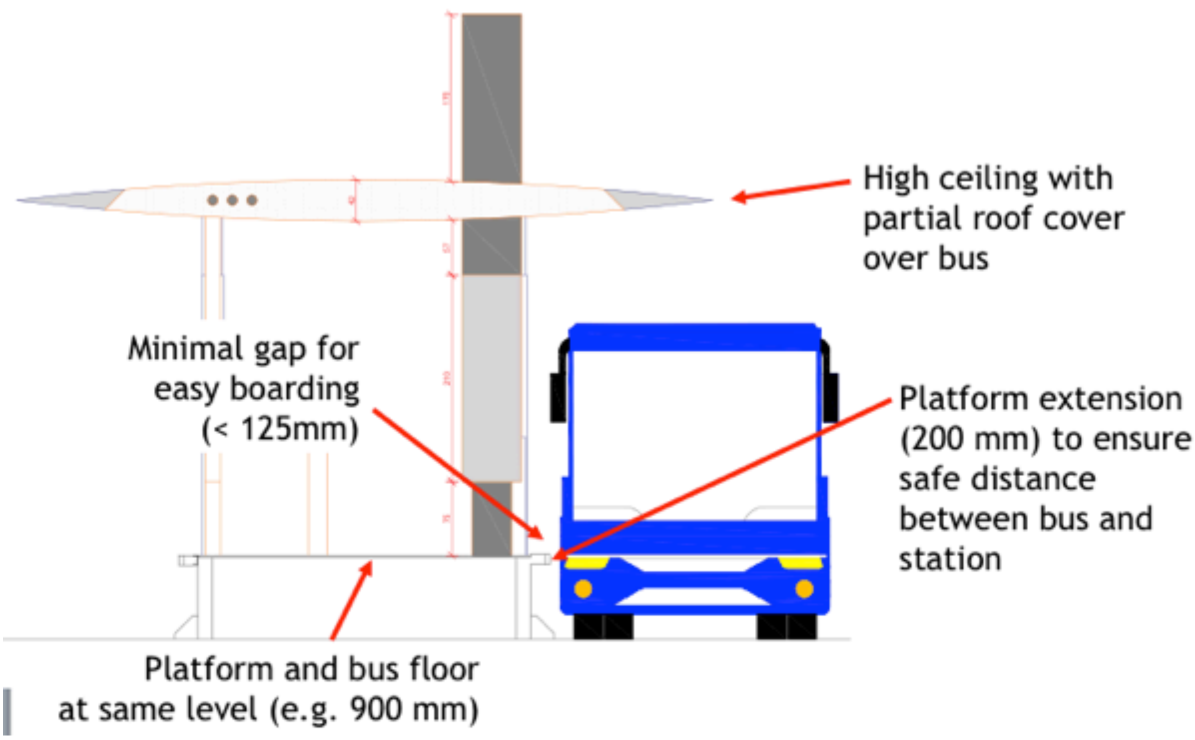


Figure 53: Station cross section of station-bus interface illustrating key station features

The above diagram (Figure 53) illustrates four key design features of Coimbatore's BRT stations. Coordinating the height of the vehicle and boarding platform, as well as minimizing the gap between the vehicle and the station are especially necessary. Also to enhance customer comfort and provide a much different experience than the traditional urban bus, it is important to protect the waiting and boarding area from rain and sunlight. The roof should provide adequate shade and be protective from rainwater blowing or seeping into the station. A direct rainwater collection and transfer system is necessary to easily route water from the roof to the ground without overwhelming the bus lane or the station facilities.

Figure 54: Stations require adequate space for boarding, alighting, and internal circulation

8.4 Carriageway / bus lane specifics

Throughout the corridor and at station area, the bus lane must be cement concrete. Asphalt pavement is not recommended as it will soon settle due to the repetitive load of bus tires in same position every day. This will lead to divots in the asphalt and imbalances in the floor levels of bus and hinder vehicle docking operations.

To make customer access safe and convenient, speed tables and raised pedestrian crossings must be constructed at each customer entrance ramp. It is very important that the height of the ramp and the speed table level are the same so that level access to the boarding ramp from the raised crossing is ensured.

Figure 55: Cement concrete surface for BRT lanes and stations.

8.5 BRT extension stops

The service extension proposed on Sathyamangalam Road will not include dedicated busways or centrally located median stations with dual side boarding. While extension services on Mettupalayam Road will be limited and dedicated bus stops provided on the curb at the left side. Most BRT services will utilise high-level boarding platforms, and require doors with a high floor on the right side.

Because BRT vehicles will also need to utilise extension bus stops, they must be also be equipped with doors on the left side. Extension stops will not be high-floor stops, so the vehicles will require stairs at the left side door.

Extension stops should include the following key features:

- The bus should stop parallel to, and as close to the kerb as possible to allow effective use of the BRT extension facilities.
- The critical dimensions to consider are the vertical gap, or step height, from the kerb to the bus floor and the horizontal gap from the kerb edge to the side of the bus. A well-designed bus stop will provide features which co-ordinate with the bus floor and minimize these two distances.
- Kerb bulb-outs (where the pavement extends out to the travel lane) are recommended to reduce the gap between the kerb and vehicle, as well as maximize the space available for the shelter and street furniture for waiting customers.
- Protected curb ramps are recommended for all extension bus stops. This will allow people with mobility challenges (permanent or temporary) to safely navigate from the bus shelter to the bus if it is unable to dock at the designated kerb space and must board customers in the middle of the carriageway away from the bus stop.
- All bus stops should include shelters that provide waiting customers the following:
    - Ample seating and waiting area that is facing the travel lane and adjacent to the boarding area.
    - Protection from the elements (sun, rain, etc.)
    - Durable construction that is resistant to vandalism and weather conditions
    - Open sides for greater safety and security
    - Clean and regularly maintained facilities
- Bus stops must include facilities for securely parking cycles and hand-powered tricycles to support multi-modal journeys.
- The area adjacent to the curb must be clear of such items as trash receptacles, vendor boxes, utility poles, benches, and shelters. The paved area of the curb bulb must be directly connected to the footpath.
- A 1,200 mm wide path of travel between the shelter and vehicle entrances must be designed, and more importantly, maintained to prevent obstructions to the front and/or rear doors.
- It is especially important that advertising kiosks, if provided at shelters do not encroach on the 1,200 mm clear path of travel described above. Advertising placement must not obstruct the view of approaching transport vehicles and traffic.
- Similarly, a clear 1,800 mm path of travel is necessary behind the bus stop so that pedestrians travelling along the corridor are able to seamlessly pass the bus stop without interruption.
- A uniform illumination level of 150 lux should be maintained throughout the bus stop

All BRT extension stops must include static stop name, system map and general customer information signage. These stops must also be equipped with dynamic visual and auditory displays to deliver in real-time vehicle arrival timings and system messages (service delays, temporary service route adjustments, emergency messages, etc.).

Regarding specific access for people with disabilities, it is important to note that BRT extension stations will not be accessible to wheelchair users. Vehicle and BRT corridor designs prohibit low-floor, level boarding on extensions. BRT extensions stations will feature the full slate of accessibility features described below (Section 8.6), besides level bus entry.

8.6 Access to stops and stations

BRT interventions offer a great potential for transforming cities—but it is important to think about for whom the city is being transformed. ITDP strongly believes that when properly implemented, a modern BRT system for Coimbatore will follow the spirit of universal design[20], which advocates against "one design fits all." Universal design involves a fundamental shift in thinking about design, particularly with regard to designing to address social difference.

Figure 56: (left) Man with crutches easily accesses Janmarg stations and (right) Tricycle users benefit from BRT corridor cycle tracks (photos by Meena Kadri).

It is important to design all BRT facilities so that they are usable by all persons regardless of their abilities, age, gender, or income (Figure 56). Inaccessible infrastructure in particular ensures that people with disabilities remain invisible in the public arena. To provide consistent and safe accessibility, the built environment and transportation systems must comply with 1995's Persons with Disabilities (PWD) - Equal Opportunities, Protection of Rights and Full Participation - Act. The PWD Act specifically entrusts the government with the task of appropriately allocating public resources so that plans and programs do not discriminate against persons with disabilities.

It should also be noted that as of March 2007, India signed the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD). The UNCRPD requires that signees take appropriate measures to ensure to persons with disabilities access, on an equal basis with others, to the physical environment, to transportation. This it is necessary that buildings, roads, transportation and other indoor and outdoor facilities be designed and implemented in such a manner that enable persons with disabilities to "live independently and participate fully in all aspects of life."[21]

[20] http://en.wikipedia.org/wiki/Universal_design
[21] http://www.un.org/disabilities/default.asp?id=150

To provide access for all people, Coimbatore BRT stations must be vigilant to include the following features:

- Station pedestrian crossings that provide an accessible path of travel that is at least 1,200 mm wide and preferably with level or have the gentlest possible gradient that does not exceed 1 in 20.
- The accessible path of travel should have a continuing common surface not interrupted by steps or abrupt changes in level. Ramps, fare gates and boarding platforms must accommodate wheelchairs.
- Obstacles such as lighting columns, bollards, signposts, seats and trees, should be located at or beyond the boundaries of walkways. Where unavoidable, protruding objects should not reduce the clear width of an accessible route or manoeuvring space.
- Free-standing columns that support an entrance canopy and low level posts, e.g. bollards, should not be positioned within the width of an access route.
- Tight bollard spacing and kerbed-medians that have been utilized by some systems to exclude 2 wheelers from the busway pose great challenges to people with disabilities. These techniques deny customers from accessing the system and are unacceptable.
- The required minimum clear unobstructed width of a ramp (i.e. between handrails) is 1,200 mm for ramps up to 3.6 meters long. For ramps longer than 3.6 m and up to 9 meters the minimum width should be 1,500mm. For ramps more than 9 m long the ramp should be minimally 1,800 mm wide.
- The materials selected for the surface finish of a ramp should be firm and easy to maintain. These must also be slip resistant, especially if surfaces are likely to become wet due to location or use, or if spillage occurs. The use of shiny, polished surface materials that cause glare should be avoided.
- A ramp shall have a level platform at the top that is at least 1,800 mm long, if a door swings out onto the platform or toward the ramp. This platform shall extend at least 300 mm beyond each side of the doorway. Each ramp shall have at least 1,800 mm of straight clearance at the bottom.
- A uniform illumination level of 150 lux should be maintained throughout the station.
- Visual information in all transport facilities should be supplemented with audible information. Station PA systems should be clearly audible.
- High-contrast, tactile warnings should warn customers with visual impairments of the approaching danger of the boarding platform. High contrast, tactile guide blocks should also be provided within stations to provide a path for visually impaired customers between the entrance, the fare windows / information kiosk and the boarding areas.
- Where auditory announcements are utilized, supplementary visual information should be provided to assist customers with hearing disabilities.

All Coimbatore BRT personnel that interact with the public (such as ticket sales professionals, security staff, fare inspectors, conductors and *especially* vehicle operators, etc.) must receive sufficient training in working with people with disabilities. Specific capacity building initiatives must be completed to ensure that future policies, programs and infrastructure do not discriminate against any customers (disabled or non). For additional details regarding the most recent guidelines for accommodating Indians with disabilities, please see the “Draft Indian Standards: Recommendations for Buildings and Facilities for Persons with Disabilities[22]” completed by AccessAbility[23] - a Delhi-based NGO.

8.7 Vehicles

The Coimbatore BRT vehicles first and foremost must be compliant with the urban bus design standards, as developed by the MOUD. Median stations with a high floor are demanded secondary to the characteristics of Coimbatore’s streets and the estimated high demand for public transport. Therefore, Coimbatore BRT requires high quality, modern buses with a 650 mm floor height with two centrally located doors on the right side as well as left side boarding via steps (Figure 57).

Figure 57: Indian BRT vehicle with right side, high-level boarding. Pune – PMPML

Two doors on the right side of the bus at 650 mm will allow for level boarding and alighting from the station (width of at least 1.2 m each and separated by at least 250 mm). Two doors on the left side with stepped entry will allow kerbside boarding and alighting when the vehicle leaves the dedicated bus ROWs (over the course of the BRT service extensions).

Initially, the BRT fleet should be comprised of 12 m vehicles that accommodate approximately 72 customers and 18 m articulated buses with capacity of 140 customers. Therefore, stations, depots and interchanges must be designed to accommodate the larger vehicles.

Similar to BRT stations, BRT vehicles must also be designed so that they are usable by all persons regardless of their abilities, age, gender, or income. The following access features (beyond the urban bus design standards) must be included on all BRT vehicles:

- Stanchions, grab bars and hand holds, must be provided so that people who are standing are able to safely react to bumps or sudden stops that the vehicle may encounter.
- Priority seating must be provided that is clearly identified as being reserved for people with disabilities, seniors, and mothers with small children, or pregnant women.

[22] http://uncrpdindia.org/files/reports/Core-Group-Accessibility-Physical-Access-Standards-Revised.pdf
[23] http://www.accessability.co.in/

- Approximately 800 mm x 1,200 mm of space on board BRT vehicles must be dedicated for wheelchair users (or other mobility device users). This wheelchair positioning area must be located adjacent to vehicle entry doors to facilitate right-side, high-level station access.
- Stop request buttons must be installed at locations of priority seating and wheelchair positioning.
- Auditory announcements of stop names and key destinations will ensure that people who are blind or visually impaired will reach their destinations
- If low-floor vehicles are purchased to provide feeder service to BRT stations, a manual ramp of sufficient slope (length) must be provided, so that conductors can provide assisted boarding from bus stops and from the ground level for seniors, wheelchair users and other people with physical disabilities.

Similar to station personnel, all Coimbatore BRT vehicle operators, conductors and service field supervisors, must receive sufficient training in working with people with disabilities. This will ensure that the policies and technology that is invested in facilitating access will be appropriately utilised and that no one will be denied service secondary to discrimination, or wilful ignorance of policy by staff.

Additional vehicle specifications are mentioned in Appendix 14.

8.8 Terminals and interchange stations

BRT system terminals and transfer / interchange facilities must be carefully planned. Such places are largely used by daily customers: transferring between services, accessing the system to reach destinations within the city, or leaving the system to connect to outside destinations. Public transport customers typically make two pedestrian journeys (to and from stations / stops) for each trip on the public transport system. Thus, these places are bound to handle enormous numbers of pedestrians on daily basis and may have multiple routes serving the location.

The following map (Figure 58) shows the entire planned Phase 1 BRT network in Coimbatore including:

- 7 terminals
- 4 interchange stations
- 66 regular stations (4 m wide)
- 4 regular stations (3 m wide)

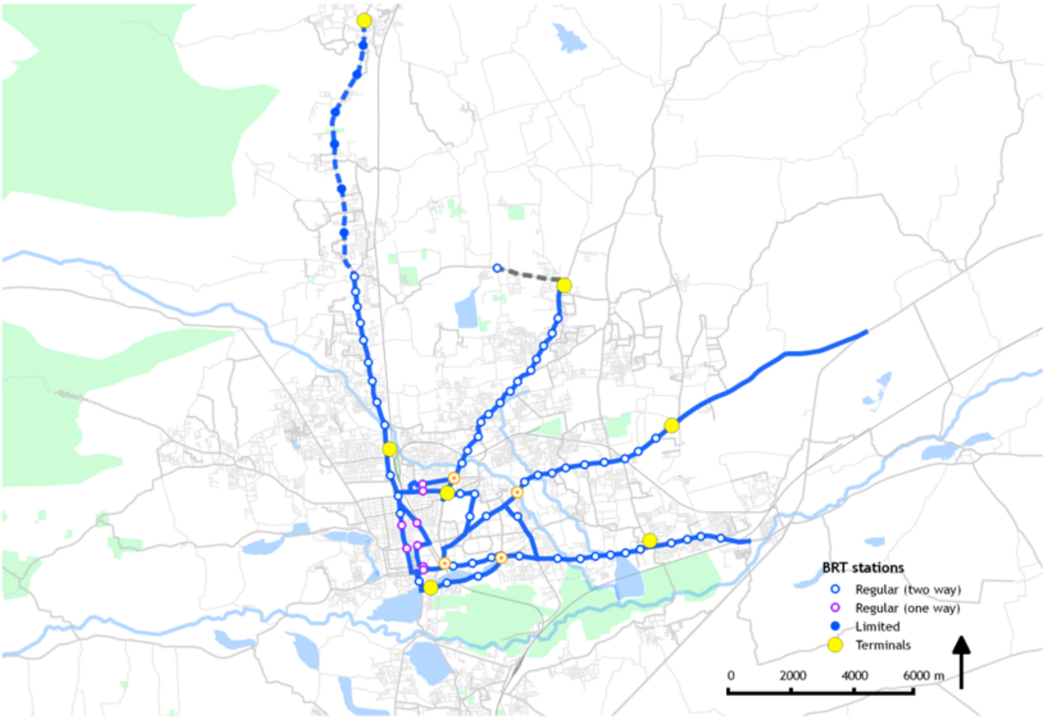


Figure 58: BRT Phase 1 showing Terminals and Interchanges

The challenge to be resolved in planning terminals and interchanges is balancing the needs of pedestrians, other modes of transport necessary to reach the stations (paratransit, cycles, etc.) and buses. It is import ant that Coimbatore plan for the infrastructure required by all BRT phases. All terminals along Phase 1 that are needed for any future phases must be constructed. Other terminals should be accounted for in the Coimbatore DPR.

1.1.1 Terminals and depots

The terminal areas in Coimbatore will be like large sized stations essentially located on off-street land pockets in close vicinity to depots. The terminal area will have BRT docking positions similar to station docks, with platform at 650 mm height from ground floor. Terminals generally will have more than one route, requiring an adequate number of platforms and passing lanes. Terminals will also have lower boarding platforms providing access to feeder services.

Figure 59: Transfer station between feeder and trunk BRT in Bogota, Columbia.

Coimbatore’s BRT terminal areas will be based on the following design principles:

- Provide maximum circulation area for pedestrians and commuters in and around the terminal
- Limit vending spaces inside the terminal. Some spaces can be officially allocated on annual auction basis to make the terminal area a vibrant place and provide commuters with extra services like pay and use toilet block, refreshment and books stalls, fruit and vegetable vendors etc.
- Restrict entry of auto rickshaws and private vehicles within the terminal area and its environs.
- Provide proper directional signage throughout the terminal area guiding the passengers. Ample static (printed) and dynamic (electronic) signage is very necessary in places with large volumes of travellers.
- Ensure quality infrastructure for administrative staff and those controlling bus operations.
- Provide facility of real time passenger information system with announcement and display
- Provide durable and large scale fare collection system. Terminals must be able to handle the large volume quickly for which sometimes more than 3 tickets counters and more than 10 flap barrier gates are required.
- Provide shelter and protect waiting customers from rain, sunlight and adverse climatic conditions.
- Provide adequate furniture for seating and secure waiting spaces (especially for women travelling in the evening) must to be included within these facilities.
- Clean and hygienic wash rooms and toilet facilities must be provided for men and women
- Co-locate terminal and depot facilities. A terminal area is generally located close to a depot that the kilometres of buses travel that are not in fare-service (dead kilometres) are minimized during start and end of the journeys.
- Plan for bus parking. During the off-peak times, a terminal area should permit the parking buses for at least more than 25% of the corridor fleet.

Detailed architectural design reports must be prepared for all of the terminals, incorporating the features listed above.

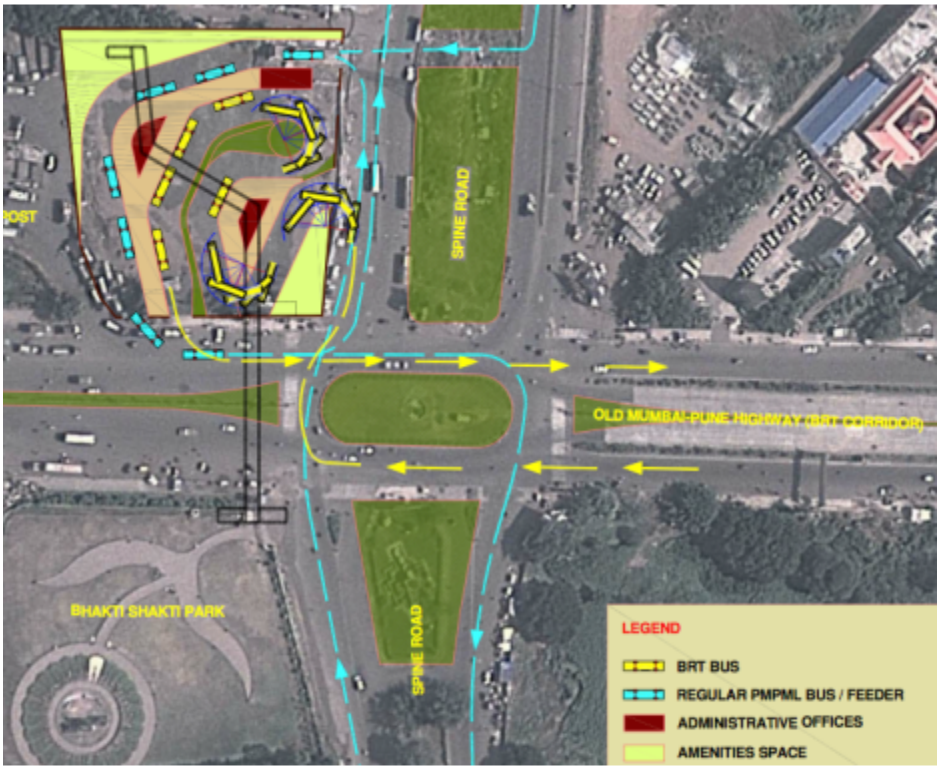


Figure 60: Conceptual design for a trunk-feeder transfer facility in Pimpri Chinchwad

It is important that TNSTC and Coimbatore BRT closely coordinate their facilities so that customers transferring between the two public transport providers are not inconvenienced. Facilitating transfers between public transport services is critical to improving all public transport usage. TNSTC operates many terminals in Coimbatore. Therefore it is important to assess how Coimbatore BRT terminals can be co-located with key TNSTC terminals.

The locations for Phase 1 terminals/ transfer stations are presented below. Some of these terminals are already functioning as depots for TNSTC buses and do have adequate space available for expansion.

Table 13: Proposed transfer station locations for Coimbatore BRT Phase 1

Terminal location	Interchange modes
Ukkadam	BRT-BRT BRT -Feeder BRT-TNSTC
Gandhipuram	BRT - BRT BRT-TNSTC
Ondipudr	BRT -BRT BRT-TNSTC
Saravanampatty	BRT - BRT BRT-TNSTC

Narisimhanaickapalayam	BRT-TNSTC
PSG College campus (opposite)	BRT-BRT
Mettupalayam	BRT-BRT BRT-Feeder

Land availability for new terminals may be an issue in Coimbatore currently but adequate space should be earmarked along all future BRT corridors. Similarly the locations for non BRT buses have been identified at Gandhipuram and Gopalpuram.

1.1.2 Large stations

Large stations are constructed where more than two BRT lines cross and customers are allowed to switch between different trunk BRT services. The station will have the facility of fare collection for those customers that are boarding the station from outside. However, it is especially important that these stations facilitate movement within the station's paid area. A customer will not need to buy a token or use a smart card when transferring within the large station. To facilitate this process, platforms must be the same height and adjacently located for multiple routes.

Wherever transfers are required between multiple trunk lines, and railway stations, large station facilitates direct transfer between a trunk BRT service and a regular city bus service or a BRT feeder service. In Coimbatore, large stations will also function as transfer stations.

The passenger without getting out of the terminal area can easily switch between different services within the same platform level. Large stations require the following key features:

- Passenger movement at same level on the common platform. Level differences, stairs should be avoided to the extent possible.
- Separate entry and exit for each service type facilitates smooth bus operations.
- Passenger information system both in terms of real time and static signage.
- No encroachment of any kind within the station.
- Adequate protection from weather conditions and provision for drainage utilities.
- Large circulation area for passengers facilitating ease of boarding and alighting along with waiting layovers.
- Off-board fare collection booths.

Large stations must be developed at below locations (Table 14) considering the phase 1 and 2 BRT routes as well as feeder services.

Figure 61. Example of Portal de Norte BRT station in Bogota with facilities for feeder buses.

Table 14: Phase 1 large stations

Location	Interchange modes
Coimbatore railway station	BRT-BRT (Phase 1) BRT -TNSTC
Anna Statue/Stanes School	BRT-BRT (Phase 1)
Sungam	BRT-BRT (Phase 1)
Head post office (rly)	BRT-Feeder (Phase 1)

8.9 Multi-modal integration

For Coimbatore's public transport system to function as a coherent network, passengers need to be able to transfer easily from one mode to another. Integration does not merely mean placing stations for multiple public transport modes close together. Instead, it involves the detailed design of stations incorporating the following features:

- Short, direct walking paths for transferring passengers
- Minimal level differences
- Adequate clear space to prevent bottlenecks
- Protection from sun and rain
- Public information
- Integration can also be enhanced through the use of a uniform electronic ticketing system. These features are described in more detail below.

Thus, we propose a set of minimum requirements for each major multi-modal hub. Needs will vary per location and context, but each multi-modal transport hub should at least include the following:

- A bus terminal (scaled to the existing connecting services) with an adequate number of well-designed bus shelters that have seating and information signage.

- Auto rickshaw stands are critical given the current demand for intermediate public transport and the potential for it to serve as a feeder service for BRT (Figure 62).
- At each station, at least 10 km of new footpaths, designated cycle parking on site, improved lighting, and public plazas should also be provided.

Figure 62: Designated paratransit stands should be provided at BRT stations to facilitate easy transfers.

Thinking broadly, the ultimate goal of Coimbatore BRT is to encourage transfers between public transport modes so that passengers have access to a wider network of origins and destinations. For this to be accomplished, *all* of Coimbatore's public transport modes must operate at a high level of efficiency. They must not act in competition with each other, but must collaborate so that each one prospers. In providing seamless connectivity at the most important transfer stations, public transport will be perceived as a viable alternative to travel by personal vehicle. This is an essential step in reducing the demand for two and four wheelers.

Figure 63: Connection between Janmarg BRT terminal (left) and Maninagar railway station (right), Ahmedabad.

It is envisaged that Coimbatore railway station, airport, and regional bus service stations will be the major multimodal integration locations wherein BRT services will be fully integrated with and supported by other modes of transport (TNSTC services, feeder services, shared auto rickshaws, and private rickshaws).

8.10 Corridor cross sections

Public streets operate with mixed-traffic, heterogeneous traffic streams containing motorised and non-motorised vehicles. These streams contain both conventional vehicle types such as private vehicles, buses, auto rickshaws and goods carriers as well as bicycles, cycle rickshaws, pedestrians, push carts and other vehicular forms. The mix of vehicles with such a wide range of dimensions and acceleration and speed capabilities means that there is not one convention for vehicle behaviour. Pedestrians also navigate these spaces, generally gravitating toward a position in the right-of-way that allows for uninterrupted movement.

BRT corridors in particular offer a powerful impact for improving streets for non-motorised transport (NMT). NMT provides basic mobility, affordable transport, access to public transport, as well as health and recreation benefits. Unlike rail-based mass transport systems where infrastructure is simply constructed along an existing ROW and station areas constitute only periodic potential for civic improvement, BRT corridors offers cities an opportunities to intervene on a much larger scale.

Because BRT stations are so close together (at most 500 m), NMT improvements, such as footpaths, street furniture, landscaping, cycle tracks, curb ramps and table-top crossings, and carriageways, must be provided continuously along BRT corridors. Thus, with BRT, Coimbatore will be able to transform entire urban passages and uninterrupted cross-cutting streets for all potential street users. BRT becomes not simply a new public transport service, but it emerges as a system through which urban areas are transformed and urban development is strengthened through increases in accessibility and mobility.

Based on site visits and GIS mapping of ROW using Google satellite imagery, ITDP developed appropriate cross section designs for each corridor.

Table 15: Phase 1 Corridor ROWs

CORRIDOR	SECTION NAME	SECTION ROW WIDTH (m)
Mettupalayam Road	Narismhanaickapalayam to Sanganoor road	20-30
Mettupalayam Road	Sanganoor road JN to Poo Market	10-20
Mettupalayam Road	Poo Market to Sukrawarpettai Road	10-15
Mettupalayam Road	Sukrawarpettai Road to Ukkadam	9-15
Avinashi Road	Neelambur to Hope College	30-40
Avinashi Road	Hope College to Lakshmi Mills stop	25-30
Avinashi Road	Lakshmi Mills stop to Stanes School	35-40
Avinashi Road	Stanes School to Marakadai stop	15-20
Avinashi Road	Marakadai stop to Manikondu stop	10-15
Avinashi Road	Manikondu stop to Ukkadam	15-20

Tiruchi Road	Ondipur to Ramanathapuram stop	20-30
Tiruchi Road	Ramanathapuram stop to Ukkadam	10-30
Sathyamangalam Road	Saravanampatty to Surya Hospital stop	20-25
Sathyamangalam Road	Surya Hospital stop to 100 Ft road	10-20
Sathyamangalam Road	100 Ft road to Gandhipuram	10-20

Based on site observations, the ROW on the proposed corridors were found to vary from 8 m to 30 m. Given the width constraints in city centre, BRT is still possible by having one way system on narrow sections (Figure 64).

Figure 64: Example of one-way BRT system in narrow streets of Bogota (left) and Quito (right).

Two-way BRT corridors can be implemented on streets of any width starting at 18 m. BRT corridors do require a wider cross section to accommodate stations. An additional 3 m to 4 m is needed at station locations; this width can be gained by temporarily discontinuing the parking lane on streets with on-street parking.

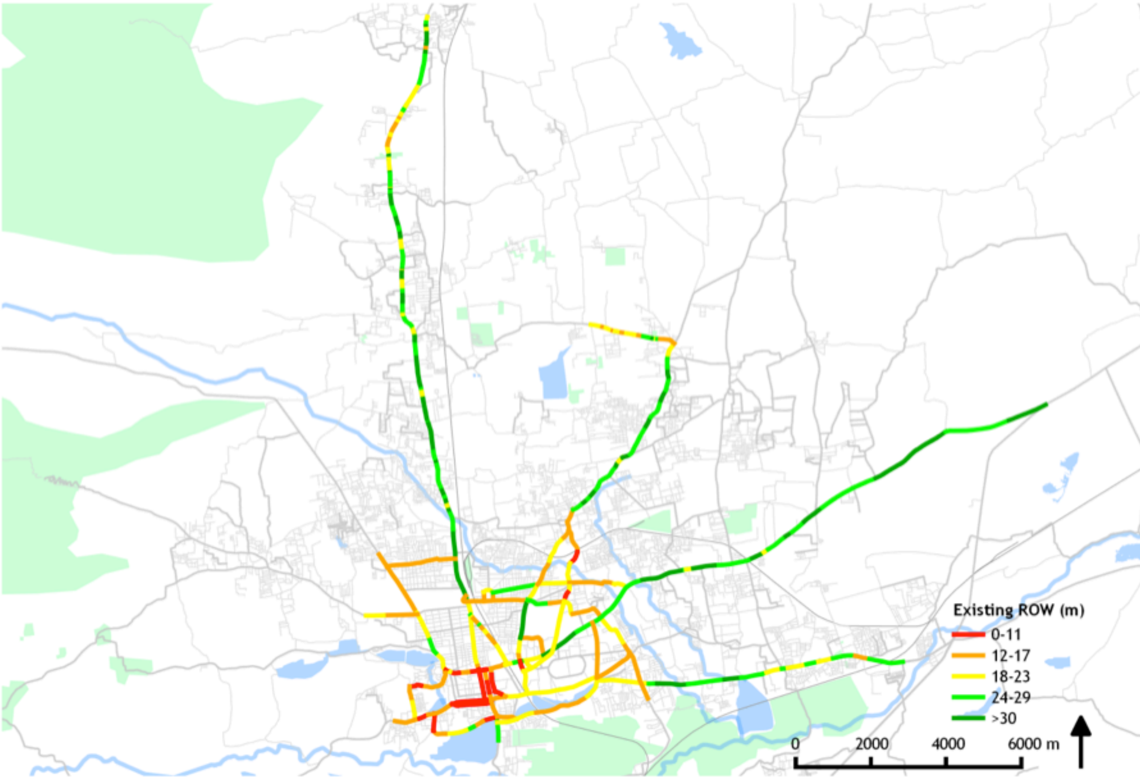


Figure 65: Detailed ROWs for Phase 1.

To introduce the proposed BRT corridor design sections, the importance of high quality pedestrian access must be again emphasized. If Coimbatore's public transport system is to facilitate the movement of *people not vehicles*, then BRT corridors must benefit all pedestrians— not just BRT customers. For example, existing pedestrian infrastructure, such as footpaths, plazas and crossings, must not be narrowed when corridors are redesigned to accommodate BRT busways and stations. Similarly, raised table-top pedestrian crossings must be provided along corridors (and at stations) to allow all to cross carriageways safely. In addition, median refuges between the bus and carriageway lanes will provide a place for pedestrians to wait before crossing the next stream of traffic.

Figure 66 illustrates a key organising principle to the BRT section designs, providing equal priority to NMT. For NMT modes to be viable and convenient, NMT users need adequate infrastructure—slow-speed shared spaces, footpaths, cycle tracks, and greenways—on which to travel. This means that BRT streets must need dedicated pedestrian footpaths or vehicle speeds need to be radically reduced in case of a shared space. Footpaths must be unobstructed, continuous, shaded, and well-lit. On BRT corridors with larger ROWs, cycle tracks are provided. In addition, the corridor designs will include provisions for street furniture and other elements like vendors, autorickshaw standing points, public toilets, city bus stops, and seating.

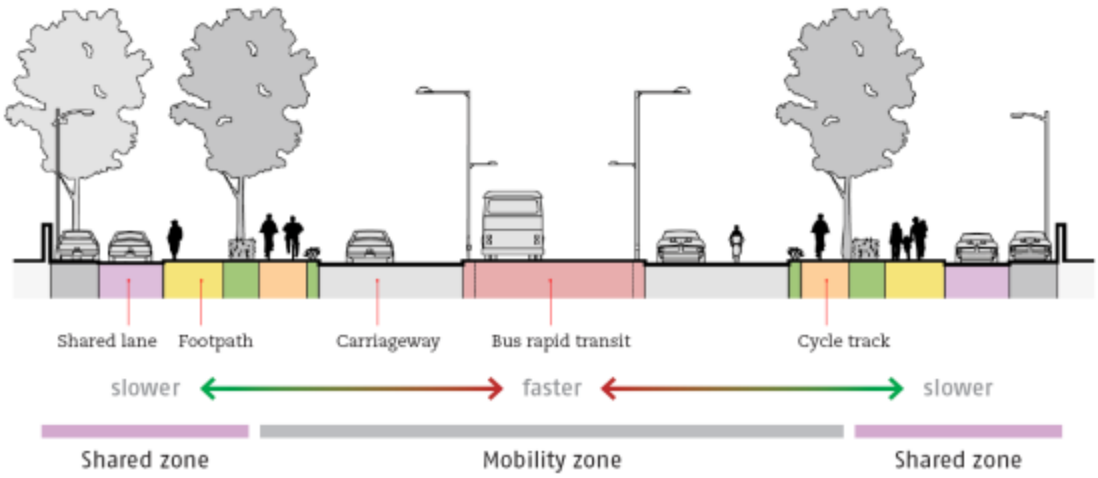


Figure 66. All streets require a slow zone that provides a safe space to walk.

Coimbatore's streets are public spaces for socialization and commerce as well as mobility. The *slow zone*—whether the entire right-of-way of a small street or a separate space on a larger thoroughfare—is space for liveability[24]: for people to walk, talk, and interact, for doing business, for children to play. The provision of an adequate slow zone recognizes that street themselves are destinations. It also enables streets to provide safe and uninterrupted mobility for all users regardless of their travelling speed. This results in a more pleasant street for everyone.

This section includes street design sections for wider road widths from 30 m, 24 m, and 22 m to narrow widths like 9.5m, and 9 m. Two types of sections are presented for each ROW width: one shows the cross section at BRT stations and other one showing the regular midblock section. The 4 m width required for the station is generally provided by temporarily discontinuing the parking lanes. Wherever the width is less than 10 m, the station width is taken as 3 m.

All sections include footpaths, carriageways, buffers and bus lanes for both one way and two-way BRT service. The mixed traffic carriageways immediately adjacent to the bus ways will be separated by physical barriers through the length of the corridor. In addition, the corridor designs will include provisions for street furniture and other elements like public toilets, city bus stops, seating, and spaces for formalized vendors.

All sections that include BRT station areas should also plan to include elements that support multi-modal integration. Autorickshaw standing points, secure cycle parking, or connections to TNSTC or Coimbatore Railway facilities will ensure that Coimbatore people can safely and easily use these systems to access Coimbatore BRT stations and stops (see Section 8.6).

A right of way with 30 m wide is available on certain sections of Mettupalayam Road, Avinashi Road and Tiruchi Road allowing for large footpaths with shade trees, area for parking and for social street uses such as public plazas or vending.

[24] Liveability implies that street designs recognize the relationship between the street and all of its users. Liveable streets are designed as public spaces that allow people to get from point A to B, but also support and encourage the activities people pursue in public spaces. Such streets are inclusive, multicultural, socially cohesive, economically vibrant, and full of life.

It is important to note that the 3.3 m for single BRT lane in each direction and 5 m carriageway width for two lanes each direction is taken as standard for the remaining (much larger) ROWs. Even as larger ROWs are available, it is recommended that this dimension be frozen and the additional space be prioritized for other uses besides traffic (such as pedestrians and cyclists). Keeping consistent carriageway widths will help prevent traffic bottlenecks.

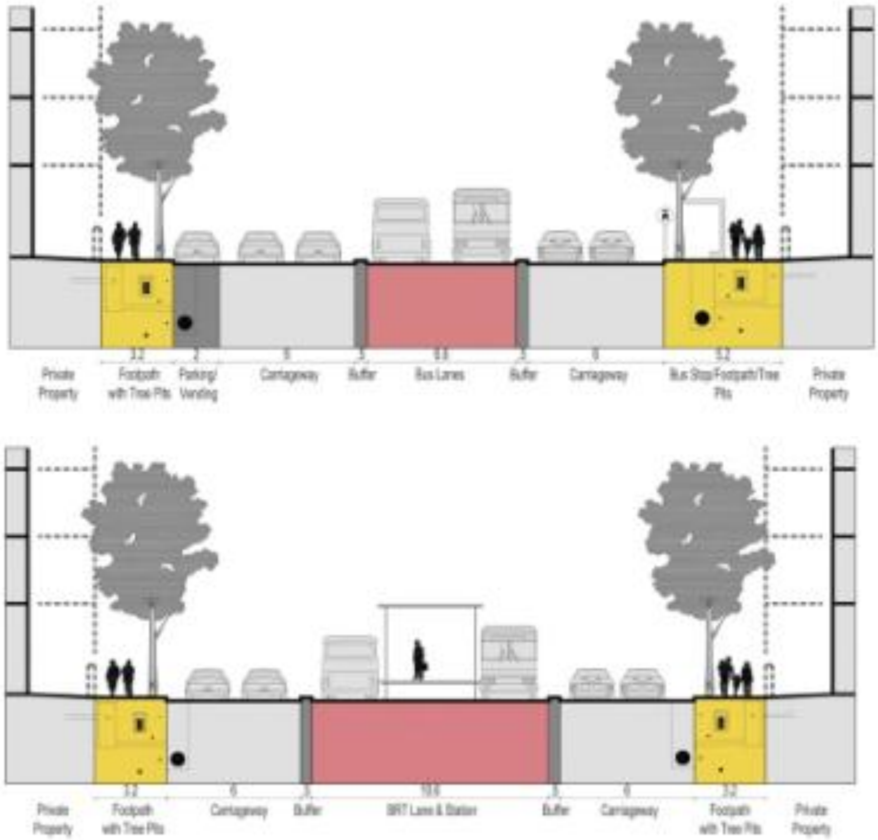


Figure 67: 30 m BRT corridor sections: midblock (top) and station area (bottom).

Some stretches on Avinashi Road, Mettupalayam Road have width of 24 m, allowing for two-way traffic and includes wide carriageways and footpaths on each side of the bus lanes. The midblock section allows space for shade trees and on-street parallel parking on stretches without stations.

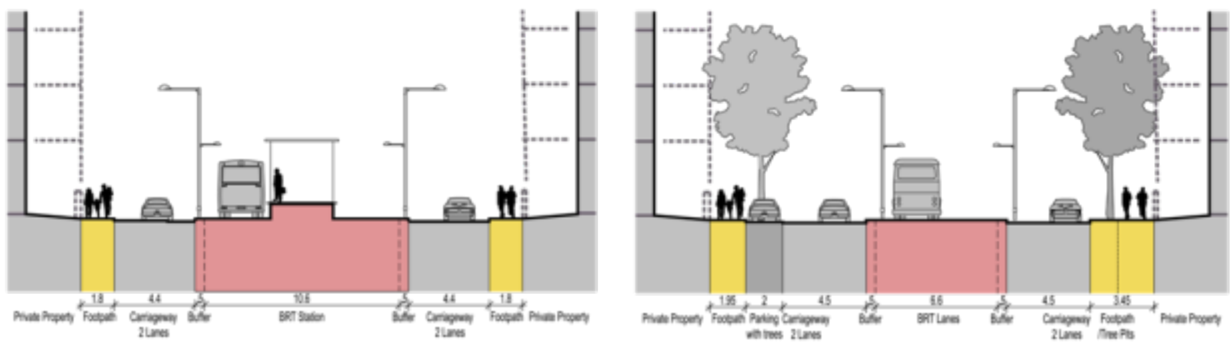


Figure 68: 24 m BRT corridor sections: midblock (left) and station area (right).

Some stretches like Huzur Road having width greater than 20 m, allows for one way BRT, two mixed traffic movement with cycle track and wider footpaths, space for shade trees on one side (see Figure 69).

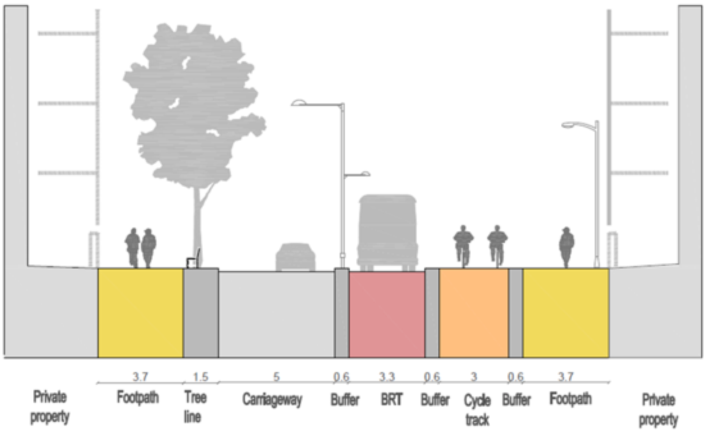


Figure 69: Huzur road: 22m BRT corridor sections with one way midblock.

Similar to the 22 m cross section, the 16.5 m section for Krishnasamy Road will accommodate both one way BRT lane and mixed traffic movement. Both sides of the street feature minimum of 2 m footpaths.

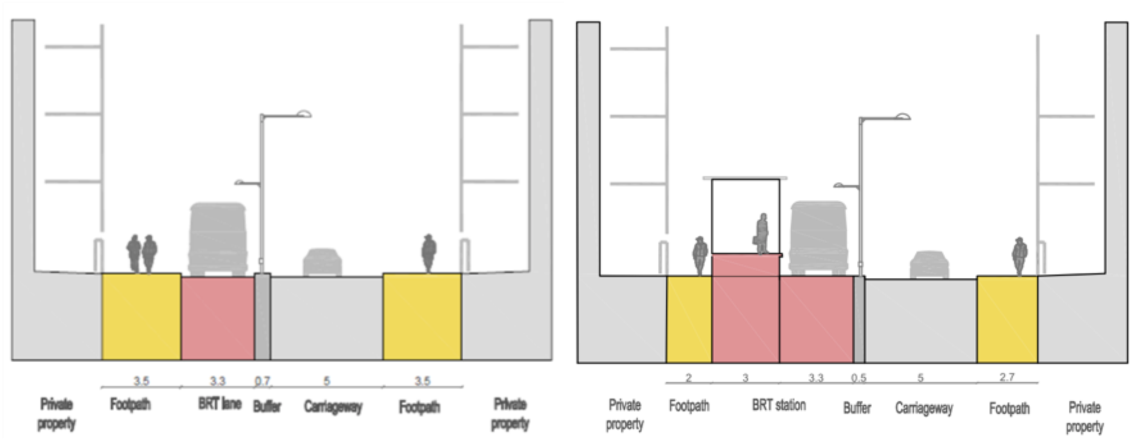


Figure 70: Krishnasamy road: 16.5m BRT corridor sections with one way midblock (left) and station area (right).

Some stretches that have transfer stations and road width more than 14 m allows for two-way BRT movement and one-way mixed traffic (see Figure 71).

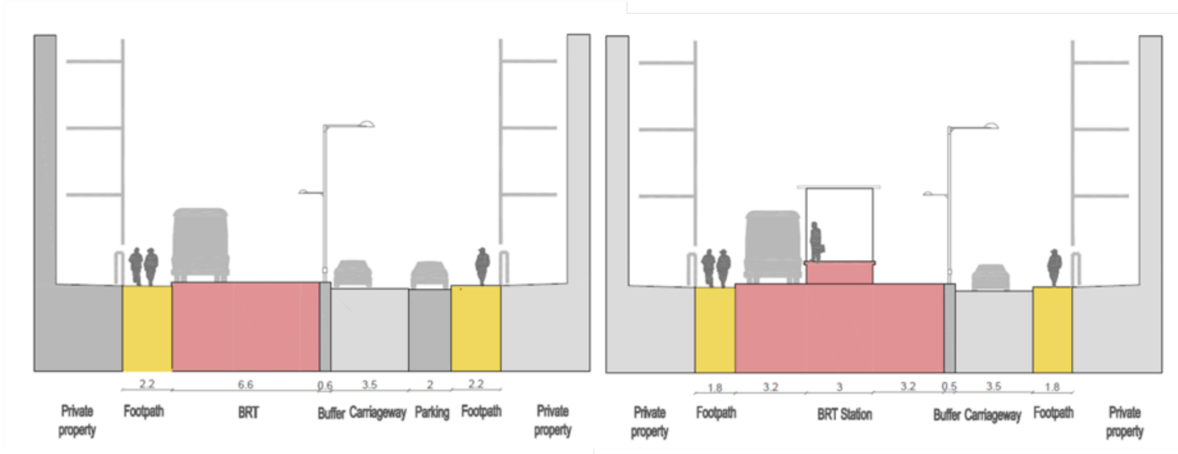


Figure 71: Coimbatore railway junction: 17 m BRT corridor with two-way movement (left) and transfer station (right).

Wherever there is width constriction or ROW less than 18 m, the sections only allow mixed traffic movement in one direction. This restriction on vehicle travel should be able to easily accommodate the demand because of the nature of the area's fine-grained street network and the proximity of alternate routes. In case of ROW less than 10 m, a dedicated one way BRT lane with narrow station area and pedestrian paths has been proposed (see Figure 72).

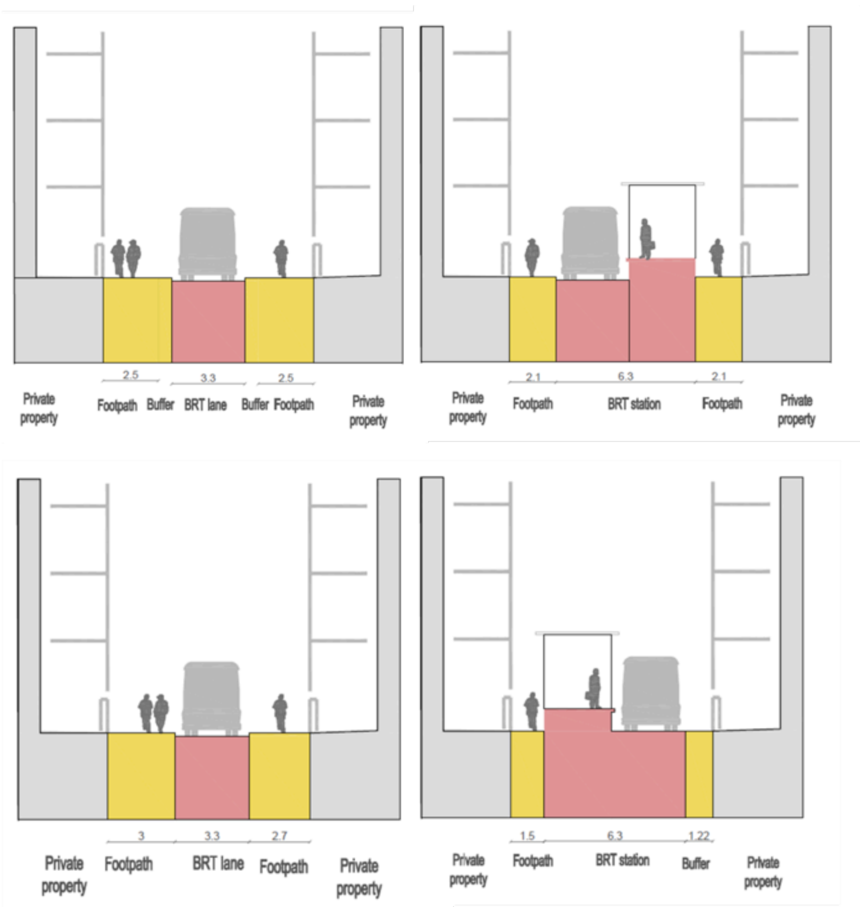


Figure 72: (Above) Oppanakara Street: 8.5 m BRT corridor section and (Below) NH road: 9.5m BRT corridor section with one way midblock (left) and narrow station area (right).

For all corridors, geometric design standards for BRT corridors are provided in the Appendix (See Section 16).

Presently, the traffic movement in the city centre is a one way route for both inbound and outbound. Some streets like NH road, Town Hall, and Oppanakara Street serve as one way link roads for Ukkadam, Mettupalayam Road and Avinashi Road. Due to heavy commercial activities and narrow widths, these roads are mostly congested and encroached with hawkers and on-street parking and high pedestrian movement. With these constraints, BRT can be implemented only if alternative roads are proposed to re-route the mixed traffic and make it dedicated for the system. This way it helps to improve the travel time and prioritises the lane for BRT only.

Based on site observations, NH road and Oppanakara Street were identified as one way pair for BRT lanes. For north bound mixed traffic, two wheelers will be allowed on Oppanakara Street along with BRT and four wheelers are required to take Rangai Gounder Street. For the southbound traffic, all the vehicles will be diverted from Mettupalayam Road via Krishnasamy Road and Goods Shed Road (see Figure 73). This way it helps the BRT buses to operate at higher speed and reduces the delay on these stretches.

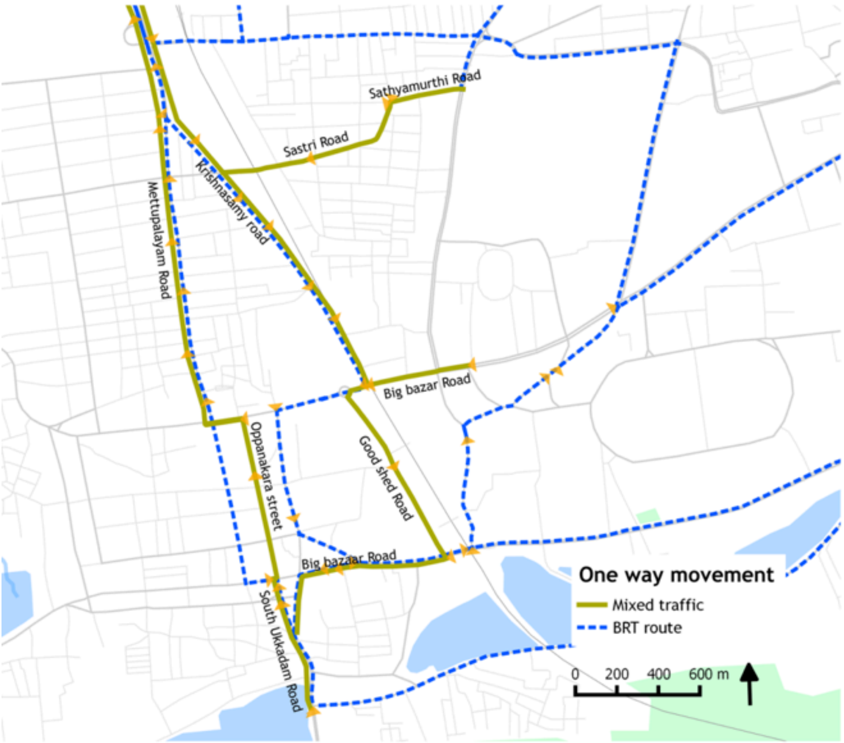


Figure 73: One way movement in Coimbatore CBD for BRT (blue) and mixed traffic (green).

A similar one-way street pair has been identified at State Bank and Government Arts College Road for both inbound and outbound traffic from Avinashi and Sathyamangalam Road. A loop system will be created where vehicles need to take detour from Town Hall through Government Arts College via Huzur Road to reach Avinashi Road. Another route will be provided from Avinashi Road through

State bank road to reach Town Hall. All the free left turns leading to State bank and Government Arts College will be prohibited and the vehicles are required to use the loop (see Figure 74).

Figure 74: One-way loop for inbound and outbound traffic from Avinashi Road.

8.11 Intersections

Intersection design involves weighing the potentially conflicting goals of safety and vehicle throughput. The quality of an intersection environment can vary significantly, depending on turning radii, the presence of refuge islands, the continuity of cycle tracks, and other design features. Intersections, rather than the standard section of a street, are the limiting factor in vehicle capacity. Therefore, intersection design needs to take into account the impact of design choices on mobility.

This emphasis on mobility should not be confused with an emphasis on private motorised traffic. Instead, it may be desirable to design an intersection in such way that prioritizes throughput of public transport, cycles, and pedestrians.

Squareabouts are a means of managing right-turning traffic at large intersections while minimising signal cycle time. Squareabouts make the right-turn phase obsolete by creating right-turn queuing space within the intersection itself. Vehicles queue in this space during one phase and exit during the next phase. Squareabouts are a valuable option on BRT corridors. While the BRT would require the addition of extra phases to a typical four-phase signal cycle, the squareabout accommodates all turning movements in only two phases.

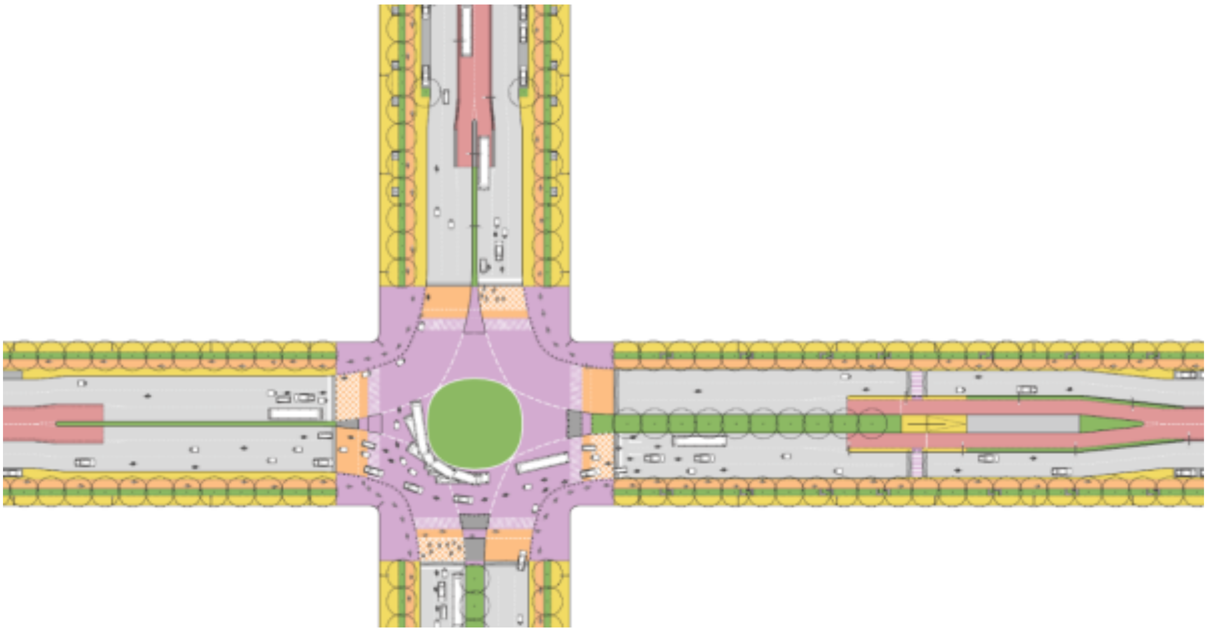


Figure 75: Typical squareabout design.

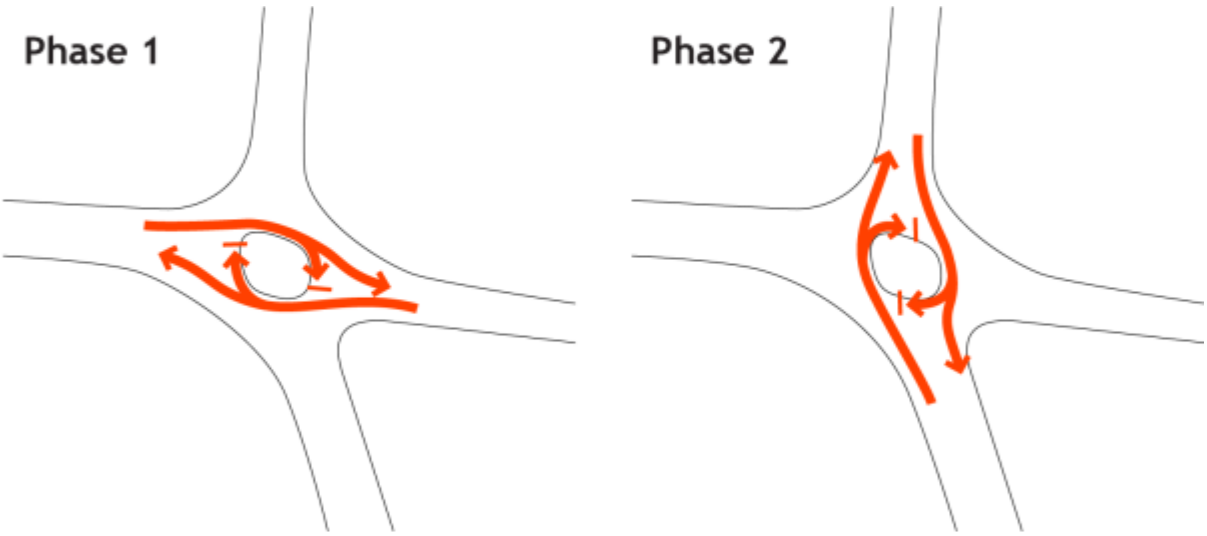


Figure 76: The signal phasing plan for a squareabout. Right-turning vehicles enter the queuing spaces during the first phase and exit the ahead of straight-moving traffic during the next phase.

Based on site observations and secondary data, there are around 70 intersections on the proposed BRT corridors. As said above intersection design involves intricate detailing of every movement happening during different signal phases. In view of pedestrian safety, turning movements and conflicts between mixed traffic and BRT, appropriate signal phasing has been proposed at four intersections. The phasing sequence has been proposed such a way there shall be minimal conflict, reduced delay times and queuing at the intersection.

Depending the lane type and location, the following key points were considered for signal phasing:

- Free left turn is mostly allowed but will be made permissive at required intersections.
- Eliminating right turn by giving priority to BRT and reducing the signal time at intersection.

- Queuing lane shall be provided either with lane marking or barricades on stretches where U-turn is allowed.

The following sub section presents the proposed signal phasing and suggested improvements for four intersections.

8.11.1 Sukrawarpet-Mettupalayam Road junction

The intersection is located on proposed BRT corridor from Ukkadam to Periyanaickampalayam via Mettupalayam Road. Presently Sukrawarpet road is a one way allowing traffic flow towards Avinashi Road and other nearby locations. Due to ROW constraints and merging traffic flow, the stretch from Oppanakara Street to Krishnasamy Road has been proposed as one way for both mixed traffic and BRT. From Town Hall, the mixed traffic is rerouted from Rangai Gounder Street and BRT on Oppanakara Street to merge at Sukrawarpet junction. As a result, the intersection becomes a critical point with too many disruptions and reduced speeds. To reduce these conflicts, the following solutions have been presented below:

- Reversing of one way movement at Sukrawarpet to allow northbound traffic towards Mettupalayam.
- Signalising of intersection with three phases by giving priority to BRT buses.
- No right turn allowed at the intersection.
- The stretch from Sukrawarpet to Krishnasamy junction is made one way for both BRT and mixed traffic.

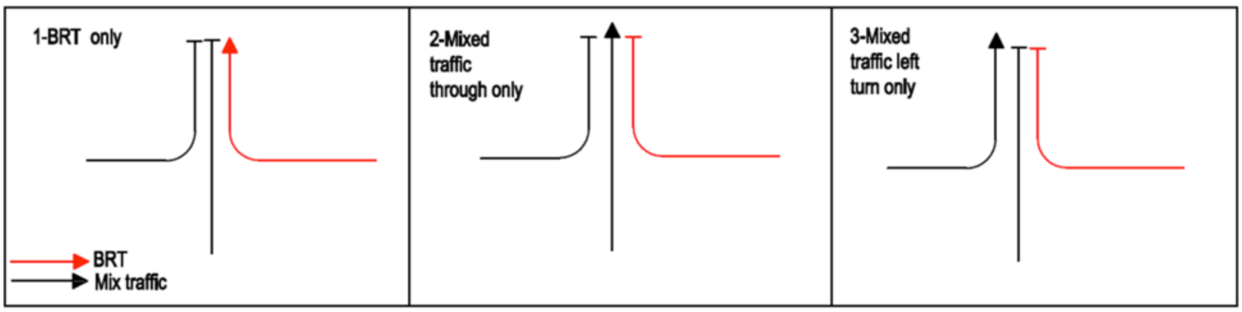


Figure 77: Proposed signal phasing with BRT services for Sukrawarpet Road - Mettupalayam Road intersection.

8.11.2 Mettupalayam Road to Krishnasamy Road junction

This junction is located on proposed BRT corridor from Mettupalayam Road to Town Hall through Krishnasamy Road. Presently Krishnasamy Road is a two-way traffic North-South direction. On the other hand, Krishnasamy Road is proposed as one-way for mixed and BRT traffic from Mettupalayam Road to Town Hall. Due to width constraints, the following solutions have been presented below:

- Two phase signal is proposed.
    - Phase 1 signal for BRT buses and through movement of mixed traffic only (towards Town Hall) and

- Phase 2 for mixed traffic right turn only.

- A signalised loop will be created at the island where vehicular traffic is allowed to make U-turn from Mettupalayam Road to T V Swamy Road and vice versa.

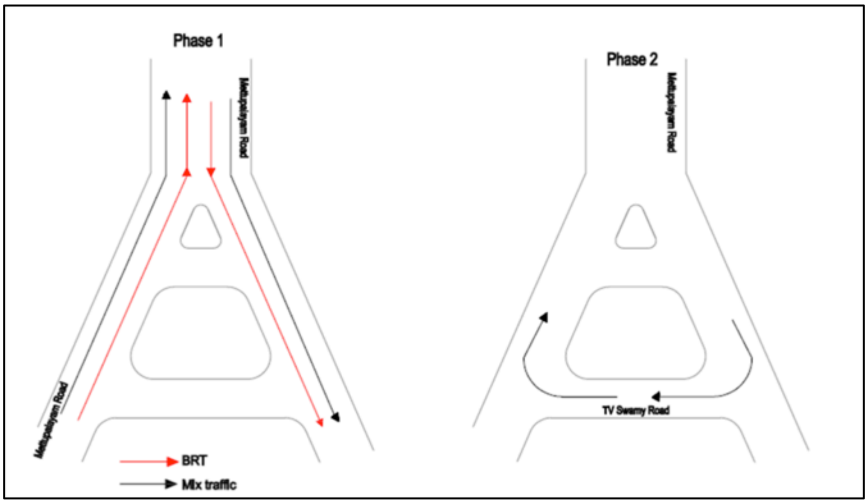
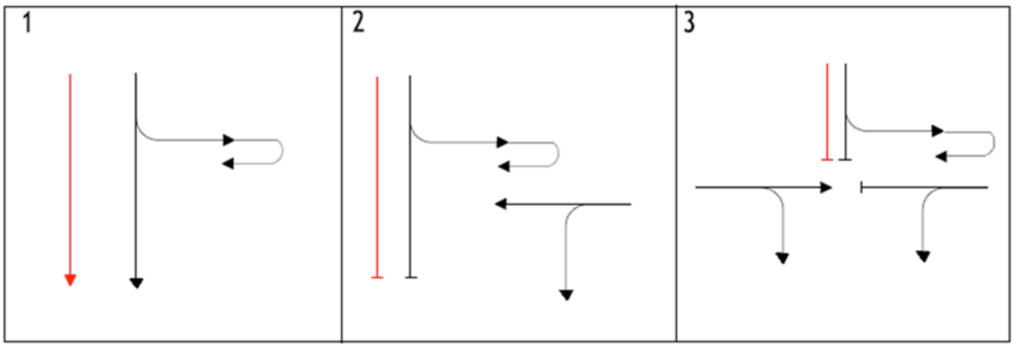


Figure 78: Proposed phasing at Krishnasamy road junction: Phase 1 for BRT and mixed traffic through movement only (left) and signalised right turn movement for mixed traffic in Phase 2(right).

As the BRT and mixed traffic approaches Sastri Road and TV Swamy Street, a conflict in the turning and through movement is likely to result in congestion and delayed clearance at the intersection. To keep the conflicts at minimal, a three signal phasing has been proposed for Krishnasamy – Sastri Road junction. For traffic proceeding to T. V. Swamy Street and Mettupalayam Road, the vehicles will be allowed to take a left and stay in the provided queuing lane until Phase 2 is green. To allow free left and adequate room for queuing, it is recommended to redesign that left arm of the junction (Sastri Road) by providing a roundabout (see Figure 79).



BRT and mixed traffic through for southbound and left turn	Mixed traffic with left and U-turn and through for westbound	Mixed traffic through and turning movements

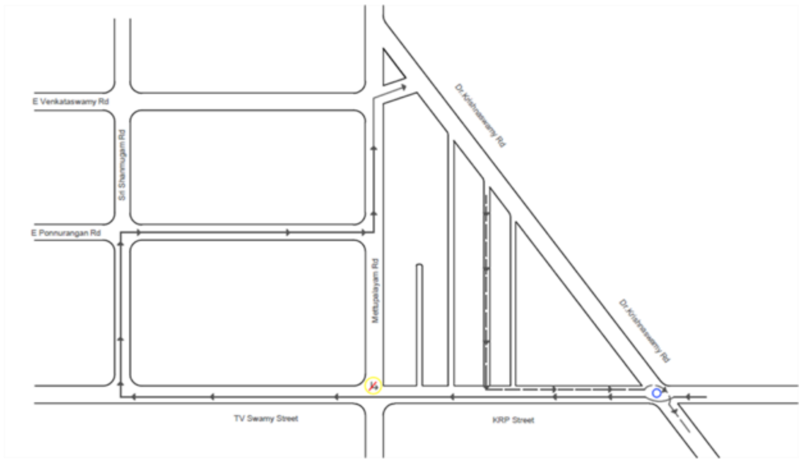


Figure 79: Proposed signal phasing for Krishnasamy Road-Sastri Road junction (above) and street plan indicating turning movement for vehicles proceeding to Mettupalayam Road (below).

8.11.3 Palakkad Road -Ukkadam junction

Ukkadam bus terminal is considered one of the important points serving South Coimbatore. Since most of the BRT and non BRT services start from Ukkadam bus terminal, the Palakkad road junction (outside the terminal) is likely to get further more congested. To reduce the conflicts and delay time, a three phasing signal has been proposed with inclusive of pedestrian crossing (Figure 80).

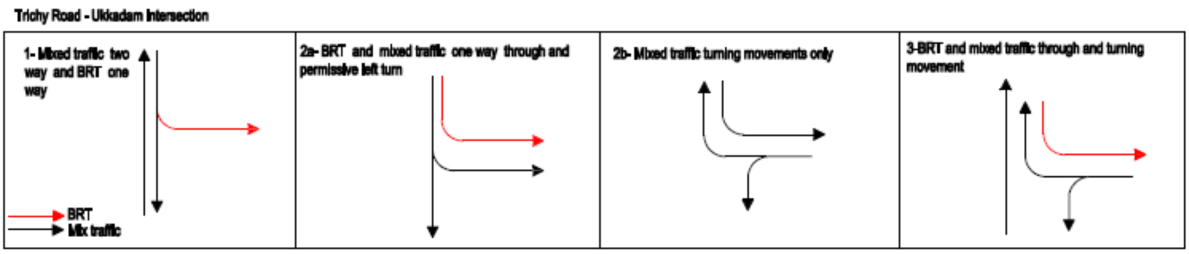


Figure 80: Proposed three phase- signal with BRT at Palakkad Road- Ukkadam junction.

8.11.4 Cross Cut Road-Bharathiyar Road

Similar to Ukkadam bus terminal, Gandhipuram is considered as another important bus terminal serving both city and regional public transport needs. In future this terminal will be upgraded to also accommodate BRT services also. Since all these buses exit the terminal and move on Bharathiyar Road to proceed towards respective locations. In this view point, a four phasing signal has been proposed for Cross cut road – Bharathiyar Road junction (Figure 81).

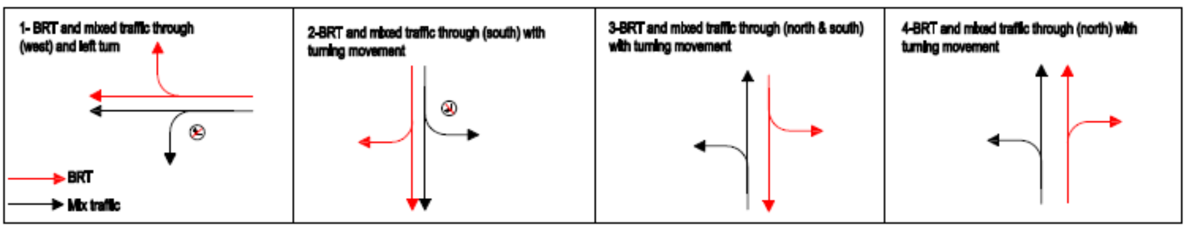


Figure 81: Proposed four phasing for both BRT and mixed traffic flow at Cross-cut and Bharathiyar Road junction.

8.11.5 Sukrawarpet Road- Mettupalayam Road junction

Since Sukrawarpet Road is narrow, it is difficult to accommodate both mixed traffic and BRT in the same width. To regulate traffic flow, two wheelers and BRT is allowed on Oppanakara Street and four wheelers on Rangai Gounder Street. Due to width constraints, traffic merging at the junction of Sukrawarpet and Mettupalayam Road is expected to cause delay and congestion. Taking into the account the present condition, a two phase signal has been proposed where BRT will be given priority (Figure 82: Proposed four phasing for both BRT and mixed traffic flow at Cross-cut and Bharathiyar Road junction.).

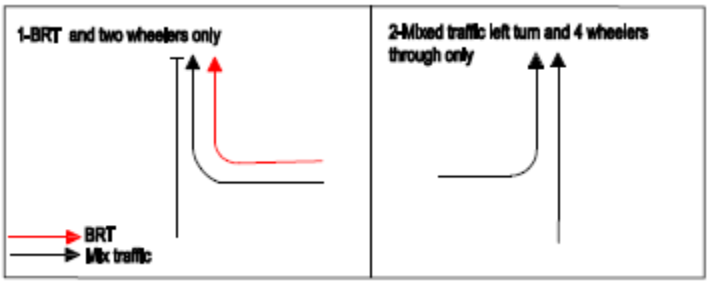


Figure 82: Proposed four phasing for both BRT and mixed traffic flow at Cross-cut and Bharathiyar Road junction.

8.12 Corridor design elements

To understand the full extent of construction requirements and costs entailed in implementing BRT in Coimbatore, the conditions of the existing paved road network and soil conditions must be evaluated. Toward this end, visual surveys of characteristics of existing pavements along the proposed BRT corridors in Coimbatore were conducted. Table 16 displays the findings of these surveys.

Table 16: Observed pavement condition in Coimbatore

No.	Corridor	Length (km)	Avg. width of paved area		Avg. width of unpaved area/shoulder		Avg. width of footpaths		Avg. width of median
			Left	Right	Left	Right	Left	Right	
1	Mettupalayam Road	23	8.6	8.7	4.0	6.5	-	2.0	2.5
2	Avinashi Road	20	10.9	10	5.1	5.2	2.0	2.0	1.8
3	Tiruchi Road	15	6.9	6.6	5	6.3	-	-	2.3
4	Sathyamangalam Road	14	5.1	4.7	3.9	1.0	-	-	1.9

Roads network in Coimbatore city consists of asphalt pavements. A visual survey of identified BRT corridors was conducted to assess their level of degradation in terms of cracks, settlements, pot holes, and rutting of pavements (Table 17).

Table 17. Pavement condition survey methodology.

Distress type	Description
Cracking	The severity of the cracking was rated.
Potholes	Number of potholes and patches was noted in corridor sections at intervals.
Rutting	The rutting extent along the corridors was observed.
Ravelling	The area and degree of severity of ravelling or stripping of asphalt surface was estimated for each section of corridor at intervals
Edge Breaking	Percentage of length of the affected areas at intervals
Shoulder Condition	Condition of unpaved shoulders was assessed.

The site visits reveal that Mettupalayam Road and Sathyamangalam Road suffer from poor pavement quality, with degradation affecting 30 to 50 per cent of the road surface (Table 18). The pavements along the BRT corridors can no longer cater to heavy vehicle loads. There is a need to redevelop road stretches chosen for BRT corridors as well as those connecting trunk corridors to improve their performance and provide better passenger accessibility.

Table 18: Coimbatore ROW / Pavement Survey

Corridor	Length (km)	Pavement degradation (%)	Remarks	Recommendation
Sathyamangalam Road	14	70%	Presently, Sathy Road when approaching city centre has good quality road surface, but will require resurfacing in the near future. Moving away from the city, the proposed BRT corridor has poor quality of pavements with lot of cracks.	Entire road stretch to be redeveloped to width as per DP. Some demolition will be required to reclaim the DP ROW.
Mettupalayam Road	23	60%	Majority of the road section has surface un-evenness. It is observed that surface has cracks, and uneven at many places. Presence of large amount of earthen shoulder and unused carriageway portion makes it more possible to develop it for BRT.	Entire road stretch to be redeveloped to width as per DP. Some demolition will be required to reclaim the DP ROW.

Avinashi Road	20	15%	Of all the roads in Coimbatore, Avinashi Road has good quality road surface and footpaths on some sections. This corridor is more suitable to develop for BRT.	Footpaths needs to be widened and BRT lanes needs to be developed with cement concrete surface.
Tiruchi Road	14	15%	Tiruchi Road has unpaved shoulder available with scope for BRT implementation possible with removal of encroachments	Entire road stretch to be redeveloped to width as per DP. Some demolition will be required to reclaim the DP ROW.

Figure 83: Existing pavement condition in Mettupalayam Road (left) and Avinashi Road (right).

8.12.1 Design of new pavements

BRT corridor infrastructure consists of important components like bus lane, station area, mixed traffic carriageway, service lanes, and footpaths, cycle tracks, landscaping, parking and vending area. Design for each component is described in detail below. To achieve pavement design and serviceability objectives, following methodology is proposed (Figure 84).

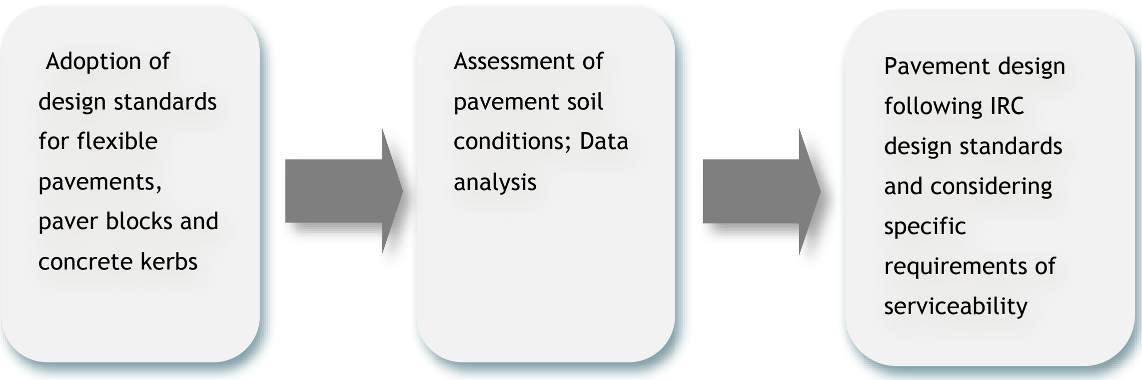


Figure 84: Pavement design methodology

The BRT implementing agency shall carry out a detailed assessment analyse soil conditions and, in cases where the existing pavement is to be retained, the pavement quality. All the geometric standards will be set based on recommended IRC guidelines and as per site-specific conditions suiting the operational requirements of the proposed BRT system. Existing medians will be dismantled and all the fixed objects such as kerb stones, electric poles, sign boards etc. will be removed. Excavation will be done up to required depth and the pavement will be redeveloped:

- Footpaths, public activity areas and parking areas shall be paved using concrete paver blocks. Interlocking concrete block paving on footpaths and parking areas are designed as per recommendations of IRC: SP: 63-2004. A typical design would consist of 65 mm thick interlocking blocks over a 30 mm sand bed and 75 mm brick bat cement concrete (or the reinforced cement concrete storm water drain). Parking areas shall have interlocking blocks of 85 mm thickness (minimum compressive strength of a single block 50 MPa), sand bed of 40 mm, base of WMM 250 mm, and granular sub base 200 mm of thickness.
- Cycle tracks will be made of cement concrete.
- Carriageways and service lanes will be developed with flexible pavement considering the high subgrade strength, low traffic loading, ease of construction, and low initial costs. The cross section design shall be based on the formulae for design of flexible pavements as per IRC: 37:2001.
- It is recommended to have cemented concrete pavement for BRT lanes throughout the entire Phase 1. BRT services will be operated at close frequencies and the repetition of the loading on the bus lane will be continuous. The area requiring more attention is at bus station where the bus will dock in the same position every 2 to 3 minutes. Experience from Ahmedabad’s Janmarg BRT system has revealed that having flexible pavement at bus station area will lead to pavement failure and potholes will be developed within 3 months of BRT operations. Improper workmanship even leads to cracking of concrete pavement.

Figure 85: Effect of repetitive bus movements at BRT stations in Ahmedabad (left) and Mexico City (right).

Equivalent Standard Axle (ESA) ratings for bus lanes will be derived from consideration of frequencies of buses in each direction. For the purpose of determining the design traffic, it is assumed that initially the frequency of buses may increase to 60 to 80 buses per hour over a period of 10 years. It is also assumed that buses will continuously operate on the dedicated bus lanes for 16 hours per day. Thus, the bus operations will have a continuous effect of laden weight of more than 10 tons. Buses will ply on a single lane in each direction, causing concentration of wheel loads in one lane only. On this consideration, lane distribution factor shall not be used for determining the design traffic. The vehicle damage factor (VDF) may be considered as 3.5 as per recommendations of IRC 37:2001. The VDF will take care of overcrowding in buses during peak hours. The design life for pavements should be taken as 10 years period considering rainfall and climatic conditions of the city.

The sub grade of the existing roads is composed of clayey soil having average 4 days soaked CBR value ranging from 8 to 10 per cent. For the design consideration, the 4 day soaked CBR value shall be derived. The pavement thickness and composition shall be taken for cumulative traffic range as computed from above. The design traffic as computed in terms of the cumulative number of standard axles for the bus lane and mixed traffic carriageway and pavement composition relevant to design traffic will be analysed.

The traffic volume plying on service roads will be lighter than that on the mixed traffic carriageway. With this consideration separate design of pavement crust for service roads can assume a lane distribution factor of –1, a VDF of 1.5, and an MSA of 1.

8.12.2 Storm Water Drainage

Adequately sized storm water drainage systems should implemented on all BRT corridors in Coimbatore. Storm water drains can be constructed beneath the footpath or cycle track, depending on the cross section. It will be a box type concrete drain or RCC pipe drain, whichever is suitable for each corridor. A representative storm water design section is shown in Figure 86.

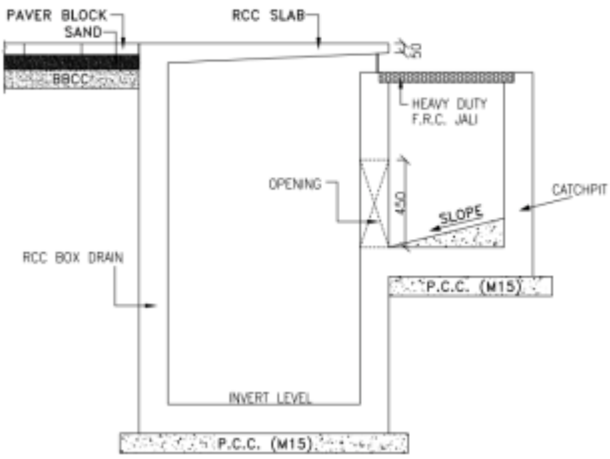


Figure 86: Typical storm water drain with catch pit.

Access shall be provided with manholes at regular intervals. The manholes shall be covered with airtight inspection covers. Care must be taken to ensure that the manhole cover and the joint between the drain access and the surrounding pavement are flush to ensure that these elements do not obstruct pedestrian movement.

Figure 87: Storm water drain positioned below a cycle track, showing adjoining catch pit.

8.12.3 Underground utilities

Shifting of utilities is one of the most critical aspects during road construction. It is recommended to dig trial pits to identify utilities prior to start of site clearance and dismantling existing roads of the accurate maps of utility alignments are not available. It is possible that different utility lines may exist below earth crust at varying depths. It is recommended to have all the utilities in a single utility corridor underneath the footpath or parking/vending area and ensure that they are not spread out throughout the entire right of way.

Old water supply and sewer pipelines shall be removed and new lines shall be joined to main connection with new alignment wherever required. During site clearance, care will be taken that communication lines (optical fibre cables) and other underground cables/lines for telephones, electricity, and gas are not damaged.

Electricity and communication boxes should be shifted and fixed at the edge of the ROW or in the parking/multi-utility strip to avoid creating an obstruction on footpaths. Similarly transformers and electricity poles should also be shifted to edges.

8.12.4 Street furniture

Electrical components like streetlights must be upgraded to ensure that the BRT corridors are safe for all users at night. The BRT implementing agency will also construct pay and use toilet blocks at regular intervals along corridors and install additional street furniture elements such as benches, tables, and dustbins wherever required.

"Bus only" lettering along BRT corridors, centre lines, edge line, and lane markings should be painted using thermoplastic paint. Directional signage, stop sign at intersection, traffic signs, and traffic signals should be installed. Bus and IPT stops will require shelters, lighting, and signage.

8.13 Depots

The major function of depots is to provide adequate parking to bus fleet and accommodate facilities to carry out regular maintenance and up keep. Separate workshops may be developed to carry out major repairs in the buses, but most repairs should be accommodated by depot facilities.

Bus depot locations that are far from the starting points of bus trips may result into increased operating costs. Therefore, the process of determining depot locations aims to minimise so-called "dead kilometres." Depot locations are also a function of real estate availability and pricing. For Coimbatore, we propose locations that balance the requirements of reducing dead kilometres and the availability and cost of depot land.

1.1.3 Phase 1 depots

Per observations and experiences with other Indian BRT system depots (Janmarg and PMPML), ITDP anticipates that 214 sq m of space will be required for 12 m bus and 327 sq m for articulated bus. Thus, for Phase 1 of the Coimbatore BRT, the following depots are planned:

Table 19: Proposed depot locations for Coimbatore BRT Phase 1

Depot location	Minimum area required (sq m)	Number of buses
Ondipur	30,000	140
Saravanampatty	17,500	82
Gopalpuram	7700	59
Neelambur	17,500	135
Sungam-TNSTC	38,800	118
Total	111,500	535

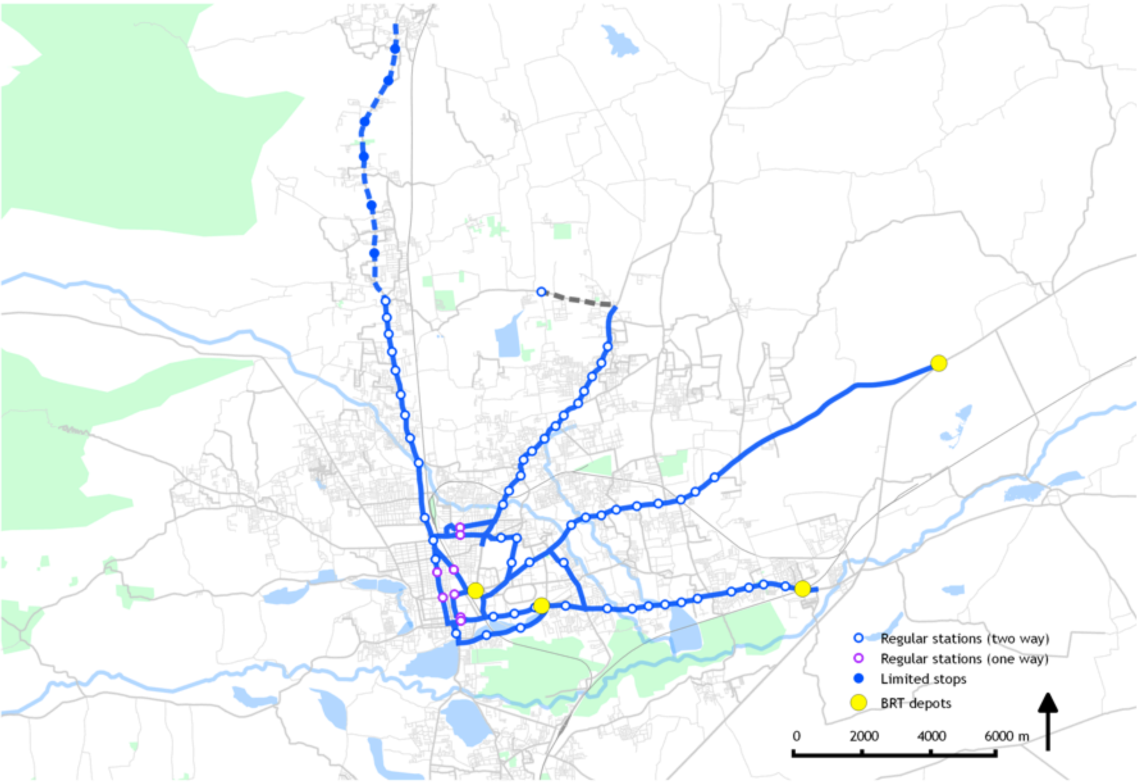


Figure 88: Coimbatore BRT Phase 1 Depot locations

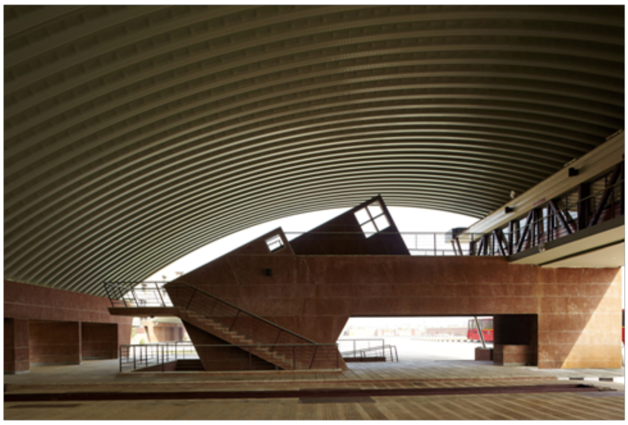


Figure 89: Conceptual diagram for depot facility to accommodate BRT vehicles (CEPT) (left) and BRT workshop in Surat (right).

In addition to the bus requirements, a depot also houses facilities such as rest rooms, refreshment canteens, and stay arrangements for drivers, conductors, supervision, and maintenance staff. A depot space has to be large enough to cater existing as well as future fleet additions.

The important components of a depot facility are enlisted below:

- Bus parking area
- Bus washing area with a ramp and a water flow channel

- Bus maintenance area
- Inspection pits and bays
- Storage of maintenance tools, equipment, materials etc.
- Store of tyres, batteries etc.
- Fuel pumps and fuel tanks
- Staff amenities like rest rooms, guest rooms, refreshment areas
- Staff Training and Meeting halls
- Manger's cabins and Security
- Landscaping
- Treatment of hazardous chemicals and toxic wastes before disposal in open environment.

Figure 90: Co-located Bus depot and terminal of the Transmilenio BRT system, Bogotá (Google maps)

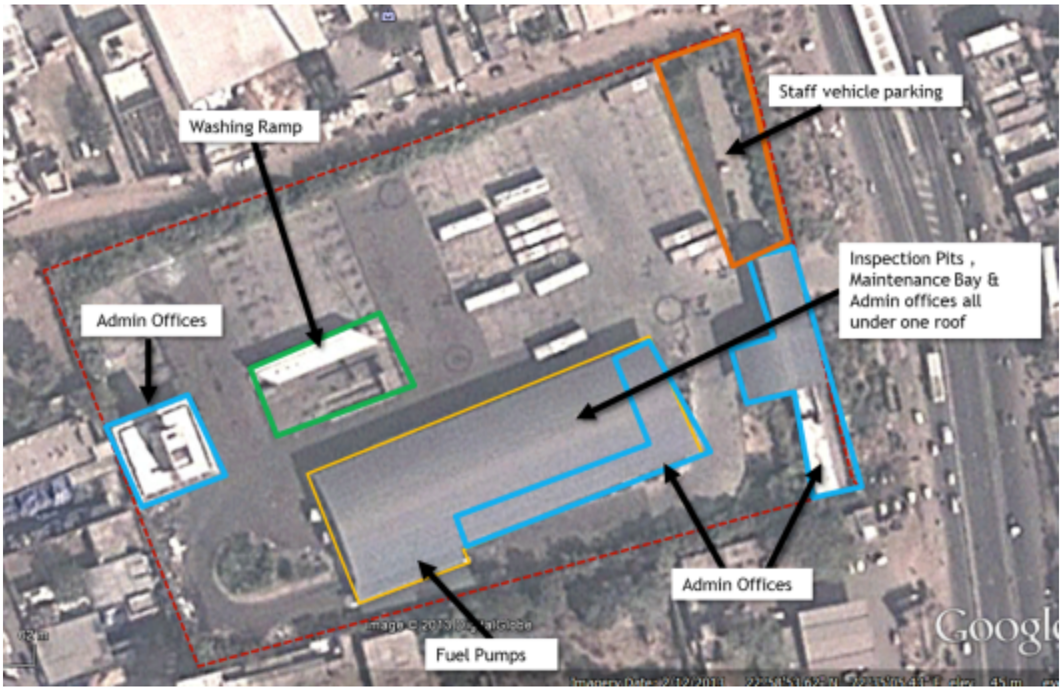


Figure 91: Chandola lake BRT depot, Ahmedabad.

At present, TNSTC holds the control over existing depots in Coimbatore. Some of the existing terminals like Ondipudur and Sungam depot do have sufficient space to accommodate Phase 1 BRT buses, however requires reconstruction of the depot. While for other locations like Neelambur and Saravanampatty, the BRT implementing agency needs to identify land to accommodate both BRT and non-BRT buses in Phase 1. In addition, the BRT implementing agency shall identify and acquire additional depot space for the Phase 2 BRT corridors.

1.1.4 Future depot planning

Land availability for future depot locations is a concern as there is no reservation in the development plan for such facility. ITDP estimates that the Coimbatore BRT will be responsible for a growing percentage of local bus service by 2031. It is likely that the city will need to operate about 1,472 buses by that time to meet the anticipated travel demand (based on our estimates of population growth and motorisation).

It is estimated that a total of 16 depots including existing ones with a capacity of 80 buses each will adequately house the required fleet of 1,472 vehicles. Therefore Coimbatore will require a total of 0.26 sq km of land for these depots by 2031.

9. BRT supporting elements

9.1 Pedestrian and cycle access

Every public transport trip begins and ends with a walking component. The success of public transport and its ability to reduce dependence on private vehicles is governed largely by the ease and comfort of pedestrian access to transit stops. A user who is forced to compete with traffic and navigate through cluttered footpaths in the sun before he reaches the public transport system is less likely to use public transport than a user who gets to walk on a shaded walkway that is active, well-lit, clutter-free, and continuous. Therefore, providing high quality footpaths is essential to the long-term viability of Coimbatore's public transport system.

All pedestrian footpaths must have:

- Continuous, unobstructed space for pedestrian movement. The size of this space is planned in accordance with observed pedestrian volumes and should be a minimum clear width of 2 m. Separate additional space is required for trees, utilities, planting, shop frontages, and vendors so that they do not encroach into the clear space. While 2 m is the minimum width, it is adequate for movement of only 800 pedestrians per hour. Width should be increased by an additional half metre for every subsequent 800 pedestrians per hour on the footpath. Pedestrian facilities become desirable when they are wider than the technical minimum so that people do not have to walk in a crowded condition. Wherever possible, they should be made wider than the technical minimum as stated above.
- Continuous tree cover to provide shade. Shade is particularly important in Coimbatore's hot, humid climate. Trees can reduce the perceived temperature by up to 8°C and make walking comfortable. The location and design of pedestrian paths should take advantage of existing trees. Wherever possible, existing trees should be retained on BRT corridors and additional trees may be planted where there is a gap in shade.
- Minimum level differences at property entrances and intersections. Abrupt and frequent kerb cuts require pedestrians to constantly step up and down and therefore discourage them from using footpaths. Negotiating level differences at property entrances and intersection with suitably aligned ramps is essential to ensure a comfortable walking experience. Otherwise, pedestrians are forced to walk on the carriageway, thus reducing the total effective width for vehicles.

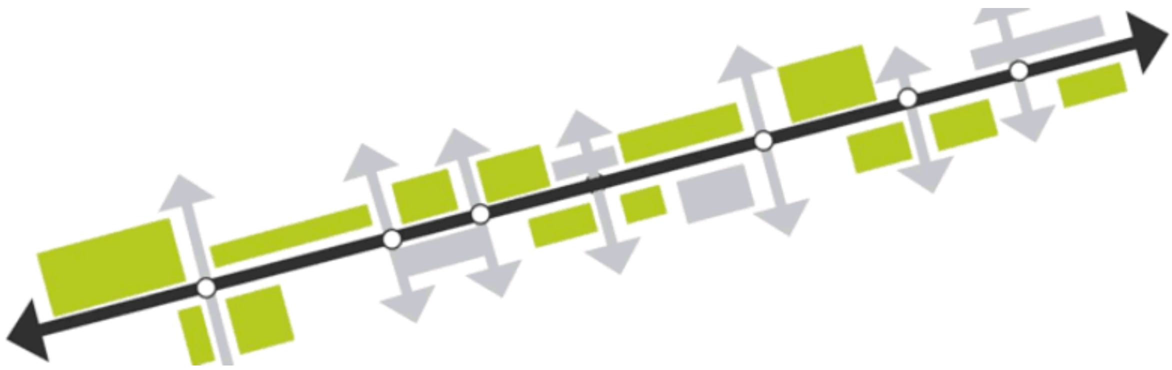


Figure 92: Pedestrian help integrate BRT corridors with the surrounding urban fabric

High quality pedestrian facilities should be developed within a 500 m radius of each BRT station. This will significantly improve accessibility and increase ridership of the BRT system. Shifting a greater share of travel to walking and combining walking with public transport trips is an effective way of reducing congestion and pollution. ITDP has developed a manual for street design for Indian cities.[25] This manual can be used as a guide for developing pedestrian facilities and other elements of street design.

Increasing walking access to public transport can give people with limited transport options access to more opportunities and services and reduce demand for parking facilities around stations. Providing better pedestrian access also increases public health benefits because the average public transport user is much more likely to achieve the recommended 30 minutes of moderate intensity physical activity a day.

Figure 93: Safe, convenient access for pedestrians and cyclists should be provided at all Coimbatore BRT stations.

9.2 Information and signage integration

Keeping the passenger informed at all times is crucial to making public transportation user friendly and desirable. Bilingual information is particularly useful in reaching out to a larger populace. At present, the lack of information on existing public transit routes and their timings discourages the use of public transport. Such information is usually only gathered from fellow passengers waiting at transit stops or from commuting on a daily basis along the same route.

For the BRT to work to achieve its full potential, it is essential to do the following:

- Display on-board schematic maps of the BRT network that indicate interchange points with other public transport systems

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[25] Institute for Transportation and Development Policy and Environmental Planning Collaborative (2011). Better Streets, Better cities: A Guide to Street Design in Urban India. <http://www.itdp.org/documents/BetterStreets111221.pdf>.

- Keep passengers informed through on-board automated announcements
- Display arrival times of the next bus to reduce the anxiety of waiting
- Provide information and maps for smart travel, highlighting walking, cycling, and public transport routes
- Before boarding, passengers need to be able to determine the routes that are available for travelling to the desired destination, transfer points, and departure times. Once on board, passengers need to be informed about upcoming bus stops and transfer opportunities.
- Public transport systems need to be simple and easy to understand. All information should be up to date because unreliable and out-of-date information pushes existing and potential passengers to distrust the system and look for alternatives.

9.3 Integrated ticketing

The use of electronic ticketing and smart cards provides a way to pay for a multi-segment trip as if it's a single trip. Combining all fare purchases into a single instrument encourages public transport use. The same smart card system can be designed so that it can also be utilized by TNSTC operated city buses, autorickshaws, taxis, or CCMC parking systems simply by validating it on ETMs or other compatible card reading technologies.

Electronic fare collection through a common pre-paid ticket or smart cards usable on all modes of transport saves time and can be used to reduce the monetary penalty for switching from one mode of transport to another.

Having such a system in place is critical to the success of BRT as well as other public transport systems because:

- It enables passengers to easily switch modes at interchange stations without queuing to buy another ticket.
- Typically, two tickets for separate segments cost more than a single direct trip. Use of smart cards provides a way to pay for a multi-segment trip as if it is a single trip. Customers do not get penalized for making transfers.
- It reduces the risk of revenue leakage by reducing the number of cash collection points.

The electronic ticketing system for the Coimbatore BRT should be designed with enough flexibility to incorporate additional public transport modes. Since access to mobiles is widespread, mobile technology should be leveraged to set up systems of payment and recharge. Mobile phone operators have a wide network of recharge centres, often run as a side business by general goods shops. With an appropriate tie up, this wide network can be used for recharge rather than setting up independent infrastructure for cash collection.

9.4 Parking management

Transport planners across the globe have come to an understanding that roads cannot be built fast enough to keep up with rising travel demand induced by the road building itself and the sprawl it creates. Therefore, along with creating high quality accessible and integrated public transport system that serves the needs of city residents, it is equally important to discourage people from using private modes of transport. Municipal areas and cities have turned to land-use planning integrated with effective transport policies to shift the demand for travel to more sustainable modes. In this capacity, parking management policies and techniques have proven to be especially effective. For Coimbatore, this means that parking must be tightly restricted in areas well-served by the integrated public transport system so that people are encouraged to use public transport.

Presently, parking occupies up to half the street width on many commercial streets. Effective on-street parking management will be needed to ensure that parking does not conflict with other activities along BRT corridors. Parking is not an inevitable need at the end of a trip. By contrast, the availability of parking at the destination results in a trip by personal vehicle. If implemented on a citywide basis, parking fees can become a major source of revenue that can help fund public transport operations and streetscape improvements. Parked vehicles encroach on pedestrian space, making it harder for passengers to access public transport.

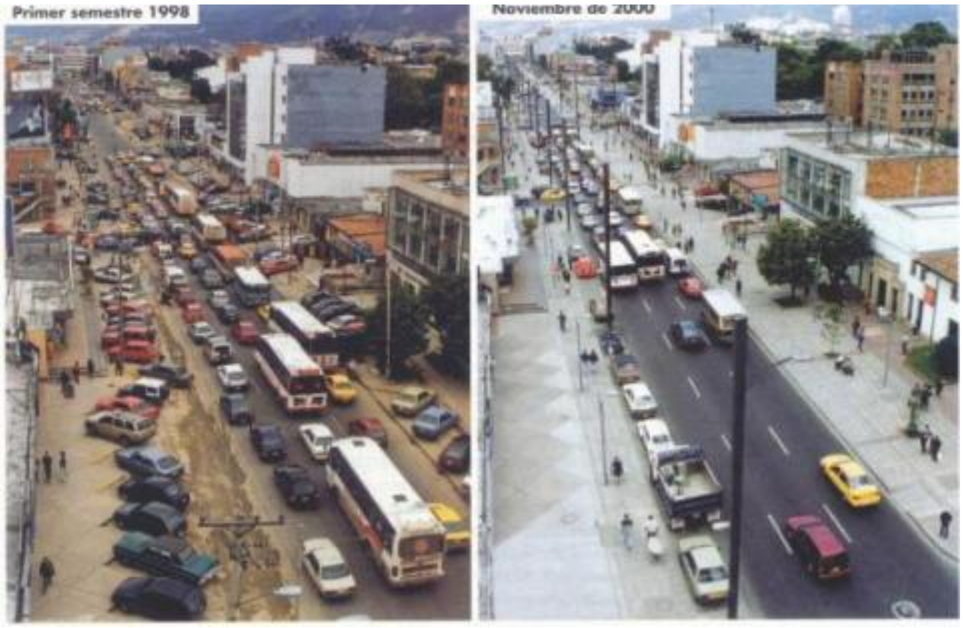

Figure 94: Clear designation of parking and no-parking zones is an essential step in effective parking management. All BRT corridors should have clearly marked parking slots. Shown here is a street in Bogotá, Colombia, before and after the delineation of parking slots.

Several dimensions of parking management will need to be addressed:

- Clear designation of parking and no-parking areas. Demarcation of parking areas is a prerequisite for enforcement.
- Introduction of appropriate parking fees. In areas with high parking demand, parking fees can help reduce the pressure on on-street parking facilities. Parking fees create an incentive for the use of off-street lots, and they also encourage people use alternate modes, including public transport. Parking fees need to be calibrated to the size of the vehicle (e.g. cars should be charged 4 to 5 times as much as two-wheelers).
- Enforcement of no-parking zones. A robust system for parking enforcement is needed to ensure that parked vehicles do not compromise pedestrian footpaths and vehicle movement in the carriageway. At present, parking occupies a great deal of the right-of-way on many of the proposed BRT corridors. Where space is limited, priority should go toward public transport,

pedestrian access, cycling, and mixed traffic. Parking can be limited through appropriate management and pricing.

Going forward, a clear policy on parking that takes an integrated city-wide approach will be pivotal to the success of the integrated public transport system. On-street parking should be discouraged near public transport stations, where people have the option of using sustainable modes of transport. If absolutely required, such parking should be priced at premium rates to discourage the use of private vehicle use.

Park-and-ride facilities may be considered only at terminal stations in city outskirts. In other locations, intensification of land use through mixed-use residential and commercial development is a more effective long- term means of generating public transport ridership.

The design and management of all parking facilities must also reflect new mobility as well as ‘safe design.’ Priority should be given to non-motorized vehicles, paratransit, energy-efficient vehicles, and car-share companies - all in advance of single- occupancy cars.

9.5 Cycle sharing

As more and more Indian cities implement high quality rapid transit systems, cycle sharing is increasingly an important means of providing last mile connectivity to mass rapid transit stations. The public cycle sharing systems that are popular in many countries are a relatively new concept in India, but in the last few years, several Indian cities have shown interest in setting up such systems. A pilot phase of India’s first fully automated cycle sharing system was recently launched in Bangalore, and additional systems are planned in Chennai, Bhopal, Gurgaon, Mysore, and Rajkot.

Figure 95: London’s Barclays Cycle Hire system: Typical station (left) and map showing station locations (right).

Today, there are cycle sharing systems in over 700 cities in 57 countries, and more programs start every year. Some of the largest cycle-sharing systems are in Chinese cities such as Hangzhou and Shanghai. Washington, D.C., USA; Paris, France; and London (Figure 95), also manage successful sharing systems, which are credited for re-energizing cycling in those cities, as well as providing an ideal transport solution for short trips and a feeder to other public transport options.

Cycle sharing is a non-polluting and healthy mode of transport. Cycle sharing helps increase the profile of cycling, bring new users into the fold.

- Critical to achieving these goals is ability to maintain high standards in reliability and customer service in the initial round of cycle sharing systems. High quality cycle sharing systems share the following characteristics:
- A dense network of stations across the coverage area, with a spacing of approximately 300 m between stations
- Cycles with specially designed parts and sizes to discourage theft
- A fully automated locking system at stations that allows users to check cycles in or out without the need for staffing at the station
- Electronic tags to track where a cycle is picked up, the identity of the user, and the station where it is returned. The identity of the user is associated with that of the cycle to ensure security
- Redistribution of cycles to ensure availability of cycles and empty docking points
- Real-time monitoring of station occupancy rates through information technology (IT) systems, used to guide the redistribution and provide user information through the web, mobile phones, on-site terminals, and other platforms
- Pricing structures that incentivise short trips, helping to maximize the number of trips per cycle per day

Figure 96: In Guangzhou, the cycle sharing system (foreground) is integrated with BRT stations (background).

Through the SCTT process, participants identified 92 potential cycle sharing station locations in Coimbatore. Taking a 300 m radius around each station, the total coverage area of the system is 19 sq km (Figure 97).

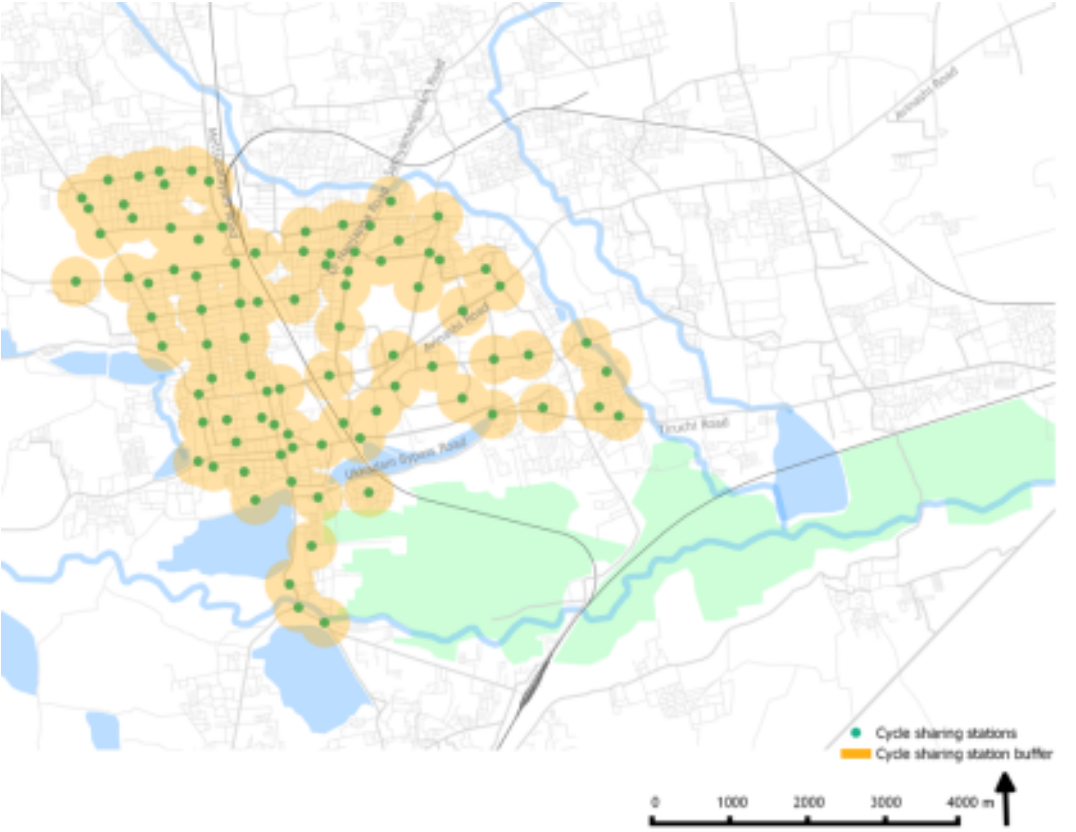

Figure 97: Proposed cycle sharing station locations in Coimbatore.

9.6 Transit-oriented development

Transit oriented development (TOD) refers to development that results in an intensification of housing and jobs within walking distance of mass rapid transit stations. In addition, the urban design and land use characteristics of TOD facilitate the use of public transport, walking, and cycling. TOD is actively *oriented* toward, rather than simply adjacent to, public transport. Well designed and fully realized TOD areas can play a key role in the city's economic and cultural wellbeing, creating vibrant, lively places for people of all ages and income groups. A strategic concentration of compatible activities in conjunction with high quality transport systems can help reduce dependence on personal motor vehicles and curb emissions of harmful smog-forming and greenhouse gas (GHG) pollutants.

Key elements of TOD include the following:

- Provisions for increased intensity of use within a 5 minute walk (i.e. 400 m) of BRT corridors.
- Pedestrian-friendly built form: for example, active uses rather than compound walls at the street edge and reduced setbacks to ensure that there are "eyes on the street."
- Small block sizes to reduce walking distances.
- Provision of open space and other social amenities to support increased residential and visitor populations.
- Reduction in the parking supply to create an incentive for the use of public transport.

- Implementation of TOD will involve several activities:
- Delineation of a TOD overlay zone as part of Coimbatore's revised Development Plan.
- Reform of Coimbatore's Development Control Regulations related to density, urban design, and parking.
- Preparation of Detailed Development Plans to guide the provision of amenities, infrastructure improvements at the local level.

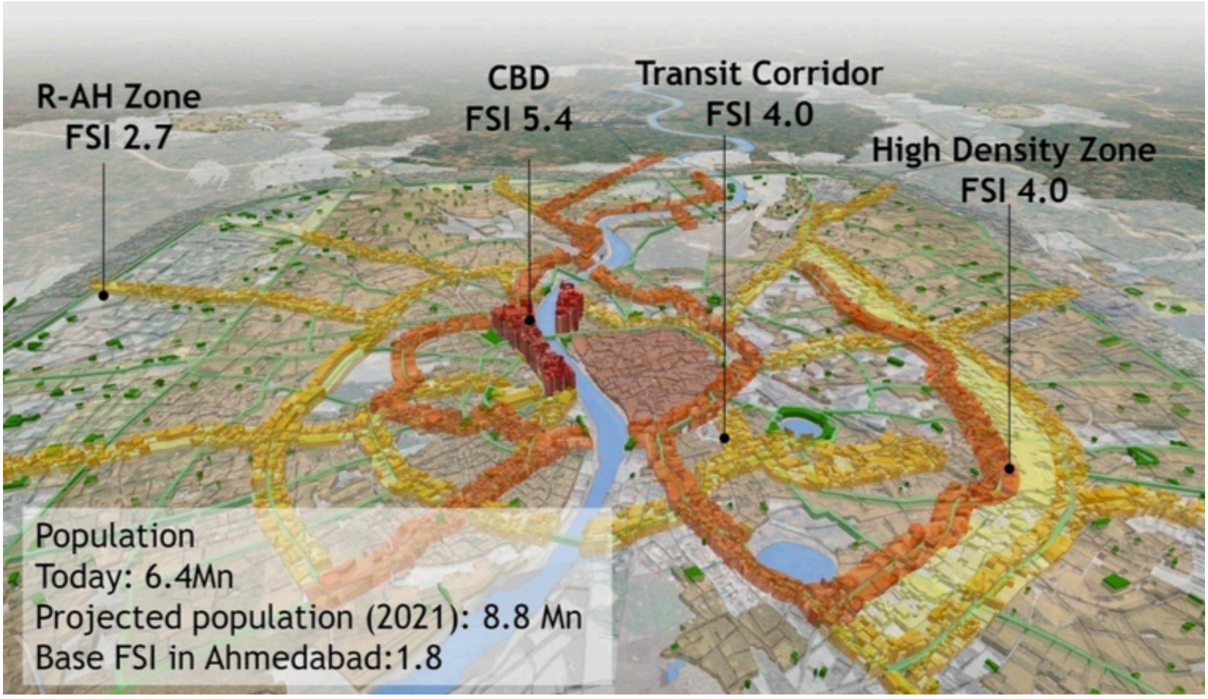

Figure 98. Ahmedabad's development plan encourages denser development within walking distance of BRT corridors.

10. Socio-environmental assessment

10.1 Social conditions

Emerging growth centres are towards Avinashi Road, Tiruchi Road, and Marthumalai Road. Most of the residential use is concentrated around Ganapathy on Sathy Road, Saibaba colony on Mettupalayam Road, Gopalpuram and Peelamedu on Avinashi Road. It is also found that the BRT corridors are mostly surrounded by commercial and mixed land use.

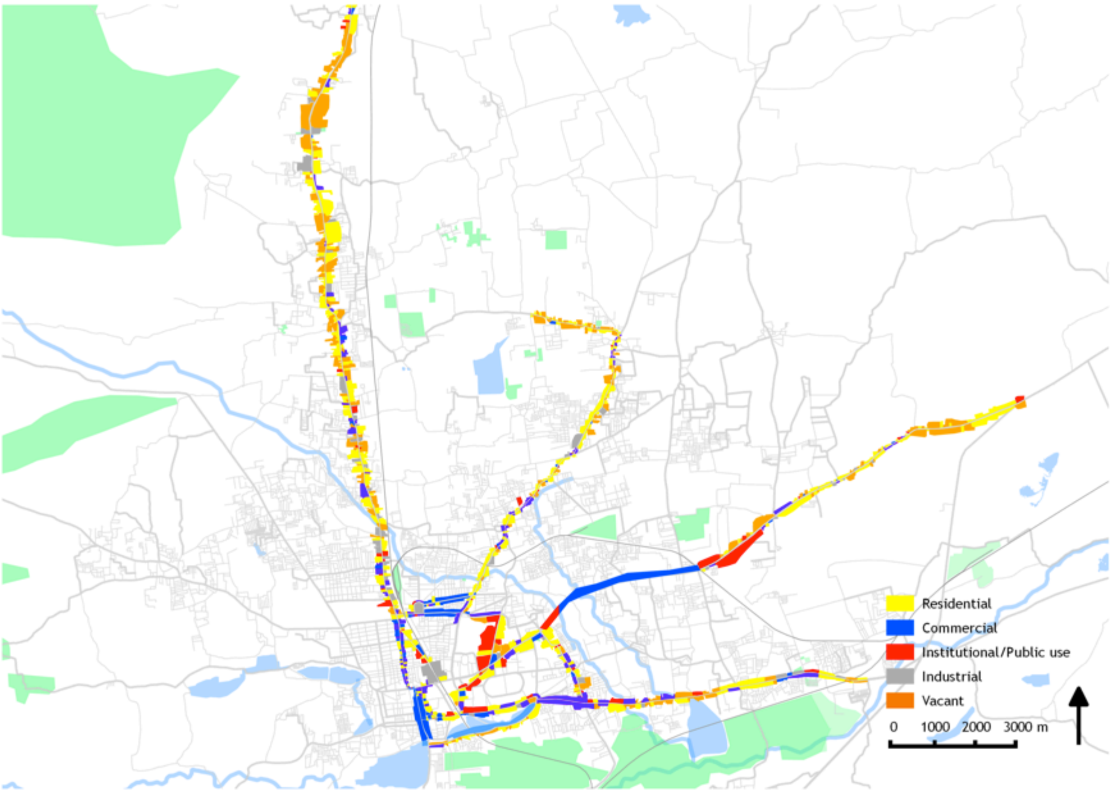

Figure 99: Land uses along the Phase 1 BRT corridors.

Coimbatore is an educational hub, with many well-known schools and colleges within city limits. For an MRT system to be successful in the city, it will need to serve the needs of these populations. The bulk of educational institutions in the city—161 schools and 115 colleges—lie within walking distance of the proposed Phase 1 corridors (Figure 100), making BRT as viable and affordable for both students and parents.

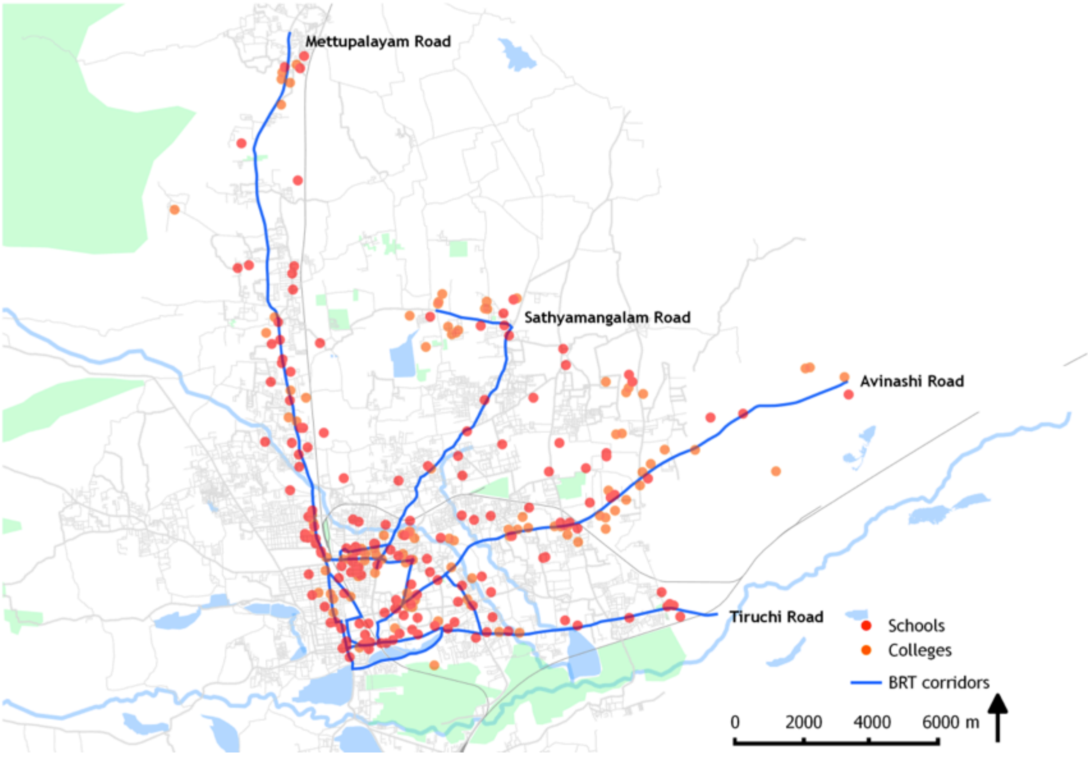

Figure 100: Schools and colleges along the proposed Phase 1 BRT corridors.

Coimbatore attracts a lot of migrants from the adjoining rural areas for employment purposes, hence contributing to the formation of slums and temporary settlements. According to the 2006 City Development Plan, nearly 20 per cent of the population are living in slums and settlements are located along the railway track, around lakes and Sanganoor stream. [26] Using the CDP and Google satellite imagery as reference, the slum locations have been mapped as shown in Figure 101.

[26] Coimbatore CDP 2006.

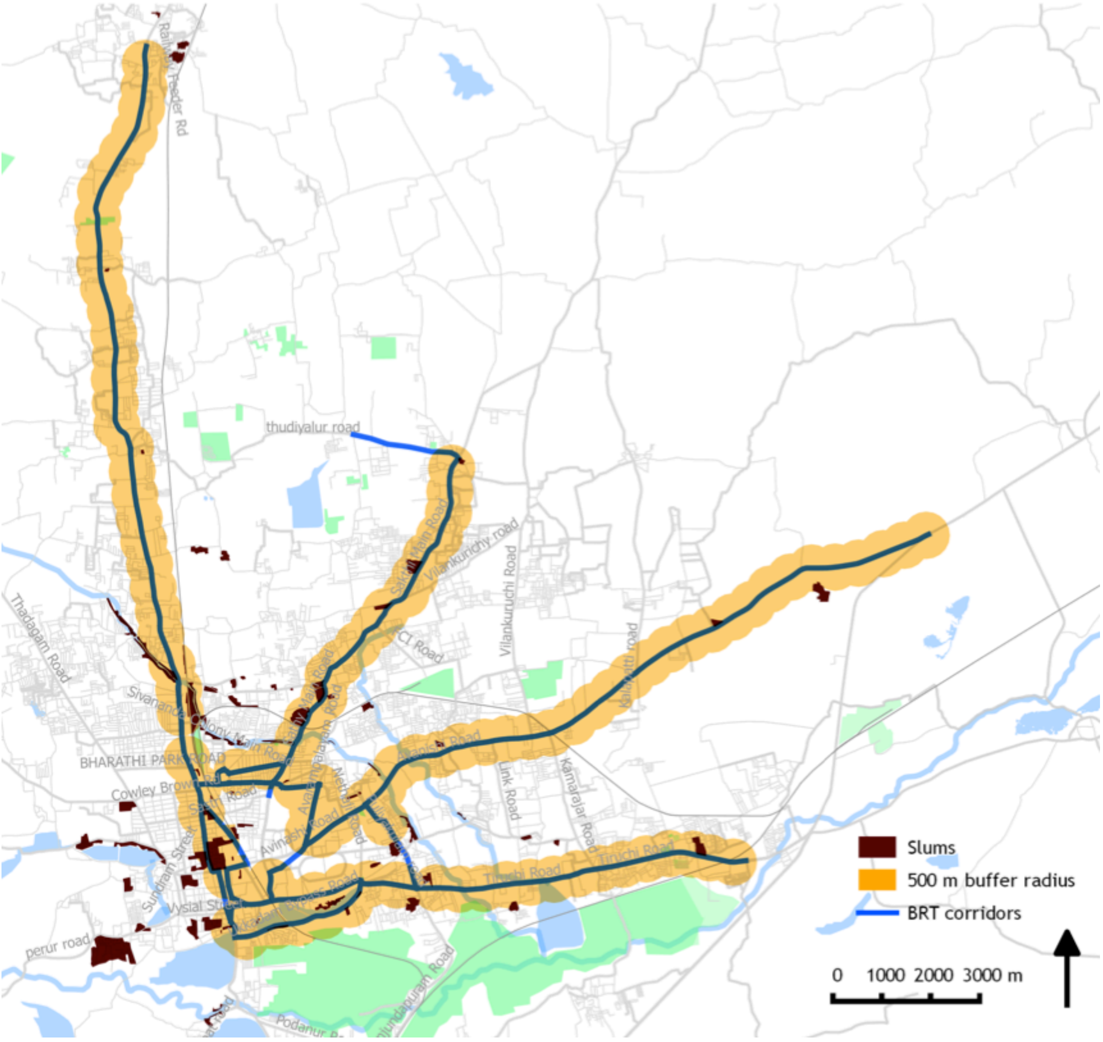

Figure 101: Slum pockets in Coimbatore.

The slum populations are likely to form a major part of the future BRT ridership base, as they depend on public transport for their daily commuting and other purposes. From this perspective, BRT corridors have been proposed in such a way that the system will have a directly benefit on these populations.

10.2 Environmental considerations

Personal motor vehicle are a major source of particulate matter, nitrogen oxides, and other critical pollutants that compromise respiratory function and are associated with chronic diseases such as lung cancer and asthma. In Coimbatore personal motor vehicles account for 34 per cent of daily trips in the city, yet they produce 74 per cent of carbon dioxide emissions (Figure 102). These figures clearly indicate a need to encourage sustainable travel by making public transport, walking and cycling more attractive and effective.

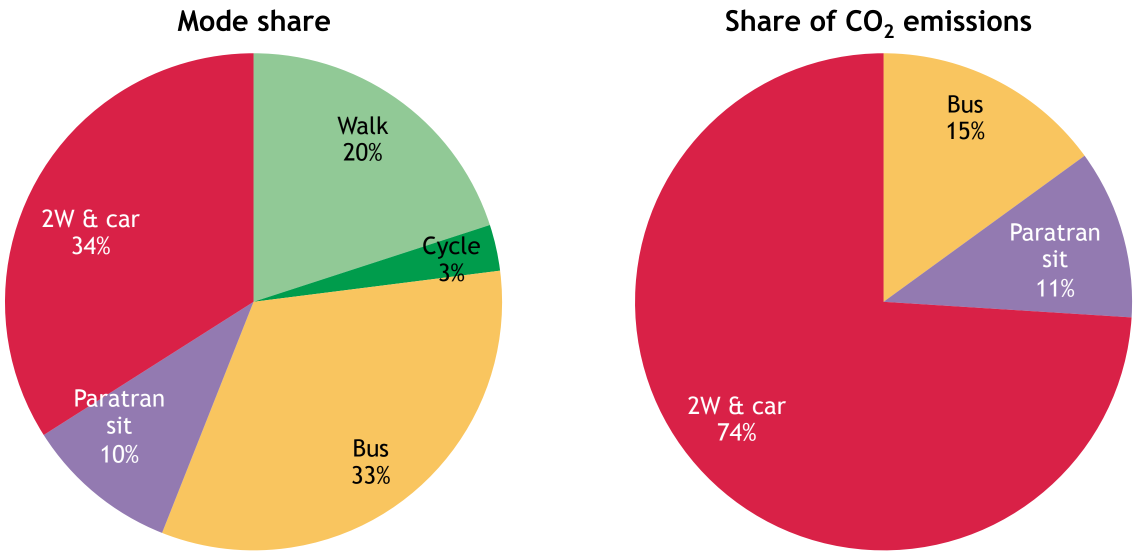

Figure 102: While private vehicles account for 34 per cent of trips in the city, they produce fully 74 per cent of the CO_2 emissions (right).

If travel behaviour in Coimbatore continues with under business as usual trends, carbon dioxide levels will increase significantly by 2031. However, investing in sustainable transport, and helping residents make better transport choices, will deliver the shift in travel behaviour and reduce carbon emitted by transport (**Error! Reference source not found.**). With the implementation of BRT and TNSTC bus fleet expansion, around 20 lakh motorised trips per day can be avoided per day and a fuel saving of Rs. 700 crores per year can be made by 2031. Having high quality public transport will help Coimbatore to witness a reduction of 2.2 lakh ton of CO2 per year by 2031.

10.3 Road safety

Road safety is a major concern for any city. Presently personal motor vehicles account for 34 per cent of daily trips in the city and expected to increase to 50 per cent by 2031 in business as usual scenario. There were and 1,150 accidents and 275 fatalities in 2013[27] and the number of fatalities is expected to increase by 67 per cent in the 2031 under the status quo. Most of the accidents are happening on wide roads and at major intersections. Improvements in public transport, walking and cycling, will help in reducing the injuries and fatalities due to traffic collisions by nearly half by 2031.

[27] Traffic police data

11. Project phasing and cost

Most of the major roads passing through Coimbatore, including many of the roads identified for the BRT network, belong to the state Highways Department or National Highways Authority of India (see Figure 103). Taking into account the jurisdictional landscape, BRT implementation can proceed in two phases, with Phase 1A focusing on the state Highways Department-owned corridors, namely Avinashi Road and Mettupalayam Road (see Figure 104). Phase 1B will bring BRT service to corridors under the auspices of the National Highways Authority: Tiruchi Rd and Sathyamangalam Rd. Certain limited stretches of road under National Highways Authority passing through CBD, such as Oppanakara Street and NH Road, should be implemented in Phase 1A as these are important links for north-south traffic.

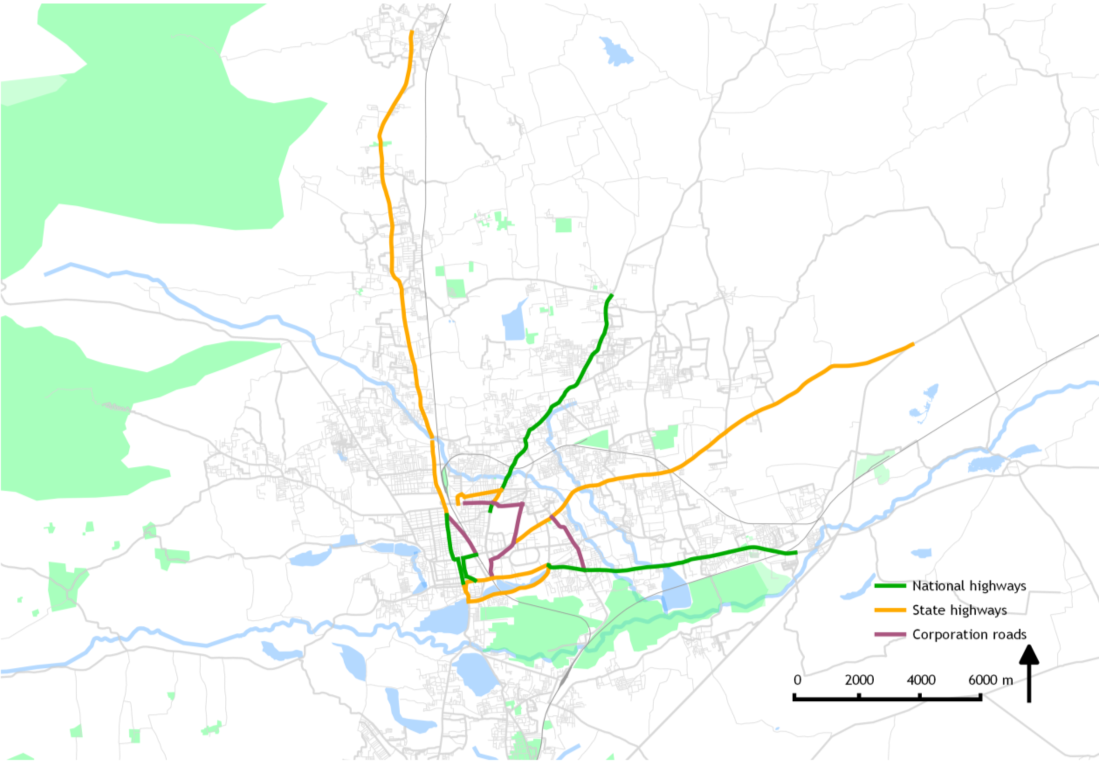

Figure 103: Classification of roads by jurisdiction.

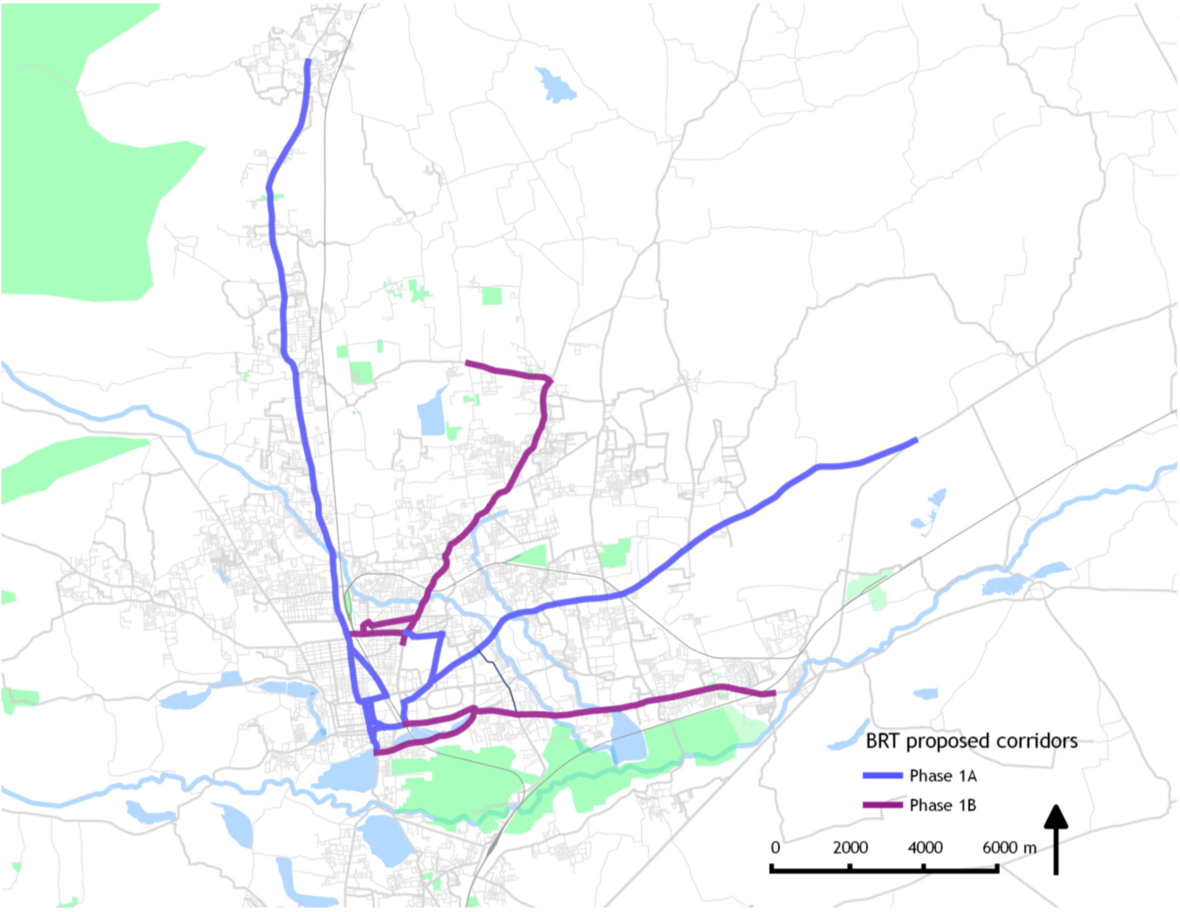

Figure 104: Proposed phasing of BRT corridors.

11.1 Capital cost

The capital cost estimates for the Coimbatore BRT show the outlay required for a fully equipped system with appropriate technology and rolling stock. The cost of IT equipment was estimated based on experience in BRT systems elsewhere in India. The capital cost has been split for Phase 1A and 1B and a summary of components is presented in Table 20.

Table 20: Capital cost for the Coimbatore BRT

Component	Phase 1A Cost (Cr Rs)	Phase 1B Cost (cr Rs)	Total (cr Rs)
Corridors	619	301	920
BRT stations	30	33	63
Terminals	20	15	35
Depots	20	20	40
ITS & control centre	19	14	33
Automatic doors	54	56	110
Consultancy	12	6	18
Total	775	445	1,220

11.2 Potential funding sources

The capital expenditure for implementing a BRT system is much lower than any other form of mass rapid transit but can still be possible by the Government of Tamil Nadu. However, other funding opportunities exist. Development banks like Asian Development Bank (ADB) and The World Bank actively support implementation of BRT through soft loans for capital expenditure and grants for system planning and outreach. ITDP can help Government of Tamil Nadu in reaching out to the appropriate divisions at these organizations to explore funding options. ITDP played a key role in case of Pimpri-Chinchwad BRT for the city to procure funding from The World Bank under the World Bank-MoUD Sustainable Urban Transport Program (SUTP).

For Coimbatore, there has been on-going dialogue between the Government of Tamil Nadu and KfW, a German Development bank interested to support the sustainable transport projects in India. Following which there has been discussion to form a PPP model help financing BRT project and funding study grant for DPR preparation in Coimbatore.

11.1 Operating costs

The operating costs for the proposed BRT system includes costs of bus operations, administration and operations management, and maintenance of IT systems and infrastructure. In order to estimate the cost of bus operations for the Phase I of corridors, it is assumed that each bus will operate at least 220 km per day. The duty of drivers, supervisors, and mechanics will be scheduled in 2 shifts per day. The cost of bus operations is estimated to be Rs 260 crore per year.

Additional operating expenses include cleaning, security, and maintenance of IT systems. To estimate such costs, information from the Ahmedabad BRT was extrapolated to generate estimates for Coimbatore. Staff salaries and maintenance of hardware and software for the IT systems is expected to cost around Rs 2.0 crore per year. Security, maintenance, and administrative expenses will amount to around Rs 14.1 crore per year.

Table 21: Annual operating expenses

Component	Crore Rs
Bus operations	260
IT system operations	14
Maintenance, security, and administration	2
Total	276

12. Implementing BRT in Coimbatore

The ultimate sustainability of any BRT system depends as much on the system "software"—the business and regulatory structure—as on the "hardware"—the buses, stations, busways, and other infrastructure. Typically, much emphasis is placed on the physical aspects of BRT, such as corridor design, bus stations, and vehicles. These are very important elements that determine the quality of any BRT system. However, the success of BRT is also a function of effective cooperation among multiple government authorities and contracting structures that facilitate efficient involvement of the private sector.

12.1 Agency roles and responsibilities

The Board plays an important role in decision of fare structure, system expansion and implementation of policy-level decisions. The board of directors will include of the heads of various state and local entities including the Regional Development Authority, Urban Development Department, Traffic Police, and RTO. The Board may constitute an Advisory Panel comprised of technical experts as well as representatives of local academic institutions. Members of the Board should include:

- Secretary, Transport Department
- Secretary, Urban Development Authority
- Secretary, Public Works Department
- Mayor, Municipal Corporation
- Commissioner, Municipal Corporation(Chairperson of the Board)
- Chairperson, Corporation Standing Committee
- CEO, SPV
- Managing Director, SPV
- District Collectorate
- Local Planning Authority
- Highways Department
- Transport Department
- Tamil Nadu Urban Infrastructure Financial Services Ltd (TNUIFSL)
- Traffic Police
- RTO

It will also be necessary to coordinate closely with the existing public transport service provider, TNSTC. In addition, the SPV will need to enter agreements regarding infrastructure construction with the line agencies that own each stretch of corridor (such as the Tamil Nadu State Department of Highways and the National Highways Authority of India). Table 22 lists the major responsibilities of the agencies that will be involved in the Coimbatore BRT project.

Considering the present structure of administration and operations of city bus services in Coimbatore, it is advisable to establish a separate entity with dedicated cell and a team of people whose primary job is to oversee the operation of bus-based public transport in Coimbatore. This entity, known as a special purpose vehicle (SPV), should take the form of a limited company under State Transport Department. The SPV will plan and implement the BRT project. Once operations begin, the SPV will oversee operations and ensure a high standard of service quality. Specific services such as bus fleet operations and maintenance, IT services, and electronic fare collection, would be procured by the SPV from the private sector to ensure that service of the highest quality can be maintained at the lowest cost to the government.

The SPV needs qualified, professional staff and the independence to make swift decisions during the implementation process. An IAS officer should serve as the CEO of the SPV and Managing Director to oversee the daily operations and management. A competent team with specializations in the areas shown below will support the CEO (Figure 105). A board chaired by the CCMC commissioner will include the Mayor, Standing Committee Chairman, opposition party leader, and the Deputy Commissioner of Police for Traffic, the Regional Transport Officer, and a representative of the Urban Development Department, to oversee the SPV.

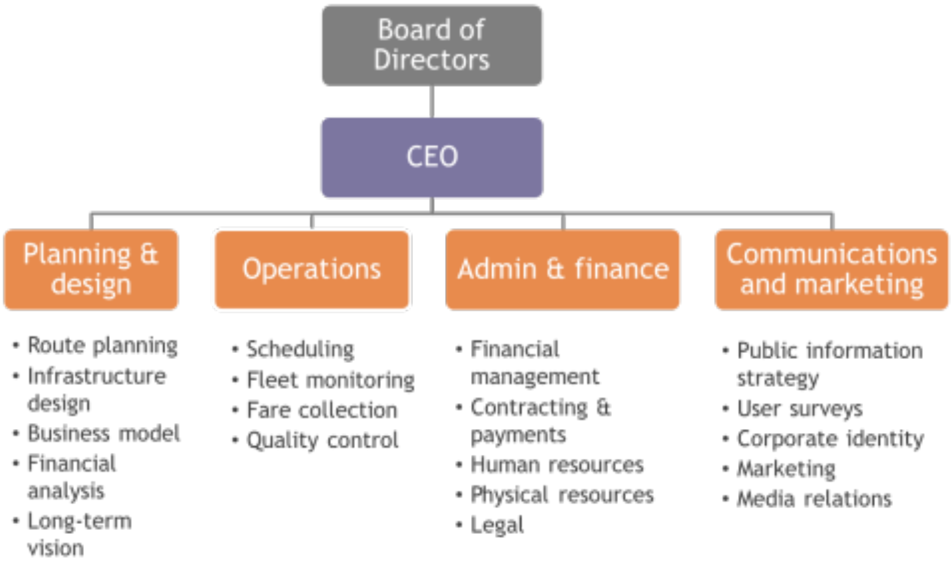

Figure 105: Structure for the special purpose vehicle for Coimbatore BRT.

Table 22: Responsibilities of various agencies in implementing and operating the Coimbatore BRT

Agency	Responsibilities
Transport Department	• Seek required approvals from state as well as national government for BRT project implementation; garner local support and consensus. • Form SPV • Construct the required infrastructure for BRT system (BRT corridors, stations, etc.) • Finance the capital cost of the project, with assistance from the state and central governments • Create a dedicated UTF in form of annual budgetary allocation reserved for public transport operations. Generate additional revenue from parking management by means of parking and advertisement.
CCMC & Highways Department	• Construct the required infrastructure for BRT system (BRT depots and terminals, Control centre etc.) • Oversee and monitor DPR and BRT project implementation process
SPV	• Monitor implementation process • Contract private players to operate buses, IT systems, station maintenance, and other

	services • Define BRT service parameters and monitor service quality • Determine BRT fares
Contracted Service Providers	• Operate respective services such as buses, IT systems, or maintenance • Give timely inputs to SPV for improving operations management
Traffic Police	• Ensure law, order and discipline • Safeguard public transport operations and infrastructure • Prevent incursions in the BRT lanes and encroachments on footpaths and cycle tracks
RTO	• Form policies and regulations oriented towards promotion of sustainable transport. • Review public transport routes and fares

12.2 Service contracting

The SPV will select the bus operator through a competitive bidding process in which the operators will quote the lowest per kilometre charge for bus operations that they are able to offer. The SPV and bus operator will enter an agreement specifying number of buses to be operated, routes, contract period, and other responsibilities. A list of penalties and fines will be developed for bus operator to ensure that the required performance is achieved. The bus operator will be responsible for hiring drivers, supervisors, and maintenance crews. The operator will provide bus services as per a daily schedule provided by the SPV, subject to a guaranteed minimum number of daily km.

The revenue from ticket sales will belong to the SPV. The operator will have no other income from any of the source within the BRT system. The operator will raise the bus operations bill periodically (e.g. every 10 days), which shall be approved and paid by the SPV after verification using data generated by the IT systems. The operator shall be paid as per the actual operated km, with adjustments made in accordance with minimum assured km as per specific formulae. The formulae for calculating payments to the operator will also include provisions for considering variations in fuel prices and other variables.

The SPV will hand over depot space to the bus operator, who in turn will maintain it through the end of the contract period. The operator will be responsible for procuring tools and equipment for bus maintenance. The operator will carry out bus cleaning regularly as per the agreement with SPV. It is recommended to have a separate housekeeping contract for cleaning of stations, terminals and interchanges at least twice a day.

12.3 Implementation process

The BRT design consultant will carry out topographic surveys and develop detailed execution drawings for the BRT corridors. The BRT implementing agency shall appoint a design firm for detailed designs of BRT corridors and appoint project management consultants to supervise BRT construction. To ensure high quality of construction, all contracts should include a mandatory maintenance period following the commissioning of infrastructure.

The procurement of buses and IT systems should be timed to coincide with the completion of the corridor infrastructure to ensure that the new vehicles and equipment do not site idle while other activities are completed.

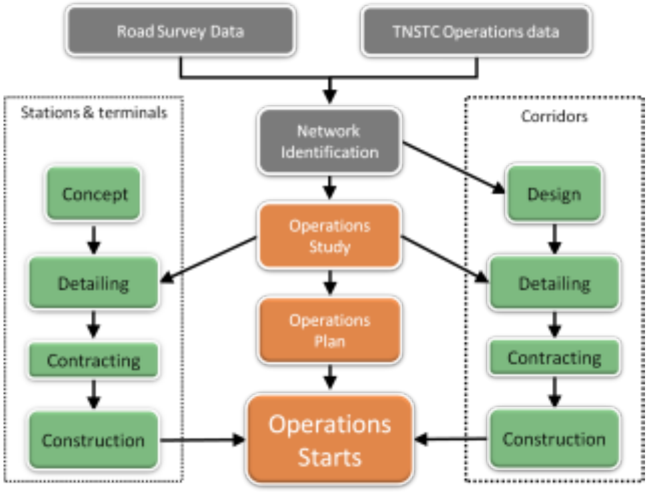

Figure 106: Process for design and construction of corridors

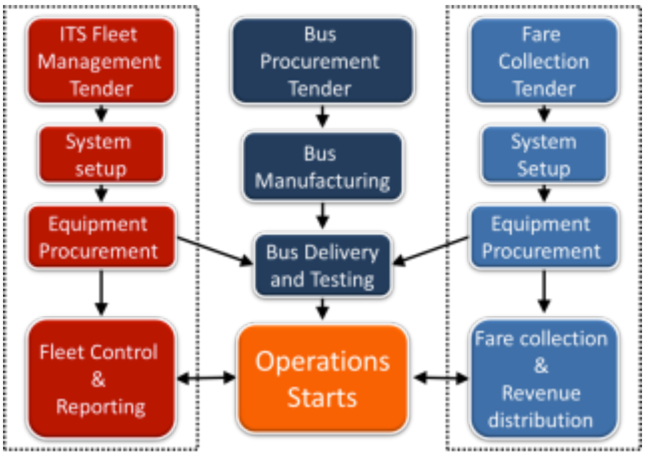

Figure 107: Process for procurement of bus operations and IT/fare collection services

The Coimbatore BRT SPV will have important responsibilities during project construction. Construction activity must be phased to avoid traffic congestion and carbon emissions due to idling of vehicles at junctions or midblock due to construction activity of pavements. All BRT construction works shall be carried out from one road junction to another junction to minimize the disturbance to road users. To minimise disruptions during construction, construction works should be divided into the following activities:

- Construction Phase 1:
  - Removal of encroachments and shifting of utilities
  - Erection of temporary barricades
  - Removal of existing footpath
  - Construction of drainage and footpath
  - Erection of light poles
  - Widening of the existing carriageway to the required width

- Widening/new construction of service road up to full width.

- Construction Phase 2:
  - Block the required width necessary for construction of central BRT lane
  - Construction of proposed median adjacent to BRT and main carriageway
  - Removal of existing median, street lights etc. for constructing new carriageway
  - Construction of BRT lanes and bus stops
- Construction Phase 3:
  - Erection of street lights on central BRT median between cycle track and carriageway
  - Landscaping, installation of street furniture like seats, toilet blocks, traffic signs
  - Residual work including installation of new traffic signals, painting road markings

Planning for traffic diversions is essential. During construction Phase 1, traffic must be allowed to use existing carriageway. Existing traffic signals must be functional. During construction Phase 2 motorized traffic must be diverted on widened carriageway

Coimbatore BRT must take the utmost care for safety of worker in construction zones. The following general precautions are recommended for all BRT construction efforts:

- Movable barricades, boards stating ‘men at work’, and red ribbons are mandatory.
- Warning lamps and reflective/fluorescent signage ensure night time safety.
- All workers must be provided with protective personal equipment, including helmets, hand gloves, and gum boots. Workers exposed to traffic must wear reflective / fluorescent jackets.

Traffic management during construction phase should be given priority. For example:

- Portable traffic signals should be used at junctions.
- Additional traffic brigades can be deployed by SPV to ensure traffic safety at junctions and also train them during construction phase.
- Traffic management plan should be prepared for each working block including diversions, parallel roads/alternate routes, regulation of traffic, guiding signs, etc.
- The contractor will study all available maps of alignment of various underground utilities prior to beginning of site clearance and dismantling existing roads.

13. The way forward

13.1 Timeline

BRT systems can be implemented in a short time period. Many systems take under three years from concept planning to start of operations. Since the detailed feasibility study has already been completed, it is possible to start the operations on the first two lines of the Coimbatore BRT system in three years and six months.

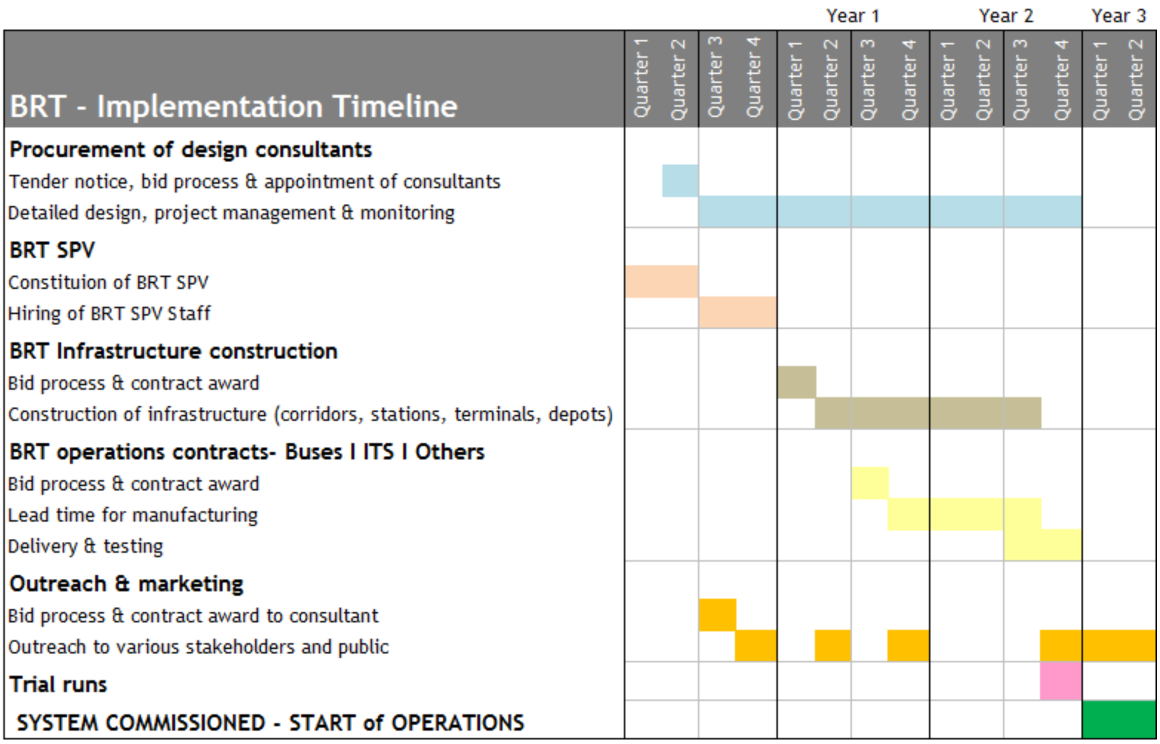

Figure 108: Suggested implementation timeline for Coimbatore BRT.

13.2 Next steps

The following next steps can help advance the BRT planning process:

- **Stakeholder consultations**: BRT will require strong and dedicated political will. With sustained communication of a positive vision for the future of the city, the BRT implementing agency can build widespread support for implementing BRT. Consultations are an essential step in gaining buy-in from relevant public agencies, citizen groups, and other stakeholders.
- **Establish the BRT SPV**: Creating an empowered BRT implementing agency is a key step toward ensuring rapid and effective implementation of BRT. Notification and staffing of the SPV is an urgent priority.
- **Seek funding for DPR study and BRT implementation**: GOTN should initiate the process of preparing a DPR and identifying funding sources.
- **Hire design consultants**: Hire consultants to developed detailed corridor designs.

- **Begin on-street parking management and enforcement**: A robust on-street parking management system will support BRT operations by ensuring that carriageways, footpaths, and cycle tracks remain free of encroachment by parked vehicles. CCMC can initiate the planning of a formal parking system so that it is ready for rollout as the BRT corridors reach completion.
- **Reconcile road improvement projects and BRT corridor designs**: Highways Department road improvement projects and grade separators, including the Gandhipuram and Ukkadam flyovers, should incorporate provision for BRT movement in order to avoid costly modifications shortly after construction.

ITDP will support the GOTN in the following activities as the BRT planning process proceeds:

- Facilitating national and international study tours for project stakeholders
- Determining the institutional structure of the SPV and training SPV staff
- BRT service planning
- TORs for consultants: engineering and architecture consultants for design of corridors, stations, terminals, depots, and other infrastructure; communications and passenger information
- RFPs for service providers: bus operations, IT services, marketing and communications
- Monitoring of consultant work

13.3 In conclusion

BRT as proposed in this report has the capacity to transform public transport in Coimbatore into a truly world class system. By providing citizens with high quality and environmentally and economically sustainable public transport, GOTN can ensure that the city's is able to provide convenient access to all as the city grows. The BRT system can integrate the city core with expanding areas in the periphery, helping to structure growth along corridors with good public transport access. Sustainable transport is key to securing a vibrant and prosperous future for Coimbatore.

14. Bus design standards

The following specifications for procurement of modern BRT buses reflect the standards issued by the Ministry of Urban Development, Government of India.

Component	Specifications for non-AC buses
Length	12 meters
Width	2.6 meters
Height (unladen)	3.8 meters
Wheel base	6.1 meters
Turning radius	As per IS: 9435 -1980
Front overhang	Not more than 45% of wheel base
Rear overhang	Not more than 50% of wheel base
Axle clearance	Min. 190mm
Min. Ground clearance	Within wheel base, not less than 270mm
Min. interior headroom	1900mm
Gangway	800 mm
Passenger Capacity	32-34 seated and 34-38 standees
Seat layout	2 x 2
Seat space per passengers	400 * 350 mm (width * depth)
Seat material	PPLD/ LDPE moulded AIS 023
Height over sitting area	> 900 mm
Seat back/pad material	Polyurethane foam IS:15061:2002, 30 mm
Head rest, seat arm	Not required
Door type and height	Double jack type, minimum 1900mm
Clear door width	1000 mm (in open position with flap gates)
Operation time in second	Less than or equal to 4 seconds
Doors for BRT operations (right side)	Entry and exit doors to be 1000 mm wide each (in open position with flap gates)
Width of partition between BRT gates	400mm max.
Door Operations	Electro pneumatically controlled
Load capacity	80 passengers
Unloaded bus weight	Not more than 10 tones
IT Systems	Bus architecture should be compatible to install IT systems like LED destination boards on front, rear and left side of the bus as well as one internal LED board behind driver seat. GPS and other related equipment for bus tracking, two-way communication and on-board bus unit should be able to be installed.
Fuel	Diesel, CNG

Max. Speed	Less than or equal to 75 km/h.
IT systems Compatibility	Uninterrupted power supply for auxiliary IT system gadgets
Engine Management	Electronic management of engine controls
Engine requirements	Operate efficiently at ambient temperatures of approximate 0 to 50 degree Celsius, humidity level from 5 to 100%.
Location of exhaust pipe	Left side
Steering	Hydraulic power type
Suspension	Pneumatic, electronically controlled
Air bellows	2 at front and 4 at rear side
Electrical system	24 volt DC, multiplex wiring inside bus
Shock absorbers	Hydraulic double acting
Braking system	Dual circuit full air brake with disc type arrangement at front and drum type at rear brake with anti-skid, anti-brake locking system.
Self starter	24V, 80Ah rating.
Batteries	Lead acid batteries as per BIS: 7372-1995
Alternator	24V, 150Ah rating
Fuel tank	Capacity >150 litres of diesel or 100 kg. of CNG
Tires	Steel Radial, preferably tube less
Steps	Max. height of 1st step to be 400 mm and other steps 250 mm
Disabled passengers	Provision for wheel chair space and its anchoring
Bus body	Design, insulation, materials as per bus code AIS 052
Floor type	Flat, except at wheel arches, seats may be given on wheel arches
Glasses	Toughened glass as per IS: 2553- 1992 (part 2)
Destination boards and PIS	As per Urban Bus Specifications by MoUD
Life cycle requirements of bus body structure	10 years and 7, 50,000 km.

15. Station design standards

Parameter	Description
Length	At least 50.0 meters
Width	Minimum 4.0 meters. The widths will be increased on corridors with high demand and wide right of ways and highest boarding points like terminals, transfer stations, intermodal connections
Height	3.0 meters (floor to ceiling bottom level)
Floor Height	650 mm from ground floor (bus lane) and in level with bus floor height
Ramp	12.0 meter long with gradient of 1:12 for ease of accessibility to passengers with disability and difficulty in walking.
Flooring	Anti-skid, rough kota stone finish flooring with tactile paving for visually challenged serving as a guide way to station doors, entry and exit ramps, ticketing booth
Air Circulation	The station sides of the stations will largely be made of material that creates a barrier but provides enough air circulation like vertical thin members.
Platforms	Each station will have at least 2 platforms in one direction. There will be a ledge cantilevered outwards up to 15 cm from the station floor level towards the bus lane.
Doors	Stations will have automatic doors at each platform. Doors will be horizontal slide type with toughened glass sheet for better visibility. Door controller will be installed at stations but the control for opening and closing will remain with the bus driver by a common button to operate bus and station doors. In addition, the station will have main entry/exit doors that are locked during night closure times.
Door Location	The doors will be staggered. No doors will be opposite to each other in both the directions. This is to ease the passenger movement during boarding and alighting. Doors located on opposite to each other create congestion and chaos in passenger movement especially during peak hours when there is lot of rush.
Fare Collection Cabin	Closed structure up to chest height of a standing passenger, the cabin will have glass window on upper part to facilitate communication between a passenger and a ticket issuer. Fare collection cabin will house all the IT system components like door controller, station server, computer for issuing tickets, smart card validators, controller for real time PIS systems etc.
Sitting	Sitting provision for elderly and senior citizens, women, children and disabled will be there in the station in form of benches.
Lighting	Station should be adequately lighted internally as the operations may be scheduled for late night hours. There should be a provision of auto-shut-off of the electricity services when the system operations are over.
Aesthetics	The station architecture has to be attractive and aesthetic and has to be coherent with system brand and identity giving the city an image. Colour combination plays a very critical role. It is recommended to have a continuity of brand, image and colour combinations throughout the system in various components like buses, corridors, stations, staff uniforms etc.
Route Map	The stations will have route maps showing the entire system network with station locations and corridors. Route map will be located inside as well outside of the station.
Fare Structure	The station will have a fare structure panel to display the existing fare charges station wise. Fare Structure panel to be located outside the station
Area Map	The station will have an area map located outside the fare collection cabin showing important landmarks in the vicinity of the station up to a radial distance of at least 300 meters from the station.
Directional Signage	The station will have adequate directional signage’s in terms of arrow markers with reflective yellow colour paint for better visibility to blind and also markers pointing exact positions to wait for coming bus, platform numbers etc.

16. Corridor design standards

Item	Standard
Design Speed	Bus lanes, 50 km/h; Carriageway 30-40 km/h; Service lanes, 15 km/h
Median bus lane width	Minimum 3.3 m; Minimum 7.5 m for bus lane + passing lane
Carriageway width	Maximum 6.5 m for two lanes; Maximum 7 m for two-way movement
Parking Area	2 m
Service Lanes	Maximum 3 m for one-way movement; Maximum 4.5 m for two-way movement
Cycle Tracks	Minimum 2 m
Footpath	Minimum 2 m of clear space
Pedestrian refuge island	Minimum 1 m
Cross slope	
Bus Lane	2.0%
Carriageway	2.0%
Parking	1.5%
Service Lane	1.5%
Cycle Track	1.5%
Footpath	1.5%
Geometric features	
Max. gradient	4%
Desirable gradient	2%
Min. gradient	0.5%
Max. grade change requiring vertical curve	0.6%
Min. vertical clearance to road bridge over road	5.5 m
Max. super elevation	7%
Min. super elevation	4%
Rate of change of super elevation	1 in 150
Drainage	
Min. longitudinal gradient	0.3%
Min. width of drain	0.25 m
Min. diameter of drain	0.45 m
Manholes spacing	10-20 m
Min. inside dimension	120 x 90 cm

Opening for entry	50cm clear
Other	
Disability Access	Draft National Building Code / BIS Indian Accessibility Standards (2009)
Traffic Signal	IRC: 93-1985 and better experiences
Pedestrian crossings and pathways	IRC: 103-2012
Road Signage	IRC: 67-1977
Pavement markings	IRC: 35-1997
Delineators	IRC: 79-1981
Depth of underground utilities	
Trunk sewer lines	2-6m
Water supply line (service line)	0.6-1m
Water supply line (trunk line)	1-1.5m
Electric Cable (LT)	0.6-1m
Electric Cable (HT)	1.5-2m
Communication Cables (directly laid)	0.6-1m
Communication Cables (in ducts)	2-3m
Gas mains and lines	2-3m
Min. cover over top of service line	0.650 m
Clearance for utilities	
Horizontal: Poles erected for street light, electric power, communications etc. for roads with raised kerbs	300mm (from edge of raised kerb) 600mm (desirable) 1.5m (for roads without raised kerbs from edge of carriageway)
Vertical: for ordinary wires and lines carrying very low voltage up to 110 volts egg. Communication lines	5.5m
For electric power lines carrying voltage up to 650 volts	6.0m
For electric power lines carrying voltage exceeding 650 volts	6.5m

17. Frequency occupancy volumes

Location	Corridor	Direction	Public transport	IPT	Total
Ukkadam Bus Stand	Palghat Road	Southbound	3366	565	3931
Thadagam Road	Thadagam Road	Northbound	1329	174	1503
Thadagam Road	Thadagam Road	Southbound	1185	1314	2499
Tamilnadu Agriculture University	Mardhumalai Road	Westbound	1575	92	1667
Tamilnadu Agriculture University	Mardhumalai Road	Eastbound	983	49	1032
Sundarapuram Iyer Hospital	Palghat Road	South	1420	28	1448
Stanes School	Avinashi	Eastbound	5760	40	5800
Stanes School	Avinashi	Westbound	2011	321	2332
Shadi Mahal / Karuparayan Koil	Palghat Road	East	333	18	351
Shadi Mahal / Karuparayan Koil	Palghat Road	West	572	41	613
Rajalakshmi mills bus stop	Trichy Road	North	1125	15	1140
Rajalakshmi mills bus stop	Trichy Road	South	1174	20	1194
Poo Market	Mettupalayam Road	Northbound	2190	27	2217
Poo Market	Mettupalayam Road	Southbound	105	128	233
Phalghat Road	Palghat Road	Southbound	5577	84	5661
Phalghat Road	Palghat Road	Northbound	2828	64	2892
Park Gate (J K Tyre)	Sathyamangalam Road	Southbound	3294	75	3369
Park Gate (J K Tyre)	Sathyamangalam Road	Northbound	2958	165	3123
New Point (St.John Brito church, Thadagam Road)	Thadagam Road	Southbound	1506	171	1677
Near Railway Station (Hotel Thai)	Trichy Road	Southbound	5884	57	5941
Near Railway Station (Hotel Thai)	Trichy Road	Northbound	2768	58	2826
Lakshmi Mills	Avinashi Road	Eastbound	4907	60	4967
Lakshmi Mills	Avinashi Road	Westbound	4421	54	4475
Koundampalayam bus stand	Mettupalayam Road	North	1515	8	1523
Koundampalayam bus stand	Mettupalayam Road	South	2328	3	2331
Karpagam	Mettupalayam Road	Eastbound	5296	116	5412
Karpagam	Mettupalayam Road	Westbound	4189	264	4453
Hope College Bus Stand	Avinashi Road	North east	2098	9	2107
Hope College Bus Stand	Avinashi Road	South west	2030	14	2044
Gandhipuram	Sathyamangalam Road	Westbound	4656	237	4893

Gandhipuram	Sathyamangalam Road	Eastbound	4364	417	4781
Ganapathy Bus Stop	Sathyamangalam Road	North	1136	47	1183
Ganapathy Bus Stop	Sathyamangalam Road	South	1772	63	1835
Edayarpalayam		North	1221	78	1299
Edayarpalayam		South	1410	60	1470
Anandhaas Hotel / Iyer Hospital		North	1389	66	1455
Anandhaas Hotel / Iyer Hospital		South	1758	23	1781