



BUS KARO 2.0 CASE STUDIES FROM INDIA





WRI INDIA



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The EMBARQ network collaborates with local and national authorities, businesses, academics and civil society to reduce pollution, improve public health, and create safe, accessible and attractive urban public spaces and integrated transport systems. EMBARQ has built its global recognition on its local experience, and addressing national and international policies and finance.

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ABOUT BUS KARO

In 2009, EMBARQ India launched the Bus Karo Programme to improve city bus service in Indian cities. The programme is designed to build capacity, provide technical support and share best practices in the field of urban bus transport in India. The initiative is a best-practice and peer-to-peer learning network, where the implementation of pilot projects brings about significant outcomes. The programme has three primary aspects (Figure 1):

- **Mentoring Transit:** Partnering with public transport agencies through support from experts to aid the implementation of pilot projects designed to enhance city bus services.
- **Talking Transit:** Organising workshops and facilitating discussions in which public transport authorities can gather to discuss strategies and hurdles to achieving sustainable transport. This also provides an opportunity for peer-to-peer capacity building.
- **Learning Transit:** Facilitating the sharing of best practices through the documentation and distribution of international and India-specific cases of city bus services.

In 2009, as part of the Learning Transit initiative, Version 1 of the Bus Karo – A Guidebook on Bus Planning & Operations (EMBARQ India 2009), was published with support from the Ministry of Urban Development, Government of India. This guidebook, meant for practitioners, planners, operators and researchers, examined advancements and best practices of public bus services around the world, in order to find applications within India (see Figure 2). The guidebook discussed in detail the key factors for

implementing successful bus system reforms. This included:

- Strong political leadership in the decision-making process
- Leadership by local institutions in the technical planning for route reorganisation
- Implementation of bus priority strategies
- Use of technology
- Innovations in contracting and tendering
- Need for managed subsidies to improve quality of service
- System performance monitoring and user feedback

Under the Talking Transit part of this programme, we conducted multiple technical training workshops, developed guidebooks, and documented and disseminated best practices in bus operations and service planning. In the last six years, more than 300 participants and 25 public and private transport agencies participated in five thematic workshops that were organised in partnership with various public transport undertakings. The workshops covered the following issues:

- Land banking to develop depots and terminals in partnership with Bangalore Municipal Transport Corporation(BMTC)
- Driver training and fuel efficiency in partnership with Andhra Pradesh State Road Transport Corporation (APSRTC)
- Feeder service and short route design in partnership with Brihan Mumbai Electricity Supply and Transport (BEST)
- Use of Telematics (Intelligent Transport Systems) in improving public transport efficiency in



Figure 1 EMBARQ India's Bus Karo Programme



Figure 2 Launch of Bus Karo Version 1.0 (EMBARQ India 2009)

partnership with Karnataka State Road Transport Corporation (KSRTC)

- Branding, marketing and communications in partnership with Atal Indore City Transport Services Limited (AICTSL)
- Integrated Transport Services with BCLL

Following the launch of the Bus Karo Guidebook Version 1, EMBARQ India continues to work closely with numerous transport undertakings and participate in several of the major reforms across the bus industry.

EXECUTIVE SUMMARY

In the last few years, Indian cities dramatically transformed their mobility through the implementation of many bus transit solutions. Urban India experienced several major accomplishments on multiple fronts:

1. Innovative policy-based initiatives in public transport
2. Various pilot reforms to enhance operational efficiency
3. The growing potential of technology applications
4. Wide-reaching and successful strategies in branding and marketing approaches
5. A significant increase in Bus Rapid Transit Systems and the optimisation of city bus services

Pilot initiatives and trends indicate that the city bus will continue to be the backbone of urban mobility in India. In the Bus Karo Guidebook v2.0, the objective is to analyse and document the implementation of these practices in the urban Indian context. Multiple case studies are investigated in great detail and the learnings are highlighted. These learnings are assessed as per the needs of bus operators, and contextualized in a way to inform planning, design and operational decisions. The purpose of this guide is to parallel the many initiatives of the Indian Government, and to strengthen bus-based public transport towards establishing larger mode shares.

DEFINING the Problem

While the various initiatives have created success, the industry requires additional efforts and further impetus towards strengthening systems. The public transport industry faces challenges in employing innovative approaches to provide improved services to the public. There are three broad areas of issues:

- The shortage of trained and skilled workers to manage adequate standards of maintenance and operations gravely affects operating agencies.
- The paradoxical nature of providing public transport as a commercial function, yet with a strong social objective, places financial pressure on the sustainability of operating agencies.
- The lack of coordination among the multiple players to allocate land for transit infrastructure needs, results in the industry falling short of its potential.

On a parallel path, similar to their global counterparts, Indian cities are undergoing global trend paths such as urbanization, motorization and congestion. Coupled with declining public transport use, the problem is further exacerbated and Indian cities are quickly losing out on the standard of living they offer.

LEARNINGS

Recognising several areas requiring focus, this Guidebook gives an in-depth assessment and documents practices and the existing challenges in six areas in the bus industry.

1. The dynamic nature of cities requires a redesign of the transport system to effectively respond to the population's changing needs.

In light of changing urban trends and the resultant impacts on mobility patterns, cities assess the mobility needs of their population, ensuring that the transport system responds effectively. Data collection is an effective tool to assess these changes and design the system as per travel patterns, system performance, public perceptions and growth in demand.

2. Safety and accessibility are two significant design components in planning for transport infrastructure.

Planning for a transport system requires a comprehensive approach. The planning and designing of safe and accessible infrastructure is critical for system operations, maintenance and expansion.

3. A structured framework to optimize fuel efficiency is important and four areas of focus can be effective: driver training, management systems, vehicle maintenance, and incentive schemes.

Many agencies have begun focusing on ways to optimize expenditure. As fuel costs make up between 35 and 50 percent of total expenditure, training for fuel efficiency has been adopted by multiple agencies across India as an optimizing strategy. A systematic framework, in this case, is effective to promote fuel-efficient driving through consistent monitoring as well as indicate the

seriousness of the initiative.

4. Intelligent Transport Systems (ITS) are useful to obtain data and use data analytics as a way to enhance operations.

The application of ITS in Indian cities has witnessed significant traction over the last few years. This brings further opportunity to collect and analyse this data for input into operations including driver monitoring, passenger information, and service planning.

5. Branding, marketing and communicating are three critical components to augment public transport outreach.

Information about new systems or changes to systems must be communicated precisely to the public in order to have a good chance of success. Branding, marketing and communication are vital to draw public attention, expedite public understanding and recognition of the system, and create a strong connection with the public.

6. The financial sustainability of operating agencies is undermined by the inevitable purpose of providing transport as a public service. New financing trends can be effective in easing the pressure on agencies.

Public transport provision faces a challenge in ensuring commercial viability and simultaneously satisfying its social objectives as a public service. In comparison to typical revenue streams, public transport expenditures are often significantly higher. It is important that fares, as a key revenue factor for agencies, be determined through a scientific approach to facilitate this imbalance. Proper financing mechanisms can be adopted to bridge the gap between revenues and expenditures.

7. An integrated approach to providing city bus services can strengthen the system.

In addition to the role of operating agencies, the state assumes a significant role in providing public transport. Four areas of improvement fall outside the purview of a city bus agency: system safety, segregated infrastructure, financial subsidy and land planning for infrastructure.

These assessments are a way to facilitate a rethought process on how to approach these problems that are prevalent in the Indian bus industry.

Based on these examples and challenges, systematic frameworks are suggested as a practice, for bus

agencies to adapt to their specific contextual demands. The publication concludes with a way forward, which elucidates the need for cohesive and practical planning.

THE Bus Karo 2.0 Guidebook

In order to encourage innovation across the field, there is a need to create a platform for sharing these practices, experiences and challenges. The Bus Karo v2.0 Guidebook is part of EMBARQ India's efforts towards facilitating this peer-to-peer learning. It provides an overview of the current state of affairs regarding the urban public transport system in India.

The last five years in the bus industry indicated phenomenal growth in numbers and the implementation of new advancements in technology, service financing methods and management techniques. Evidently, there is a paradigm shift towards public transport, with strengthened policies and investment, and formal systems of high quality and capacities.

The next decade requires focus on precise and system-wide improvements. The call of the hour is to maintain bus transport mode shares and introduce operational, infrastructural, technological, marketing and financing innovations to double this share. It is universally recognized that for cities to be livable, city bus and bus rapid transit systems (BRTS) must be an integral part of development.

As the mobility needs of the population change, it is important for the public transport system to respond effectively. The way forward now is to maintain this momentum and strengthen the approach.

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World Resources Institute



CHAPTER ONE

URBAN BUS TRANSPORT IN INDIA: STATUS AND TRENDS

The development of city bus systems can be significantly strengthened by lessons learnt through the implementation of innovative practices and challenges faced in urban India. We start by evaluating the relative successes and challenges of city bus reforms initiated by some of EMBARQ India's partners - Brihan Mumbai Electricity Supply and Transport (BEST) Undertaking, Bangalore Metropolitan Transport Corporation (BMTCL), Atal Indore City Transport Services Ltd. (AICTSL), Bhopal City Links Limited (BCLL) and the Metropolitan

Transport Corporation, Chennai (MTC). While EMBARQ India was actively engaged in some of these initiatives, other observations are based on our collaboration with partners. Figure 3 outlines the case studies and examples discussed in the Bus Karo 2.0.

Pilot initiatives and bus reforms in recent years reinforce that city bus systems will continue to be the backbone of urban mobility in India. It is therefore imperative that cities across India focus



Figure 3 Urban Bus Reforms discussed in this Guidebook

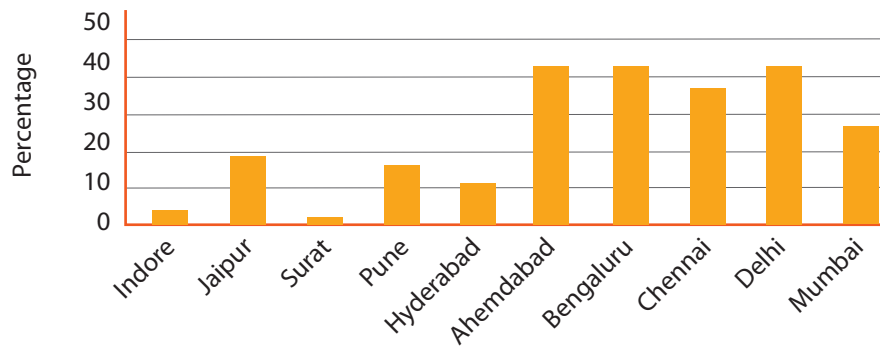


Figure 4 Bus Transport Mode Shares (excluding non-motorized trips) in Indian cities; (RITES 2011) (WilburSmith Associates 2011); (Centre for Environmental Planning and Technology & LEA Associates South Asia Pvt Ltd n.d.); (Pune Municipal Corporation 2008); (Centre of Excellence in Urban Transport - CEPT University n.d.); (LEA Associates South Asia Pvt. Ltd. 2011); (RITES 2011); (CMDA (Chennai Metropolitan Development Authority) 2010); (Ministry of Urban Development (Delhi Division) 2007); (Lea International Ltd., Canada and LEA Associates South Asia Pvt. Ltd., India 2008).

on sustainable transport and set targets to achieve a higher modal share of public transport. Buses take up over 90% of public transport in Indian cities (Pucher, Korattyswaroopam and Ittyerah 2004), and serve as an economical and convenient mode of transport for all classes of society. There are approximately 35,000 buses operational in urban areas. Of this, eight of the bigger cities - Delhi, Kolkata, Mumbai, Chennai, Bangalore, Hyderabad, Ahmedabad, and Pune - account for 80 percent of all buses. Currently, the bus modal share of these cities varies from one percent (Surat) to 43 percent (Bangalore), as seen in Figure 4. The challenge is to retain the bus modal share and further increase the modal share of public transport through various initiatives. EMBARQ India recommends that by 2020, bus transport must comprise of at least half of the mode share of all motorized trips in Tier 1 cities and at least one-third of the mode share in Tier 2 and 3 cities.

Following the launch of the Version 1 Guidebook, EMBARQ India continued to work closely with numerous transport undertakings and participate in several of the major reforms across the bus industry. The following section highlights some of these phenomenal and unprecedented changes.

1.1 RECENT TRENDS IN URBAN BUS TRANSPORT IN INDIA

In the last decade, six areas witnessed reforms in the urban bus industry – policy-level initiatives, on-the-ground pilot projects, technological applications, branding initiatives, financing efforts and the advancement of bus-based transport to Bus Rapid Transit Systems (BRTS). At various levels and scales, these reforms are paving the way for increased

modal shares of public transport in India.

POLICY Initiatives

In the last few years, the Indian Government, along with the support of global institutions, introduced some policy-based improvements to the transport system. These initiatives were aimed at providing technical and financial inputs.

CENTRAL GOVERNMENT'S JNNURM FUNDING PROGRAMME

With the intention of providing an economic stimulus to heavy industry, the Ministry of Urban Development (MoUD) initiated a bus procurement programme for city bus operations, under the Jawaharlal Nehru National Urban Renewal Mission (JnNURM). The mission combines an offer of financial support for infrastructure projects under a cost-sharing arrangement with state and local governments. This is linked to a structured governance model that includes central assistance and mandatory reforms.

In 2009, the JnNURM provided funding for 65 cities to procure 15,000 buses. City authorities responded and the scope for funding was expanded to include the procurement of an additional 10,000 buses and ancillary infrastructure such as depots terminals, and intelligent transport systems (ITS). The programme was made available to all Indian cities, towns and urban agglomerations (including non-JnNURM cities).



The GEF programme includes three components:

- Technical Assistance (TA) on regulatory, institutional and fiscal issues
- City Demonstration Project – TA & Capacity Building
- City Demonstration Project – Physical Investment (Global Environment Facility n.d.).



The expenditure under the JnNURM Round 1 scheme for bus procurement is to be treated as counter-part funding by the Central Government, to avail the World Bank loan (Global Environment Facility n.d.). Presently, four cities are short-listed for the programme: Bhopal, Mira-Bhayander, Jaipur and Chandigarh.

Figure 5 JnNURM Round 1 Funding

THE GLOBAL ENVIRONMENT FACILITY (GEF) 5 FUNDING

The GEF is a partnership for internal cooperation, aimed to assist in the protection of the global environment and to promote ecological sustainable development (Global Environment Facility n.d.). Under the GEF, the MoUD and the World Bank, proposed the promotion of efficient and sustainable bus transport systems in India. The purpose of the fifth round of the GEF programme is to encourage private to public transit mode shift, through focus on the operational, financial, regulatory and fiscal constraints of city bus systems.

URBAN BUS SPECIFICATIONS (UBS) II

The MoUD created an Urban Bus Committee in March 2012, to work towards revising the existing urban bus specifications and implement uniformity in the bus manufacturing industry. The guidelines were aimed to shift from the use of truck-chassis and to establish bus-based designs. Program objectives include driver and passenger comfort, enhanced safety, universal design, in-built ITS components, etc. The specifications are also aimed at achieving lower pollution and higher fuel economy. In addition, new bus types to include BRTS applications were also introduced. The UBS-II with all these characteristics was published as a reference point for city authorities (Recommendatory Urban Bus

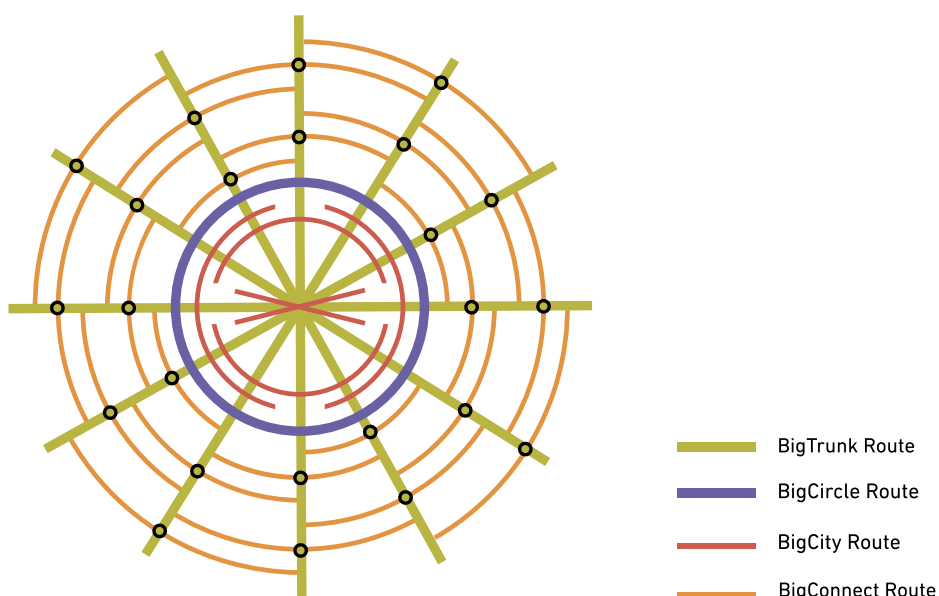


Figure 6 BRTC Bus Corridors (BRTC 2014)

Specifications – II n.d.).

ON-THE-GROUND Pilot Initiatives

The second area of city bus reforms included demonstration projects which were implemented to pre-empt and assess impacts.

LARGE-SCALE ROUTE RATIONALISATION BY BANGALORE METROPOLITAN TRANSPORT CORPORATION (BMTc), BANGALORE

The BMTc operated roughly 6,500 buses over 2,400 routes, with an average of three buses for each route (BMTc 2014). Like most cities, this was managed as a destination-based approach, which connects any destination directly to other major destinations in the city. Due to the large number of routes, this approach resulted in poor service quality on account of low frequencies. Route rationalisation can be challenging due to the requirements of a major systemic change not only in operations and planning, but also in usage.

To simplify the network, BMTc introduced the Bangalore Intra-city Grid or BIG Bus Network in 2013. The BIG Bus network is a citywide network of very high frequency services along major roads,



Figure 7 Fuel Efficiency Workshop in Vishakhapatnam (EMBARQ India 2012)

which forms a ‘connective grid’ of routes to provide coverage across the city. This bus system also incorporates transfer facilities, service branding, a simplified numbering convention, restructured fares, and passenger information delivery.

This direction-based network structure is planned for 12 major arterials, the Outer Ring Road, and in other high-density and high-demand areas of the city. At present, three major arterials are functioning as direction-based routes with a 185-strong bus fleet. BMTc is currently working to increase frequencies and upgrade three additional corridors.

FUEL EFFICIENCY TRAINING

As a step in the direction to improve the financial sustainability of city bus agencies, the APSRTC’s (APSRTC) fuel efficiency program was showcased as an effective initiative. (see Figure 7) Through EMBARQ India’s Talking Transit platform, APSRTC demonstrated a fuel efficiency training framework used to train and monitor drivers and manage the system to optimise fuel use.

APSRTC reports one of the highest fuel efficiency standards in the country (over 5 kilometers per litre or kmpl, as compared to the industry standard of 3 kmpl) (APSRTC 2013). EMBARQ India collaborated with APSRTC to facilitate pilot programmes (see Figure 7) with several public transport undertakings, including BEST, BMTc, MTC Chennai, Janmarg BRTS, Star Bus, NMMT, AICTSL, and Jaipur City Transport Service Limited (JCTSL). In the last 2 years, programmes on fuel efficiency training have been conducted in 12 different cities. A total of 19 classroom trainings amounting to over 65 hours, and 15 on-road practical sessions amounting to 110 hours have been conducted so far. While classroom trainings engaged almost 1800 drivers and training staff, field practice training was undertaken by 700 drivers. As a result, on average, the cities experienced a 75 percent increase in fuel savings and in some cases post-training monitoring for the pilots indicated up to a 100 percent increase in fuel efficiency (EMBARQ India 2014) (see Figure 8). In 2013, BEST and NMMT began to scale up these efforts.

LAND PROVISIONS AND FINANCIAL ASSISTANCE FOR BUS SERVICES IN MUMBAI

Cities face difficulty in earmarking space in prime locations nearer to transport demand, due to rapidly growing urban population. An increase in fleet size and operations required BEST to construct a new

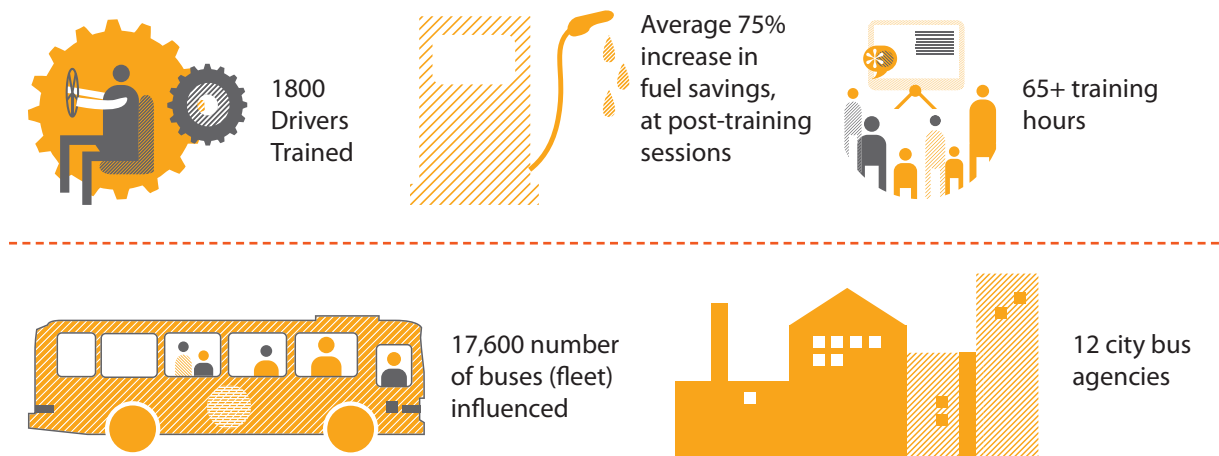


Figure 8 EMBARQ's Fuel Efficiency Training Programme Outcomes (EMBARQ India 2014)

depot facility for maintenance and bus parking. In spite of the difficulties, in April 2014 and after 15 years, BEST inaugurated its 26th depot at Malad. This new infrastructure accommodates up to 120 buses and allows for the expansion of services to the Western part of the city (BEST Undertaking 2014).

Additionally, due to a significant growth in vehicle ownership and motorisation in the city, resultant traffic congestion continues to diminish the reliability of bus services. BEST has subsequently witnessed a drop in ridership over the last decade, seriously affecting the agency's revenues. In 2012, a significant loan was sanctioned by the Municipal Corporation of Greater Mumbai (MCGM) for the BEST Undertaking. Over the next five years, this loan can prove to be a tremendous boost for the organisation and public transport services in the city.

INNOVATIONS IN CONTRACTING BUS SERVICES IN DELHI

For years, the Delhi Transport Corporation (DTC) operated its bus services with 5,500 buses in use, in a city where the requirements have surpassed a 10,000-strong bus fleet. The Government of the National Capital Territory of Delhi (GNCTD) introduced a new model for the operation of private stage carriage services to replace the existing private stage carriage service scheme. This system is changing the way urban bus services are provided, by increasing the involvement of the private sector. As a result of this contracting service, private bus operators will now function in line with benchmarks and processes set by the city. This enables the city to maintain a level of uniformity across the bus services offered.

The existing network of 650 routes was remodelled

into 17 clusters. Under the Delhi Integrated Multi Modal Transit System (DIMTS), each cluster will be served by the DTC and the private stage carriage in a 40:60 ratio. The scheme will provide an optimised solution for the scheduling of resources, planning of routes, and utilising of assets through data-sharing. Currently, nine clusters with 1,150 buses (under private operators) are operational. However, one of the forefront challenges for further expansion is the need for depot space (EMBARQ India 2012).

PUBLIC-PUBLIC PARTNERSHIP MODEL AT JAIPUR

Until 2013, bus services in the city were managed under a unique kind of public-public partnership between the Special Purpose Vehicle (SPV) - Jaipur City Transport Services Limited (JCTSL) and Rajasthan State Road Transport Corporation (RSRTC). This partnership functions under a gross-cost model, where the SPV is in charge of supervising, controlling, and monitoring operations. This enabled the SPV to build on existing knowledge, operations and infrastructure in the region.

By the end of 2013, JCTSL contracted a private operator to manage 120 buses and provided the operator with a depot facility. The remaining buses were taken over from RSRTC and are operated directly by JCTSL. The agency now manages all functions including the hiring and training of drivers. This model can be useful in initiating operations, since most states have an existing State Road Transport Corporation.

INTRODUCTION OF NEW SERVICES IN TIER 2 AND TIER 3 CITIES

In 2012, the Northeast Karnataka Road Transport

Corporation (NEKRTC) initiated basic bus services in six cities, which were previously managed by informal transport services. As a result, Gulbarga now has a total of 10 bus routes, with an operational fleet of 40 buses. Bus services were also introduced in Bellary, Bidar, Yadgir, Hospet, and Bijapur with about 175 buses in total.

MIDI BUSES IN BANGALORE AND CHENNAI

In 2014, in an exercise to expand services and respond to a distinct urban demand, bus agencies in Bangalore and Chennai introduced the midi bus. The aim of these services in both cities was to improve service accessibility to areas of low-demand, particularly in the peripheral parts of the metropolitan areas. In Bangalore, midi buses serve as feeder services for the BIG bus network. MTC is using these buses in Chennai to serve parts of the city that cannot be accessed by larger vehicles. They are useful in providing public transport access for residential catchments located in constricted parts of the city.

INITIATIVES Towards Financial Sustainability

Being at the forefront of discussion, innovations in the financial sustainability of city bus agencies also witnessed a number of initiatives. The following section introduces two initiatives undertaken by the BMTc.

TRAFFIC AND TRANSIT MANAGEMENT CENTRES IN BANGALORE

Long-term visioning and effective planning enabled the BMTc to use land-bank planning as an approach towards financial sustainability and public transport accessibility. Over the years, the agency purchased land parcels across the city as an investment for future operations. As the city grew, BMTc developed these sites and designed them into dual-purpose terminal facilities for interchanging passenger use and commercial activities (see Figure 9). Since 2009, BMTc has been operating ten Traffic and Transport Management Centres (TTMCs), allowing the agency to leverage its land holdings and promote bus transport use through integration of feeder modes, including the private car and bicycle. The revenue

from these commercial uses eases the financial burden on the agency by significantly offsetting a part of its operational costs.



Figure 9 Traffic and Transport Management Centre in Bangalore (BMTc 2014)

SCIENTIFIC APPROACH TO FARE REVISION AT BMTc

For its ordinary and differentiated bus services, BMTc employs a scientific approach to fare revision to determine the rise required to absorb increases in diesel price and staff payments. BMTc conducts a fare review twice a year and determines the change required. This process manages gradual increases in fares, which also places a more manageable burden on users. Furthermore, any decrease in diesel prices also results in a reduction in bus fares.

TECHNOLOGY Initiatives in Bus Operations

Several cities adopted and took steps towards incorporating technology to collect data and improve services. The following section includes some examples of these initiatives.

ITS AND COMPUTERISED STAFF SCHEDULING AT BEST, MUMBAI

As pioneers in adopting and implementing multiple new technologies and innovative processes, BEST experienced significant operational improvements through applications of resourcing softwares

¹A gross cost contract is where the operator is paid a specific sum of money to provide a specified service for a specified period (EMBARQ India 2009)

(Brihan Mumbai Electricity Supply and Transport Undertaking 2014). The agency is proficient in utilising surveillance cameras and passenger information systems to enhance commuter safety and convenience.

In addition to this, BEST introduced a computerised system to prepare its staff schedule. The software uses a specifically-designed algorithm to create shift timings for over 23,000 of the agency's drivers and conductors. In mid-2013, a pilot programme was initially implemented in two depots and later expanded to 12 more. By June 2014, the agency introduced this system to all 26 depots. As a result, BEST reduced their staff requirements by approximately four percent (BEST Undertaking 2014). Like most public transport agencies, BEST manually prepared schedules for its drivers and conductors - cumbersome process taking several weeks to complete. For large agencies, scheduling resources is critical to maintaining system efficiency. In the next stage, BEST expects to introduce computerised scheduling of buses and depots to match efficiency in staffing requirements.

PASSENGER INFORMATION SYSTEMS IN MYSORE

In November 2012, the Karnataka State Road Transport Corporation (KSRTC) implemented a unique ITS solution known as the Mysore Intelligent Transport System (MITRA). The project implementation covers 500 buses, 105 bus stops, 6 bus terminals and 45 bus platforms. The system primarily consists of vehicle-location and passenger communication solutions. The ITS vendor is expected to operate and maintain the system for the next three years (KSRTC n.d.). The first level of implementation involved data collection, which was used to convey information to waiting commuters so they could plan their journeys. The second phase of the pilot implementation incorporated an analytics solution where data was analysed and used to provide inputs into the planning and scheduling processes. Operators also use this information to efficiently deploy buses and maintain convenient headways.

ELECTRONIC TICKETING MACHINES IN USE

The application of technology in public transport saw a dramatic rise in implementation over the last few years. Multiple transit agencies upgraded to the use of Electronic Ticketing Machines (ETMs), which simplifies back-office processes for the agency. ETMs make available data that can be analysed for the improvement of services and operations.

Several cities are progressing towards automated ticketing systems: Mumbai, Indore, Bhopal, Mysore, Vishakhapatnam, Jaipur, Gulbarga, and Bhubaneswar have ETMs on their entire fleet, while Chennai is working towards equipping their fleet. The status of ETMs in each city is as follows:

- 4533 buses in Mumbai
- 110 buses in Indore
- 225 buses in Bhopal
- 416 buses in Mysore
- 560 buses in Vishakhapatnam
- 408 buses in Jaipur
- 74 buses in Gulbarga
- 150 buses in Bhubaneswar-Puri-Cuttack city bus services
- 200 buses in Chennai
- 40 percent of the cluster model operated privately in Delhi already use automated ticketing
- BMTC and DTC have tendered for ETMs

Numerous cities use ETMs to collect data, paving the way for data analysis and inputs into enhancing system performance.

BRANDING Initiatives

Efforts to brand public transport and communicate information to users were prominent in the industry. Initiatives to upgrade city bus services and introduce BRT systems incorporated strong branding and outreach strategies.

REBRANDING THE BANGALORE CITY BUS SERVICE

In 2009, the Bangalore Integrated Grid, or BIG Network led to the rebranding of BMTC's services, which created a distinct identity for the service. The new brand enables users to understand a simple route structure and identify with a visually-uniform bus system. With attractive livery schemes, the bus system gained popularity among users.

With over a 180 operational kms serving around 308,000 people per day, the last decade witnessed a significant growth in the number of corridors from zero to 24.

MARKETING THE BRTS IN INDORE

As the second 'complete' BRT system, Indore's iBus established a new benchmark for marketing and communicating in the public transport field. The processes adopted by the team were far-reaching and their impacts were successful in gaining the support of the citizens of Indore. Engagement strategies included social media use, specialised focus group sessions, and free trial runs, which were able to create continuous focus on the project, throughout its planning and inception. Ultimately, when the system was launched, ridership along the pilot corridor was double that of initial estimates.

BHOPAL BRTS STAKEHOLDER COMMUNICATIONS STRATEGY

Bhopal's MyBus also devised a comprehensive communication plan to implement during the course of the project. Strategies to increase public awareness were implemented through workshops, public discussions, periodic newsletters, and constant media attention. In a first-of-its-kind exercise, Bhopal marketed the system through high-quality aerial imagery of the corridor to maximise their effort. The system witnessed strong public support throughout the project.

BRT Systems in India

The last decade witnessed a growth spurt of bus corridors and BRT systems across the country, with operations being started in over ten cities. This amounts to over 180 kms of BRT systems operational or underway and over 440 kms of BRT systems under planning. In addition, there are eight operational bus corridors and BRT systems in India. Six more cities have BRT lines under construction, and an additional five announced future plans to build such a system. In less than a decade, the number of BRT systems and bus corridors in India will have gone from zero to 24 (see Figure 1.5).

SITILINK, SURAT

In 2014, a closed BRT system was launched in Surat. Currently, nine buses are operated along a 10-km corridor. The first corridor along Surat Navsari Road caters to a per day ridership of 5,000 passengers. The Surat system identified nine corridors for BRTS operation, of which two have been sanctioned (Surat Municipal Corporation 2014). The system entails all features that make up a full BRT: bus stops in the road's median, stations with prepayment and level boarding, good quality buses, information technologies and a distinctive image (EMBARQ 2014).



Figure 10 With the launch of the MyBus system, 24kms of BRTS are presently operational (Bhopal City Link Limited 2014)

IBUS, INDORE

In 2013, the first pilot corridor of iBUS was launched in Indore. The 11.45-km corridor running along AB Road from Rajiv Gandhi to Niranjapur is functional, with 20 median bus stations and a daily ridership of 40,000 passengers and growing (AICTSL2014). The system includes off-board payment facilities, a segregated corridor, dual-entry buses, and one of the most advanced ITS systems in India, used for tracking buses. The proposal is to build a network of 120kms of BRTS for the city.

BHOPAL BRTS

The first phase of the MyBus system totals 44 kms, with 24 kms presently operational, making it the second-longest operational BRTS corridor in the

country (see Figure 10). The corridor is an open system that runs through mixed traffic in some parts of the corridor. The first corridor from Bairagarh to Misrod sees a daily ridership of almost 48,000 passengers in 185 buses (Bhopal City Link Limited 2014).

RAJKOT BRTS

The Rajkot BRTS, or Rajpath, began operation in 2012 with a total planned coverage of 63 kms. The current operational 10.7 kms are served by 10 buses running within a closed system. The second phase includes two additional corridors. In April 2014, the average ridership was around 10,680 passengers per day (Rajkot n.d.). The salient features of this system include the following:



Figure 11 JnNURM Cities, BRT and Bus Corridors in India (EMBARQ India 2014)

- An automatic door system at bus shelters: to enhance passenger safety at stations
- Passenger information systems: to allow passengers to plan their journeys more precisely
- Real-time vehicle tracking: to provide for dynamic bus scheduling
- Off-board fare payment: reduce bus waiting times

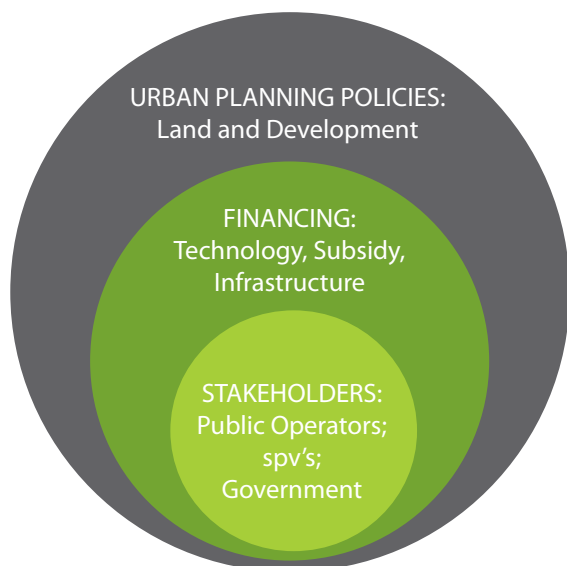


Figure 12 A way forward for City Bus Operations: Cities' Role

AHMEDABAD BRTS

Janmarg was acclaimed internationally and is acknowledged as the first 'complete' BRTS in India. The Janmarg system of Ahmedabad has expanded and currently includes 86 kms of operations. With a 143-strong bus fleet, the system serves 1.3 lakh passengers per day (Ahmedabad Municipal Corporation 2014). The system has median bus lanes and includes three types of services: trunk, complementary, and feeders (Ahmedabad Municipal Corporation 2014). It has all elements of a complete BRTS, including prepayment, overtaking lanes, branding, well designed stations with level boarding, and centralised Information Technology control.

1.2 WAY FORWARD

The High Powered Expert Committee on Urban Infrastructure set up by the Ministry of Urban Development in 2008, estimates that cities in India will need about 1.5 lakh buses, amounting to approximately Rs. 60,000 crore in the next 20 years. The current investments in public transport, especially city bus service initiatives, are far

from adequate to meet the emerging demand. Furthermore, the recommendations of the Working Group on Urban Transport for the 12th Five Year Plan include as one of its goals, the introduction of organised public transport in all 2 lakh+ population cities and state capitals (Planning Commission Government of India n.d.).

While the challenges in this mission are numerous, the impetus to advance the role of city bus services in urban transport is stronger. This decade should be dedicated towards the improvement of city bus systems and strengthening the implementation of existing practices. It is an underlying fact that political will and strong leadership, with support from communities, Non-Governmental Organisations (NGOs), and other stakeholders will assume a fundamental role in city bus reforms.

In addition, the limited availability of skilled human resources remains a challenge due to the time necessary to adequately train staff. Therefore, in order to expand our city bus services, the following key issues need to be addressed (see Figure 12).

ECOSYSTEM OF MULTIPLE STAKEHOLDERS:

The bus industry experiences a lack of innovation. To promote public transport over private transport, a creative approach and upgrades to vehicles is critical. The government needs to understand and recognise the role of manufacturers, operators and service providers in three core functional areas:

- **Manufacturers:** the JnNURM calls for an additional 10,000 buses, and in the next 20 years, cities will need another 1.5 lakh buses. Buses in India continue to be built using truck chassis and a bus body, indicating a strong need to move towards better safety and design standards. In addition, the further development of skills and capacity within the industry can expedite the timely and effective delivery of high-quality buses. In 2010, the Indian Association of Bus Manufacturers (IABM) came into existence. Deeper government support and engagement with this sector is crucial for further expansion.
- **Operators:** Private operators are viewed as competition, and their inclusion in platforms such as the Association of State Road Transport Undertakings (ASRTU) are perceived negatively. SPVs and private operators as a part of the ASRTU can allow these stakeholders to also maximise on bulk buying, capacity building, and data-sharing. The system needs to acknowledge a three-way relationship between the government, SPV, and

the private operator and formalise and clearly facilitate the roles and interactions of each.

- **Service providers:** Ancillary service providers such as ITS service providers are vital to the expansion of city bus services. Currently in India, a platform for interaction, sharing of ideas and best practices, and for recognition as part of the city bus system does not exist.

The challenge is to retain and increase the modal share of city bus services. Cities in India will need about 1.5 lakh buses, amounting to Rs 60,000 crores in the next 20 years.

There is an overall need to bring together these stakeholders into a regulated framework. This framework can largely facilitate stronger partnerships by improving skills within the workforce and strengthen interactions in order to incentivise bus use.

FINANCIAL POLICY

There is an urgent need to acknowledge, financially plan and earmark the required resources for city bus operations. There is a need for active engagement by both the central and the state governments to ensure that transport undertakings receive the necessary financial support. It is necessary that this support recognises and works within the social framework in which public transport service provision functions. The following points will facilitate this financial planning:

- **Tax exemptions:** The exemption of taxes for bus transport including excise duty, cess, surcharges, etc. can be effective in promoting patronage.
- **Managing subsidy:** Currently, subsidies are based on decisions by political leaders. It is important to evolve an approach where subsidies are not provided to address the inefficiencies in the system; rather they can be introduced as a tool to incentivise public transport use through systemic improvements. Financial subsidies should be based on anticipatory estimates of costs and income, taking inflation into account. A fare structure that considers both the financial

costs and the social responsibility of providing the service is more appropriate in maintaining a sustainable financial position of the agencies.

- **Dedicated urban transport funds:** Local bodies can actively set up a dedicated urban transport fund, and earmark a percentage of the funds towards improving the city bus services.
- While municipal bodies spend thousands of crores every year on road repairs and widening, dedicated funds for city bus services are consistently overlooked. In addition to national policy, states and local bodies can provide financial support in the form of capital expenditure for bus procurement and infrastructural requirements.

URBAN PLANNING

City bus agencies operate under the broader policies and rules set within urban planning principles. This area is generally worked under the jurisdiction of local and state planning authorities. It is essential that city planning authorities work along with city bus agencies towards an aligned vision. More importantly, urban planning authorities should prioritise and incorporate the needs of city bus services into the overall strategy. For example, this interaction can be exercised in two ways to address the land requirements of bus transport:

- Local and state government should be more proactive and prioritise city bus services through land allocation.
- As part of the city's development plan, land should be reserved for usage by transport undertakings in the future. A land-banking strategy for the future expansion of city bus service should be taken into account.

1.3 THE BUS KARO 2.0 GUIDEBOOK

In the process of implementing these practices, many lessons and challenges have emerged. These case studies are used as a tool to demonstrate how public transport agencies and authorities can approach various issues related to operations, service and infrastructure planning and financing. The 2.0 Guidebook provides a detailed assessment and learnings from some of these challenges (Figure 13 indicates the scope of this guidebook).

The intended audience includes the MoUD, city, state authorities, public transport agencies, private operators and planners. When used parallel to central and state processes in this field and as an in-depth manual for city bus agencies, these learnings can be contextualised to further strengthen bus systems on multiple levels.



Figure 13 Scope of the Guidebook

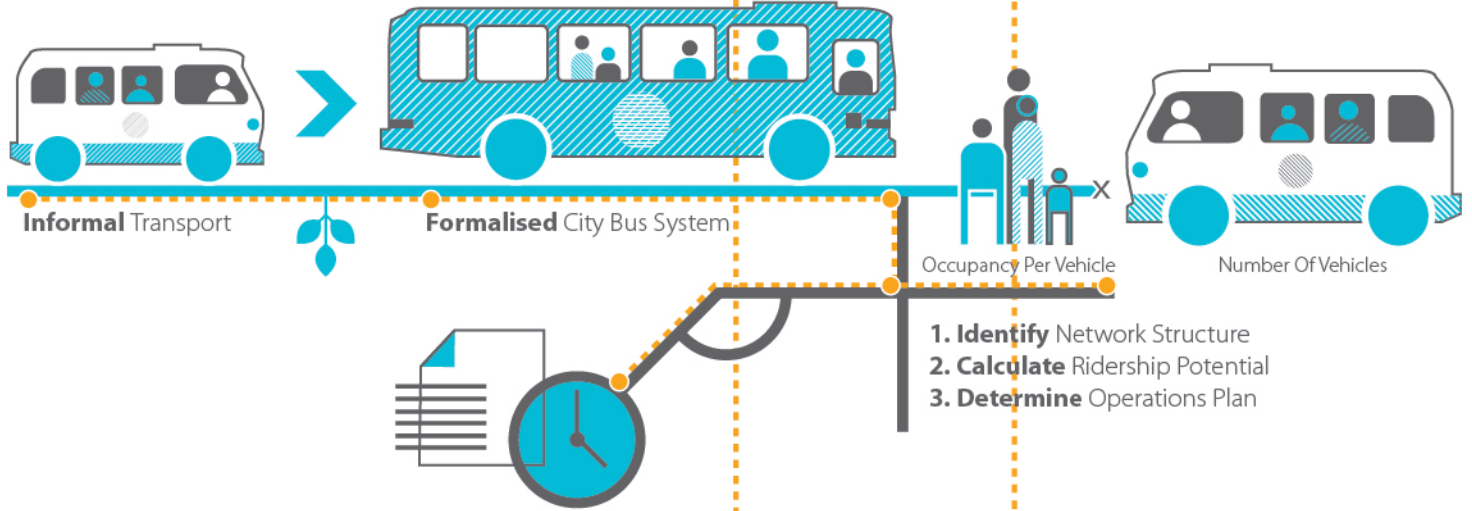
2

SERVICE PLANNING AND OPERATIONS

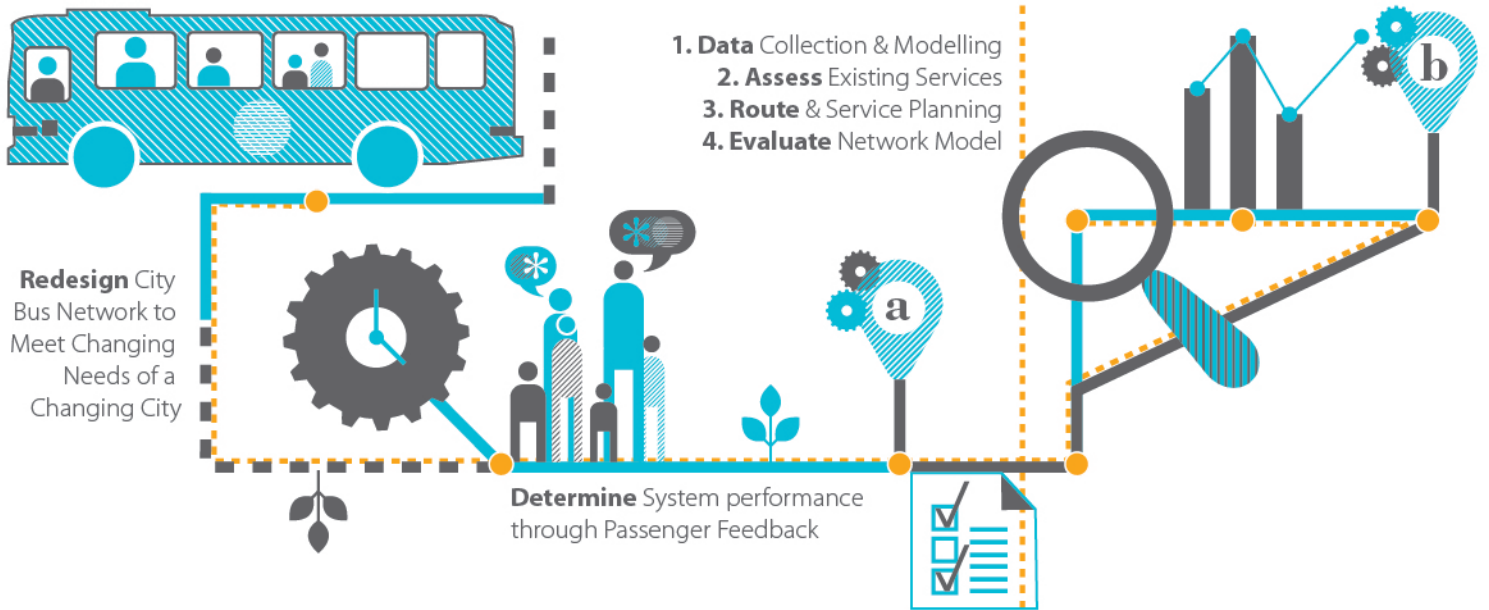
2.1 Data Collection and Uses

DATA COLLECTION

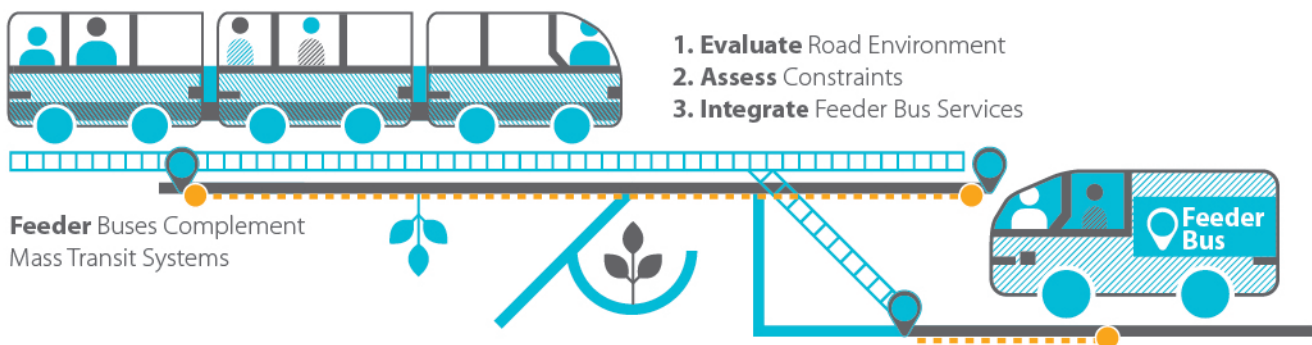
2.2 Initiate Services



2.3 Route And Service Optimisation



2.4 Complement Mass Transit Through Feeder Buses



CHAPTER TWO

SERVICE PLANNING AND OPERATIONS

Indian cities are witnessing tremendous population growth, spatial evolution of residential and employment concentrations, resulting in a significant change in how people move. As the mobility needs of the population change, it is important that the transport system responds effectively. Most initiatives have focused on upgrading and modernising services through the quality of the fleet or utilisation of Intelligent Transport Systems (ITS) components. While these efforts are important, they are likely to remain sub-optimally effective if the underlying service and network structures are also not improved. There is a need to improve public transport operations through periodic reviews, to optimise city bus services. Data collection is a vital tool to assess these changes in travel patterns, system performance, public perceptions and growth in demand. This will result in improved service quality and capture a larger share of travel demand.

The first section begins by discussing the goals of data collection and how the process applies to the assessment of city bus services, at various levels. This is followed by a focus on planning for bus operations in cities with no formal public transport service. The next level of review involves a periodic assessment of existing bus systems to further optimise it. This chapter concludes with a focus on complementing mass transit systems through the integration of feeder bus routes (see Figure 14).

2.1 Data Collection and Uses

Data collection enables transport agencies to obtain vital information such as trip characteristics, travel behaviours, and demographic characteristics from

customers. This information facilitates three goals:

- Operational Improvements
- Improved staff behaviour and performance; and
- Monitoring change in user perception and needs

This section discusses types of surveys and their application to planning operational elements.

Data collection enables agencies to obtain vital information such as trip characteristics, travel behaviours, and demographic characteristics from customers.

SURVEY Types and Uses

Data collection is typically undertaken by two types of surveys – field-based and technology-based. Field-based surveys require surveyors to physically collect data on or off-board for existing and potential users (see Table 1). Intelligent Transportation Systems (ITS) use other modes to collect this data (see Chapter 5 for data collected through ITS and their uses). There are four types of field-based surveys that are useful in monitoring system performance.

The data collected from these methods can be analysed for route modifications, to provide the following:

- Route-wise ridership / boarding-alighting patterns
- Route-wise headway



Figure 14 Data collection as a tool to address changes in travel patterns

SURVEY TYPE	USE
Boarding alighting surveys (bas) provide data on the number of passengers getting on and off the bus. This data is useful in identifying high-activity areas	<ul style="list-style-type: none"> • Identify high activity centres • Route performance and load factor on each route • Determine major travel patterns • When combined with etm data, it can help identify the number of pass users
Bus occupancy surveys (bos) record the number of persons in every bus that passes a certain point	<ul style="list-style-type: none"> • Identify high-demand and low-demand sections along the corridor, to reallocate resources as required • Determines throughput on the corridor • Provides an estimate of the number of buses required to satisfy demand on the corridor
Origin-destination surveys collate data on passenger trip start and end points	<ul style="list-style-type: none"> • Determines operational and service plan • Identifies potential users
Passenger perception surveys	<ul style="list-style-type: none"> • Provides detailed characteristics of passengers and trip patterns • Provides opinions on service quality parameters

Table 1 Types of field-based surveys and uses (EMBARQ India 2014).

- Route-wise travel time variation
- Peak- and off-peak passenger load variation
- Bunching of buses
- Staff performance and driver inefficiencies

The data sets collected can be utilized to understand multiple aspects: existing situation or performance of a specific route, the impact of operational changes, passenger feedback, travel demand models, service contract and adherence monitor.

EXERCISE	SURVEY TYPE	DATA COLLECTED
Initiating New Routes	Passenger Interviews Origin-Destination Survey Maps	Important Points for Boarding / Alighting Load in bus at various points Direction-wise travel time Activity centres, Road networks
Planning Type of Service	Boarding Alighting Survey (BAS) Stage-wise ETM data	Boarding / Alighting numbers by bus stop
Scheduling	Boarding Alighting Surveys Trip-wise ETM data GPS location data	Time of trip Travel Time for trip, by direction, route segment, time of day and type of day (i.e. weekday vs. weekend)
Demand on Corridor	Bus Occupancy Survey	Occupancy by bus route
Bunching / Schedule Adherence	GPS data	Time Geo-location
Driver Performance	GPS data	Acceleration patterns Driving Speeds Trip timing

Table 2 Types of surveys to be undertaken for each decision (EMBARQ India 2014).

To monitor performance, agencies are required to study travel pattern shifts and determine the systemic changes required to satisfy the change in needs. Table 2 indicates the surveys required for each decision type and the resultant data.

SERVICE Planning and Scheduling

Experience indicates that the volume of passengers boarding and alighting at a particular stop can be useful in planning a service. There are three types of services that are generally planned to manage all travel patterns along a corridor:

- End-to-end services (express);
- Specified stops (skip-stop); or
- Local services.

For corridors or the time of day (i.e. peak or non-peak hours) that indicate low boarding and alighting

at several stops, a skip-stop service would be more appropriate. A skip-stop service can also be implemented in heavily congested areas, such as walled city or downtown areas, where the speed of traffic is slow or space is not available for bus stops. Similarly, for heavy movement between two neighbouring cities, an express service would satisfy demand.

EXAMPLE: Planning Operations for the Hubli-Dharwad Bus Service

Data from the BAS or ticketing data can be used to determine the type of service. For example, a survey from Hubli-Dharwad indicated maximum boarding at the Central Bus Station in Dharwad and alighting distributed along five stops in Hubli (see Figure 15). The data shows low boarding and alighting at stops between Hubli and Dharwad; hence, express services can be directly operated between Hubli and Dharwad.¹

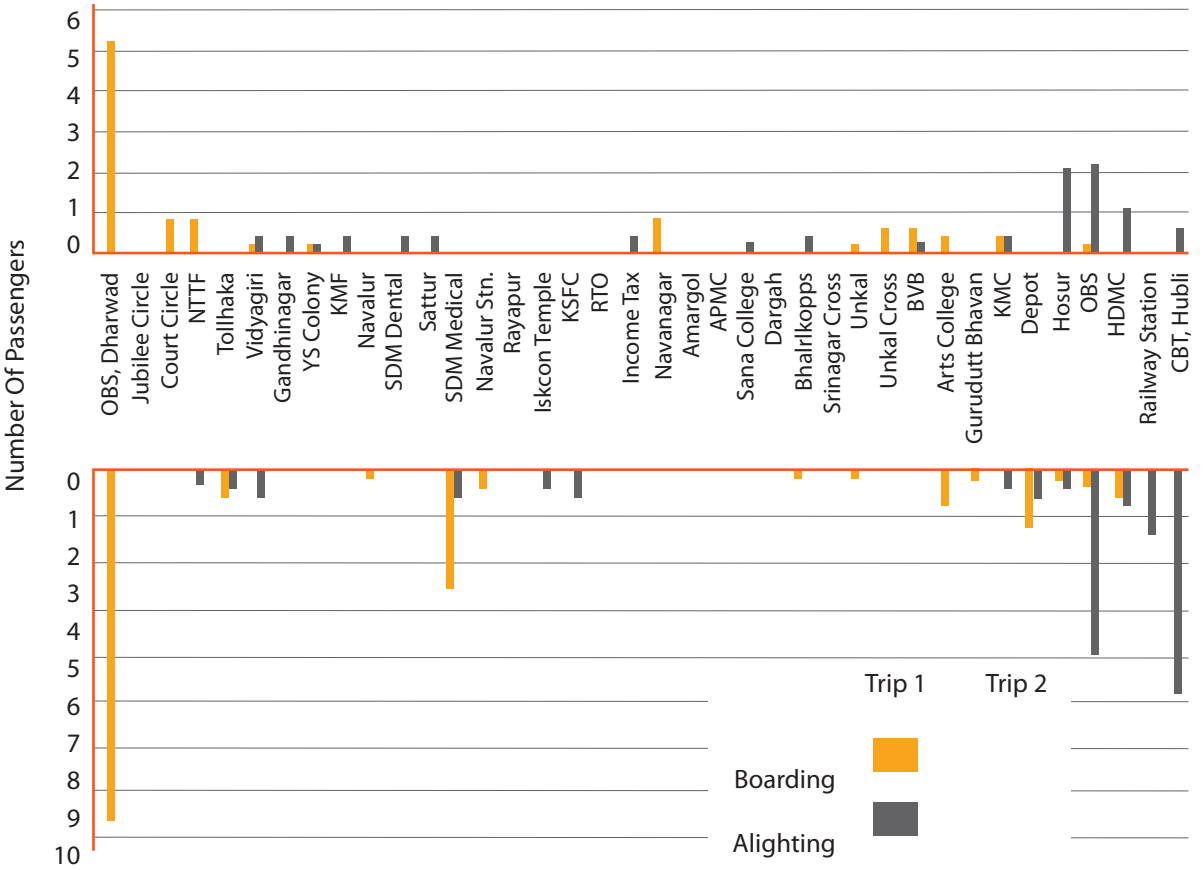


Figure 15 Boarding and Alighting Patterns between Hubli and Dharwad (Northeast Karnataka Road Transport Corporation 2014)

¹This conclusion is strictly based on what the data indicates, not other important factors such as the social repercussions of these changes. These other factors are also critical to use in the decision-making process.

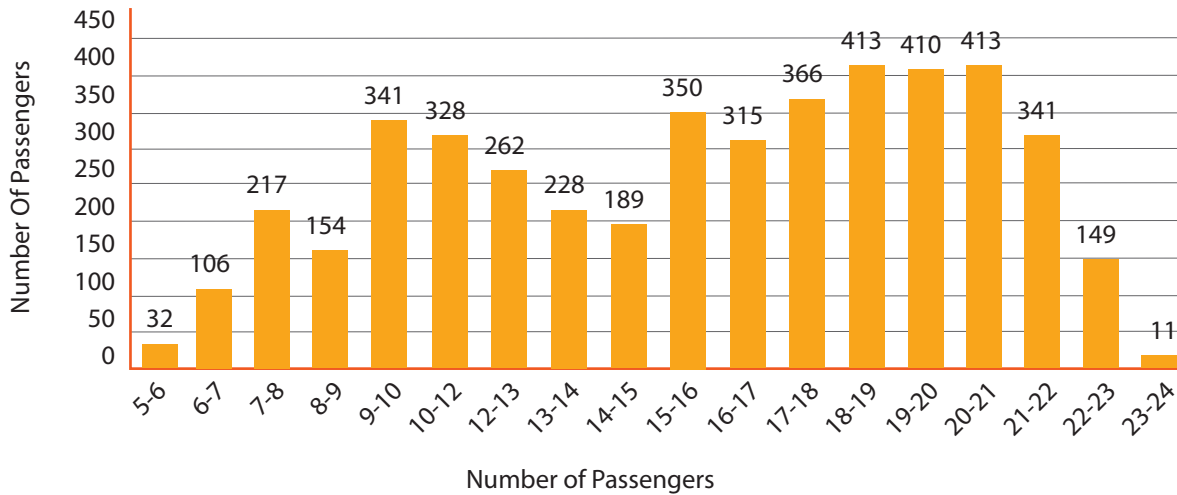


Figure 16 Demand Variation by Time of Day from Rashtrapati Chowk, Gulbarga (Northeast Karnataka Road Transport Corporation 2014)

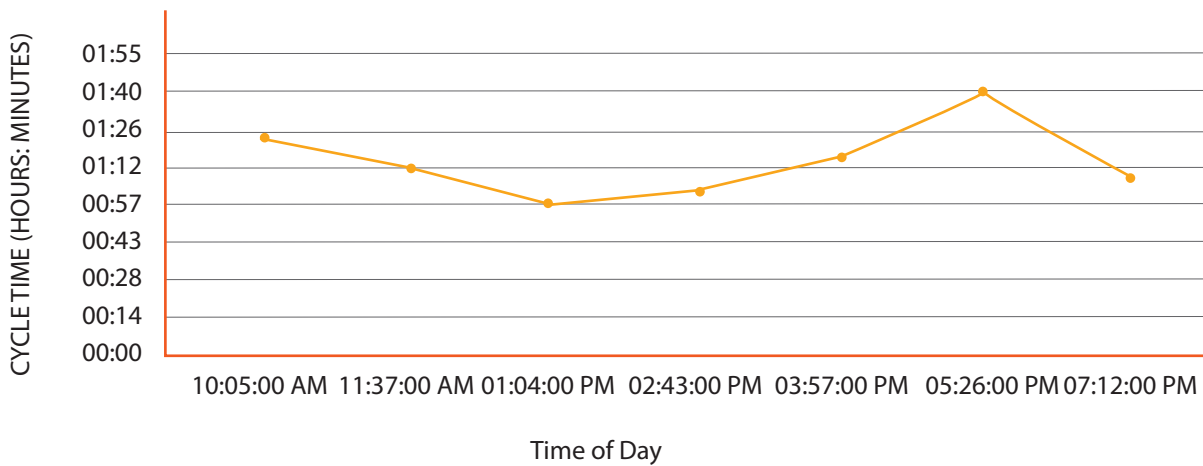


Figure 17 Cycle Time variation for Route 207 in Bhubaneswar (DTS 2012)

EXAMPLE: Using Data To Plan For Demand Variation In Gulbarga

Data revealed that the same frequency throughout the day was not required. As seen in Figure 16, demand was low at the early morning and late evening periods. To respond to this variation, the frequency can be reduced during off-peak times. Similarly, additional services can be introduced during peak-hours, particularly between 3pm and 10pm, to cater to the heavy demand.

CASE STUDY: Using Data to Schedule and Plan Operations in Bhubaneswar

Dream Team Sahara (DTS), the bus operator in Bhubaneswar, initially operated bus services with the same frequency throughout the day. As a way to create better efficiency in operations, ticketing data was used to determine the ridership at different times of the day. The data indicated five variations in demand, according to the time:

- Early Morning: 5am – 7am
- Morning Peak: 9am – 10am
- Evening Peak: 4pm – 10pm
- Late Evening: 11pm – 12am
- Day Service: 7am – 11pm

Data was also collected to alter the bus schedules to reflect varying traffic conditions at various times of the day.

Cycle times² can be calculated from BAS, ETM and GPS data. As seen in Figure 17, the cycle time for Route 207 varies from 55 minutes up to 1 hour 40 minutes during the peak traffic period.

A key part of the scheduling process is to consider the variations in travel demand and patterns that occur at various times of the day. Peak hour traffic conditions typically mean slower speeds and hence longer cycle times. These variations are sometimes overlooked while scheduling buses, often due to the

unpredictable nature of these variations. As a result, drivers face pressure to ensure that the bus reaches the stop or destination as per the recorded schedule. To make up for time lost to traffic congestion or other factors, drivers speed up, miss stops or divert routes. The analysis of GPS data was useful in determining realistic cycle times and ensuring improved operations.

SECTION SUMMARY: Data Collection and Uses

Data collection is useful to determine critical information on trip characteristics, travel behaviours, demographic characteristics and user opinions. Data pertaining to boarding-alighting points and origin-destination trends can be effective in identifying major travel patterns, high activity centres and operational plans.

This data can be analysed to monitor system performance and improve service planning. The DTS bus operators in Bhubaneswar used data to determine the variation in demand and cycle time at various times of the day. As a result, service frequencies and cycle times were altered to match the existing demand and improve operations.

² Cycle time is the total time taken for the bus to reach its destination and return. The cycle time also includes terminal wait times.

2.2 Initiating City Bus Services

Public transport network planning and designing are key to the success of the system. Cities with no formal public transport system in place require planning from the basics. The desirable features of a good public transport system include (Gustav Nielsen 2005):

- Network simplicity to enhance system legibility
- Convenient and seamless transfers
- Demand responsiveness to ensure that routes and schedules correspond to the existing travel patterns and demand
- Coordinating services and timetables, where demand is lower.

In order to implement a good bus system that incorporates these attributes, there are three critical points of focus: network configuration, ridership demand and service type (Gustav Nielsen 2005).

Implementing a new system requires three critical points of focus: network configuration, ridership demand and service type.

IDENTIFY the Network Structure

The first step in planning for city buses is to identify a route structure. By plotting all the trip-generating activity centres and major roads (on which buses can operate) of the city on a map, a basic idea of the travel patterns there can be determined. This ensures that the bus network reflects travel patterns which include movement between activity centres such as places of employment, schools / colleges, markets and commercial areas, etc.

A rough route structure can then be identified

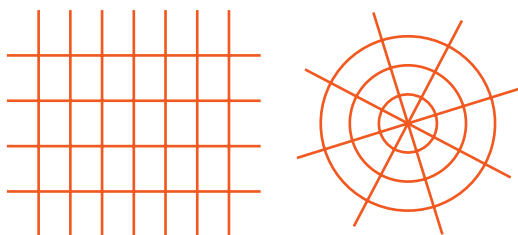


Figure 18 Two types of Network Structures: Grid (left) and Radial (right) (EMBARQ India 2014)

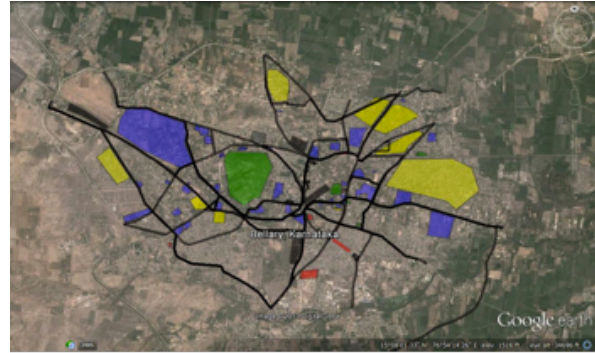


Figure 19 The traffic generator nodes in Bellary, Karnataka and the existing road network.(Northeast Karnataka Road Transport Corporation 2014)



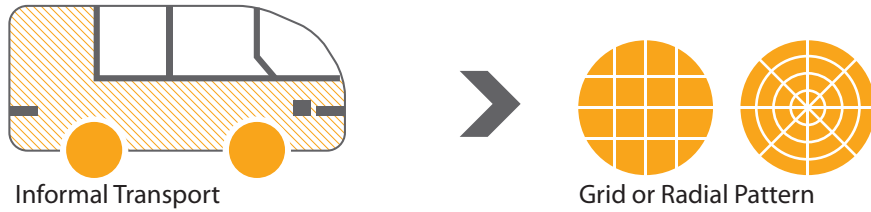
Figure 20 A preliminary draft of the possible public transport routes for Bellary, based on the existing generator nodes and road network.(Northeast Karnataka Road Transport Corporation 2014)

by joining all of these activity centres. This route structure can also be compared against any informal public transport routes that might exist in the city (i.e. auto-rickshaw or private buses). This structure follows the road pattern in the city, and can often be simplified into a grid network or a ring and radial system as seen in Figure 18. A simplified route structure is easier for users to understand and is also easier for the transport agency to operate.

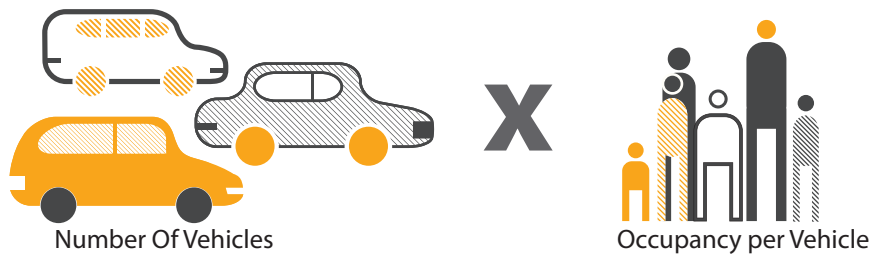
For instance, in Bellary, Karnataka, the Northeast Karnataka Regional Transport Corporation (NEKRTC) surveyed land use in 2011 Northeast Karnataka Road Transport Corporation 2014). Figure 19 shows residential, commercial, business, and educational nodes, along with the major road connections. A preliminary network was developed by mapping these activity centres and connecting them via the existing road network as seen in Figure 20. Origin-destination surveys were conducted at key interchange points along the network. New routes were added based on the travel patterns indicated by this data.

INITIATING BUS SERVICE

1. Informal Transport



2. Calculate Ridership Demand



3. Determine Operational Plan

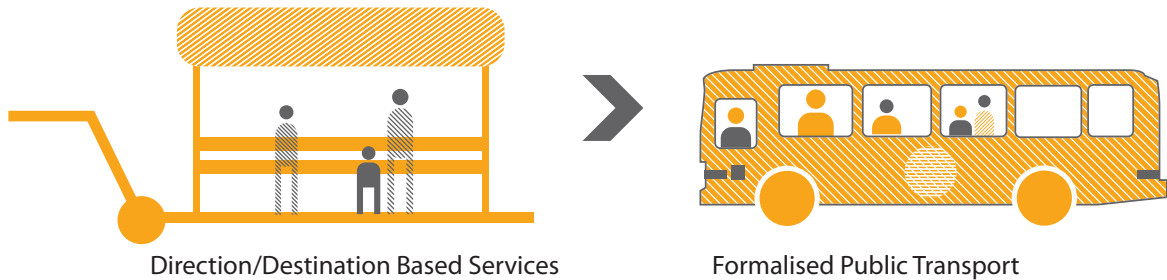


Figure 22 Chapter Summary: a 3-step process to advance from an informal to a formal transport system (EMBARQ India 2014)

CALCULATE Ridership Demand

Once the overall route structure is determined, the next decision to be made is the planning of operational aspects like the number of buses to operate and where to stop. In cities where formal public transport systems do not exist, informal public transport systems such as auto-rickshaws, private buses and minivans might serve the demand. By surveying these modes, it is possible to identify the number of people travelling on the main corridors and also to identify major bus stops. An occupancy survey can be used to determine the ridership potential and hence calculate the number of vehicles required (refer to Figure 21).

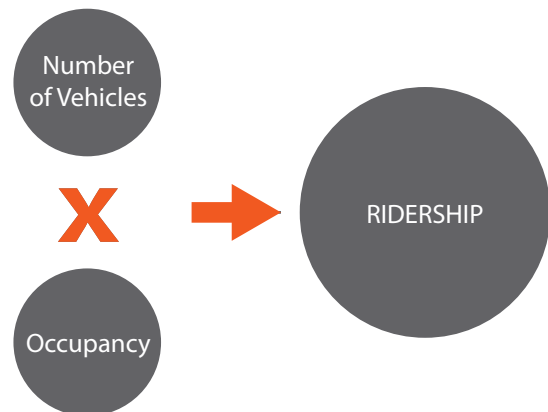


Figure 21 the existing ridership can be calculated by multiplying the number of vehicles and occupancy (EMBARQ India 2014)

DETERMINE the Operational Plan

The third aspect of planning is to determine the type of service required. Once the demand is determined, it is crucial to understand the variation of demand through the day as well as based on location.

Demand varies by the time of day (i.e. peak hour vs. non-peak hour), the time of week (i.e. weekday vs. weekend), and the time of year. Data collection to understand the distribution of demand is useful in creating an operational plan.

The operational plan is determined by the network model as destination-oriented or direction-oriented (see Figure 10):

- In a destination-oriented service, a destination – a neighbourhood, market, or village – is connected directly to major destinations. The direct connection minimises transfers. This model is generally best suited for smaller cities, where the majority of travel patterns can be served through a small number of direct routes.
- In a direction-oriented model (direct connection), mobility patterns are served by a combination of interconnected routes. This model emphasises transfers between services operating in different directions. Larger cities have a distinct hierarchy of major and minor travel corridors, and hence this model is better suited for them. In this case, attention must be paid to the level of service for multiple routes, to ensure that waiting times are minimal and transfers are seamless.

This chapter highlights a 3-step process to initiate city bus services (see Figure 22). In 2013, NEKRTC undertook a similar process in several Tier 1 and Tier 2 cities that were dependent on informal modes of transport. The next section discusses the introduction of services in Gulbarga and the impacts of this initiative.

CASE STUDY: Introduction of City Bus Services in Gulbarga, North East Karnataka Regional Transport Corporation (NEKRTC), Karnataka

The city of Gulbarga has a population of 5.3 lakh and is the headquarters of NEKRTC (T.V. Ramachandra 2013). An ageing fleet of 17 buses served a demand of approximately 18,000 passengers per day (Northeast Karnataka Road Transport Corporation 2014). The IPT sector flourished in areas where public transport services did not operate. Following a study in 2010 by the Directorate of Urban Land Transport

(DULT) under the state government, the decision to revitalise city bus services was taken (Northeast Karnataka Road Transport Corporation 2012). In November 2012, a fleet of 40 new buses under the brand name of Nruptunga was introduced.

Using the City Traffic and Transportation Plan and observational data on auto-rickshaws in Gulbarga, the main traffic corridors in the city were identified. The network developed was a ring and radial system, which is in keeping with the travel patterns of the city (See). A total of 10 routes were identified for implementation. Using passenger counts and traffic counts at various points, the demand on these corridors was then estimated to determine the number of buses and trips.

Post-implementation data was obtained in June 2013, to understand the performance of the new service. The performance indicators before and after implementation show a positive impact on each of the indicators (see Table 3).

network model. If it is deemed necessary, the following steps are carried out.

3. Data Collection and Modelling: In this step, relevant data is collected to develop an in-depth analysis of existing services. Data pertaining to ridership estimates by route, bus frequency by route or area, origin-destination surveys and passenger travel patterns are useful for this exercise.

If the agency is considering a change in the network model, data collected can be used to support or weaken the argument for this change.

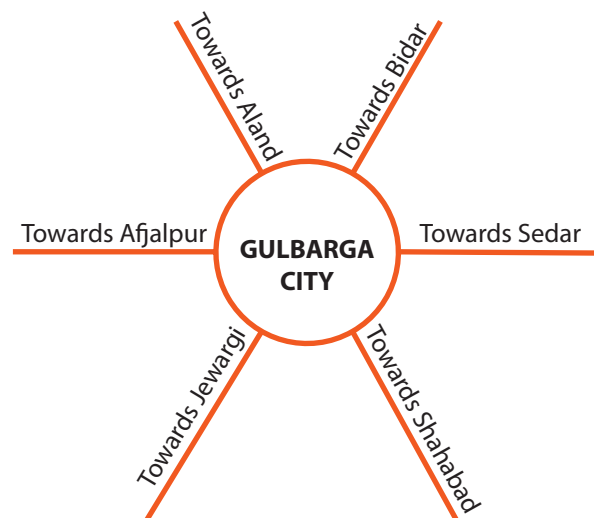


Figure 23 The proposed network structure for Gulbarga (Northeast Karnataka Road Transport Corporation 2014)

PERFORMANCE INDICATOR	BEFORE SERVICE INTRODUCTION	AFTER SERVICE INTRODUCTION	VARIATION
Fleet (no. of buses)	17	60	+43
No. of trips	290	1,168	+878
Route Length (kms)	53.40	135.10	+81.7
Scheduled route (kms)	2,494	10,625	+8,131
Revenue per day (Rs.)	55,000.00	3,59,762.50	+3,04,763
Revenue per day per bus (Rs.)	3,235	5,996	+2761
Average earnings per km (Rs.)	17.5	33.86	+16.36
Occupancy Ratio	60%	89%	+29%
Total Ridership per day (passengers)	18,000	75,000	+57,000
Ridership per bus (passengers)	1,059	1,250	+191
Ridership per trip (passengers)	60	64	+4
Head way (minutes)	25 - 45	10	-25
Vehicle Utilisation (kms)	147	180	+33
Average cost per km (Rs.)	25.50	31.46	-5.96

Table 3 System Performance before and after the initiation of city bus services in Gulbarga (Northeast Karnataka Road Transport Corporation 2014)

2.3 Route and Service Optimisation for City Bus Services

Operators serving within more established transport systems often engage in continuous, small-scale changes at the route level, based on passenger feedback, ridership analysis, revenue considerations and related factors. While these are short-term improvements, a system-based approach can drastically upgrade services. Route and service rationalisation at the network level ensure that services are of high quality and meet the changing needs of a growing city (BMTTC 2014) (Brihan Mumbai Electricity Supply and Transport Undertaking 2014). Route and service rationalisation in this section refers to a large-scale, periodic review of the entire network (see Table 4).

ROUTE and Service Rationalisation: Methodology

Based on the exercise in Bangalore (see Case Study section), EMBARQ India compiled the following methodology:

1. Qualitative Assessment of Existing Services: Service providers conduct a qualitative and comprehensive evaluation of the existing services. This can be targeted at certain groups such as passengers, transport agency employees, urban transport experts and other relevant stakeholders. For example, a user perception survey that asks specific questions related to the overall system is useful to understand how well the system performs. This will help in identifying issues with the existing services. Once these are highlighted, broad, system-level reforms can be determined.

2. Network Model Evaluation and Alternative Development: In this step, agencies explore the underlying network model of the service. The aim of this step is to ascertain whether a network-level restructuring is required to address the issues identified in the first step. The two network models are: destination-oriented and direction-oriented (see Figure 24). For a more established system, a third type of network model can prove suitable. A hybrid service combines both of these types of services, catering to the specific demand along a route. In megacities where neither the direction-oriented nor destination-oriented model alone effectively serves the

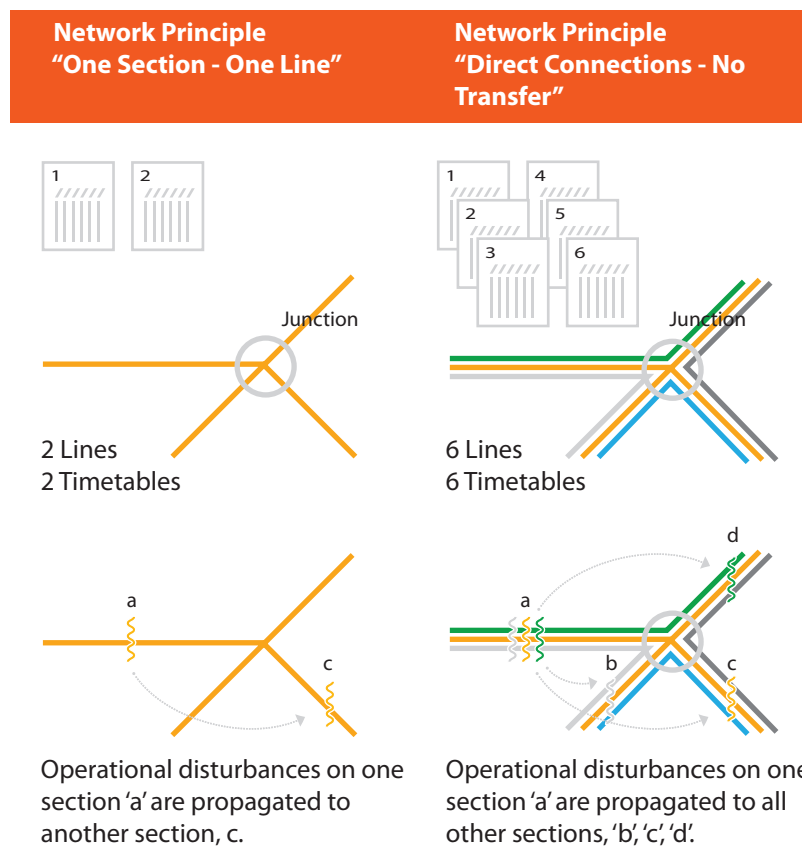


Figure 24 Two operational models destination-oriented (left) and direction-oriented (right) services (Modified from (Gustav Nielsen 2005))

WHAT?	Periodic review and redesign of entire city bus route network and service
WHY?	To meet the changing public transport needs of a changing city
WHERE?	Small to medium size systems should conduct route and service rationalisation for the entire system. Larger systems may choose to conduct the exercise for different parts/sections of the city in a sequential manner.
WHEN?	Route & Service Rationalisation exercise should be conducted, at minimum, once every 10 years. Agencies with sufficient resources may choose to conduct the exercise every 5 years.
HOW?	Extensive data collection on performance and passenger feedback (See section 2.4 for further details)

Table 4 Route and Service Rationalisation for City Bus Services (EMBARQ India 2014)

needs, this combined model suits well. Most city bus services will likely fall into this category, with varying degrees of emphasis on the direction or destination-oriented model.

At this stage, the agency must decide whether the qualitative evaluation justifies an in-depth investigation of re-working the underlying

4. Route and Service Planning: The magnitude of planning in this stage will be based on the decision from Step 2 and 3. If the decision entails a system overhaul and change in network model, this step will require the development of an entirely new slate of routes and services. If the data supports the existing model, a marginal yet meaningful effort will be required.

CASE STUDY: BIG Bus Network, Bangalore

City bus services in Bangalore, operated by Bangalore Metropolitan Transport Corporation (BMTC) are presently undergoing a series of major reforms, which can be used to further illustrate the route and service rationalisation process (BMTC 2014).

QUALITATIVE ASSESSMENT OF EXISTING SERVICES

In this first step, BMTC identified that the following major issues were impacting service quality:

- A large number of routes in the network: Bangalore has a total of around 2,400 bus routes. This is significantly higher than other cities of similar size and similar ridership: Seoul has 500 routes, London has 700 routes, Mumbai has 550 routes and Shanghai has 1,000 routes.

Route and service rationalisation refers to a large-scale, periodic review of the entire public transport network. This is essential in order to ensure that services are of a high quality and continue to meet the changing needs of a growing city.

- Poor service on many individual routes: BMTC has significantly expanded its bus fleet in the past decade and currently operates 6,500 buses. With 2,400 routes however, this means an average of 2.7 buses per route. This ultimately results in low frequencies on individual routes.
- High degree of system complexity: The large number of routes means that the overall system is complex and difficult to navigate. New users may find it difficult to plot their trips, thus discouraging public transport.
- Difficulty in providing user information: With a large number of routes, developing informational aids for users –such as route maps at bus stops – becomes challenging. Creating modern tools such as smartphone apps also proves difficult, due to the large amount of information that needs to be processed.

NETWORK MODEL EVALUATION AND ALTERNATIVE DEVELOPMENT

BMTC assessed that the issues identified with the existing services are the result of the adoption of a destination-oriented model. In the suburbs,

for example, several settlements along a road are served by multiple distinct routes and separated by relatively small distances. This redundancy in routes is a major factor leading to the high number of overall routes in Bangalore – the major issue at the core of all other problems, as identified in the previous step.

Hypothesising that the city would be better served by a direction-oriented network, BMTC conceptualised the BIG Bus Network – a citywide connective grid of high-frequency services on all of the city’s major roads. This network comprises the following elements (as seen in Figure 25):

- Big Trunk routes, providing high-frequency services on Bangalore’s 12 major arterial roads;
- Big Circle routes, providing high-frequency services along Bangalore’s circular Outer Ring Road (ORR);
- Big City routes, providing high-frequency services along high-density and high-demand corridors in the city centre; and
- Big Connect routes, providing high-frequency services between arterial roads beyond the ORR.

In addition to this, feeder routes will also be introduced to link villages and suburban destinations to their nearest arterial roads. Since these routes are significantly shorter than the direct services to the city centres, they will have a much higher frequency, even when operated by a single bus.

DATA COLLECTION AND MODELLING

Having hypothesised that the city would be served

better through a direction-oriented network, BMTC collected the relevant data at a major nodal point at Chandapura (see Figure 26). In this case, two primary questions had to be addressed. First was the issue of whether existing direct service routes were effectively serving the travel patterns of commuters. Second was the issue of bus-to-bus transfers, which was now necessitated by the new direction-oriented model.

An extensive survey of bus users at several nodal points along major arterial roads was undertaken. The survey results suggested that BMTC was correct in recommending a shift to a direction-oriented network to serve existing travel patterns.

Data was collected and the following findings were analysed:

- A majority of the users on existing direct service routes did not use the service for direct trips (see Figure 27). Rather, commuters were transferring to another service at a nodal point on an arterial road.
- A significant proportion of BMTC users were using more than one mode for their entire journey (See Figure 28). In other words, they were making multimodal transfers regularly as part of their journey. The use of a different mode for the initial segment of their journey was primarily due to the poor frequency of existing bus services. This indicated that increasing frequencies on those segments would allow BMTC to attract higher ridership.

BMTC modelled the impact of the transition from the existing model to the BIG Bus Network. This exercise

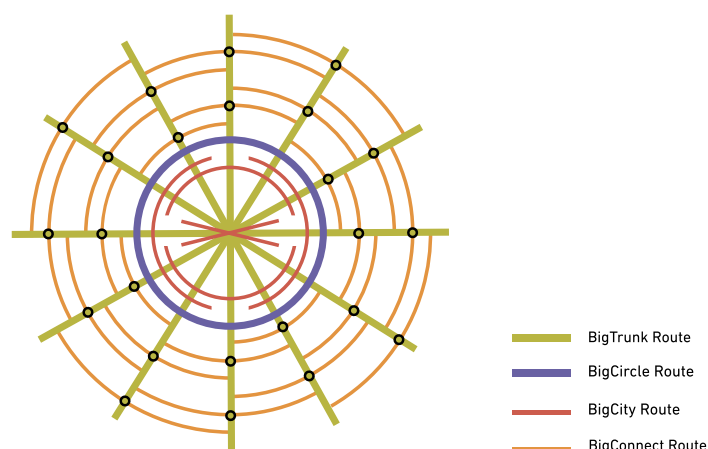


Figure 25 The BIG Bus Network in Bangalore (BMTC 2014)

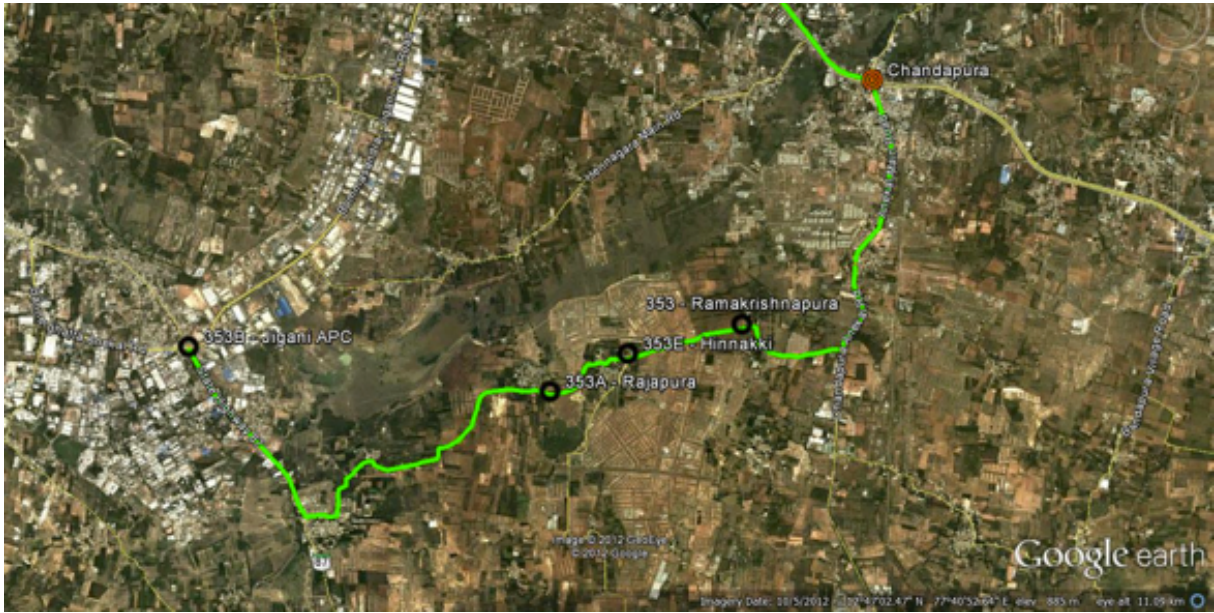
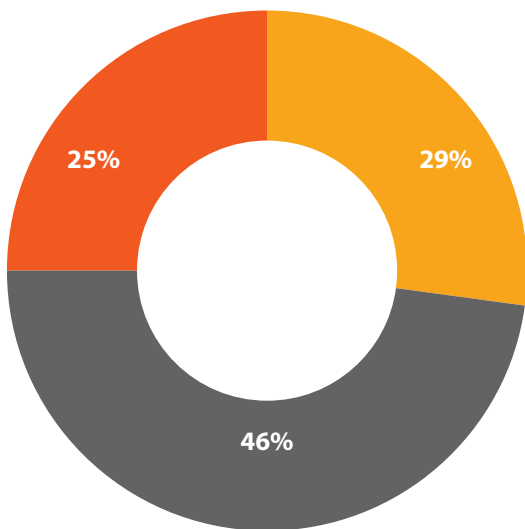


Figure 26 Chandapura Junction (BMTc 2014)

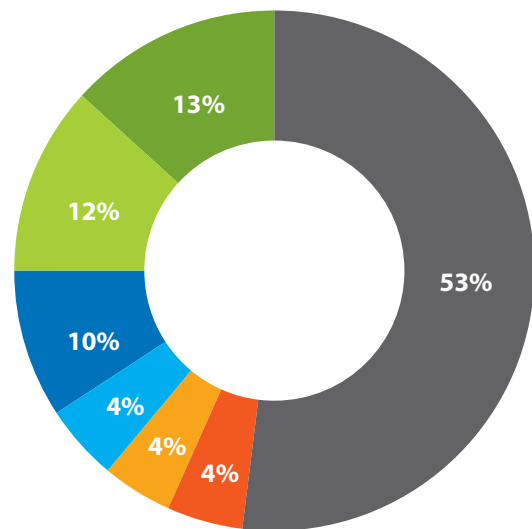
indicated that the impact of the new route and service model would be significantly more positive. As per the new model incorporated with feeder routes, the system would have a total of 30 routes in a single corridor. Compared to the 63 routes in the existing system, this was a 52.4% reduction. For all bus stops served by this new system, waiting

times for bus services would reduce by an average of 56%. Finally, the new system would require the exact same number of buses as the existing system. In other words, the improvements in service quality would be accomplished without any increase in fleet size.



- Direct Trips
- Feeder Trips
- Trunk Trips

Figure 27 Trip Patterns at Chandapura Junction (BMTc 2014)



- BMTc
- KSRTC
- Private Bus
- Auto
- 2W
- Car
- Walk

Figure 28 Bus Stop Access Modes at Chandapura Junction (BMTc 2014)

ROUTE AND SERVICE PLANNING

The results of the previous steps indicated to BMTC that a transition to the direction-oriented model would provide a higher quality of public transport for Bangalore residents. A decision was made to pilot the new concept on Hosur Road, a major arterial road in Bangalore.

The pilot was implemented in two phases. In the first phase implemented in September 2013, BigTrunk routes were planned and deployed along the corridor (see Figure 29). In the second phase, which was implemented in February 2014, the Suburban feeder services were launched (see Figure 30). Recently, as a scale-up effort, this network was expanded to two additional corridors – Kanakpura Road and Old Madras Road. A combined 42 buses, namely the BigTrunk buses and the Samparka Sarige feeders, were launched on Kanakpura Road and a combined 51 buses on Old Madras Road. This brings the total BIG Bus Network to three corridors, of the 12 planned, and a total of 185 buses as part of this network. The next step is to intensify services along these three corridors through additional buses as well as launching the next 3 corridors.

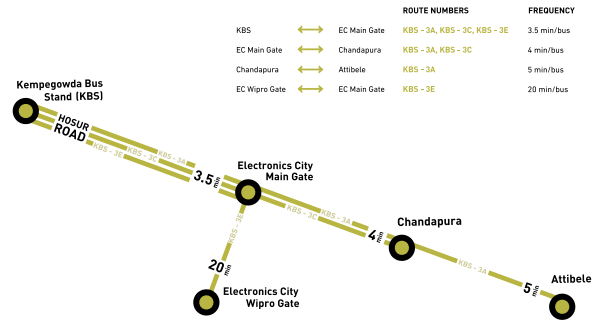


Figure 29 The plan for the BIG Bus pilot project along Hosur Road (BMTC 2014)

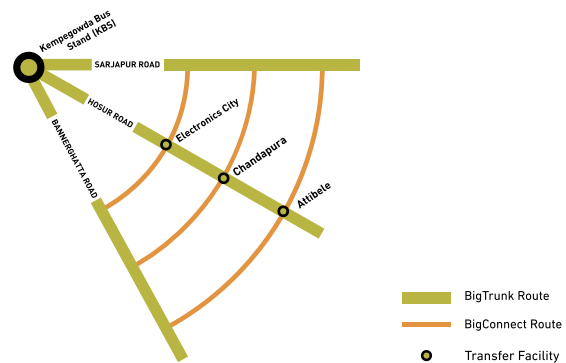


Figure 30 Feeder services for the BIG Bus Network (BMTC 2014)

SECTION SUMMARY: Route and Service Optimisation for City Bus Services

Periodic reviews of the transport network are required to meet changing travel patterns. This review incorporates a four-step process: a qualitative evaluation of the existing services, assessment of the network model and alternative development, data collection and modelling, and operations planning. BMTC in Bangalore undertook this four-step process to rationalise its bus services. As a result, the transport network was restructured to a direction-oriented model with a simplified route structure and reduced waiting times.

2.4 Complementing Mass Transit Systems through Feeder Services

In the last decade, the implementation of mass transit systems has become more prominent, with several cities deciding to build metro and Bus Rapid Transit (BRT) systems. Chennai, Mumbai, Delhi and Bangalore are in the midst of metro construction projects, while Pune and Bangalore are in the planning phases for their BRT systems, and the country's first monorail recently began operations in Mumbai. With the escalation of such mass transit projects, there is a need to plan for last-mile connectivity and to expand the influence of trunk corridors. This places pressure on city agencies to use a coordinated approach and simultaneously plan for feeder systems.

In general, there are four distinct types of feeder modes in Indian cities: non-motorized modes (i.e. walking, cycling), intermediate public transport (i.e. auto-rickshaws, taxis), shared-ride services (i.e. shared taxis, shared auto-rickshaws) and buses. This section focuses exclusively on feeder buses and the need to integrate them to complement mass transit networks. In an urban setting, feeder bus systems have a general set of characteristics. These characteristics and typical examples in urban areas are shown in Table 5.

FRAMEWORK for Feeder Route Design

The first step of route planning, introduced in Version One of the Bus Karo Guidebook (EMBARQ 2010), is demand assessment through the collection and analysis of mobility data. In expanding this methodology, the design of feeder routes necessitates two additional factors to consider. The first is the physical condition within which the route operates. Assessment of the environment requires understanding of the local conditions, such as congestion levels, roadway characteristics (i.e. road width, road condition and intersections), turning radii, road layouts, and capacity. This will facilitate the implementation of the route, including bus manoeuvrability and bus stop placement. The second aspect to include is the evaluation of constraints in the planning process. It is more practical for city bus agencies to design feeders within existing limitations, such as the lack of space for bus stops at railway stations or the absence of turnaround space.

To ensure proper implementation, the feeder must be integrated into the mass transit system. There

are five types of integration: physical, service, fare, information and institutional integration (see Table 6).

With a well-established bus network in place, the Brihan Mumbai Electricity Supply and Transport (BEST) undertaking has been successful in providing last-mile connectivity to the suburban railways system. The following case study demonstrates the importance of integrating feeders into mass transit system planning and discusses the challenges BEST faces in operating feeders.

CASE STUDY: Challenges and Integration of Mumbai's Feeder Routes

Among its peers, BEST is known to be proficient in operating feeder routes to connect to suburban railway stations (BEST 2014). The city however faces difficulty due to the lack of physical integration of its feeder and mass transit system.

The suburban station areas are highly crowded due to many reasons including the number of commuters accessing the station and the vendors that operate in these areas. In addition, station access lanes are often narrow and have low capacity. In the case of feeder buses, these factors restrict the ability of a bus to turnaround or to stop for a long period of time. The physical integration of the mass transit station and feeder bus stops is needed to provide a more comprehensive public transport network.

Of the 7 million journeys made by rail every day, 1.5 to 2 million journeys access stations by a BEST bus (LEA Associates 2008). These numbers indicate the significance of this system in the colossal movement of people within the Mumbai Metropolitan Region (MMR). BEST capitalises on the three railway lines' zones of influence by providing the following feeder services:

BEST operates feeder routes to suburban railway stations. Table 7 details Mumbai's feeder operations and financial statistics. The agency defines its feeder routes, as routes connecting to railway stations, within 10 km. More than 50 percent of all routes are feeder routes. While most feeder routes are within 10 kms, due to the lack of space, BEST is required to operate long routes as feeders. This will be discussed in further detail in the next section.

Statistics also indicate that 38 percent of the fleet (seen in Table 7) is used for providing the city with access to the suburban train stations. BEST's function

CHARACTERISTICS	TYPICAL EXAMPLES IN URBAN AREAS
Serves short distances	4 - 6 kms (typically)
High frequency service	5 - 10 minutes
Connects commercial, residential nodes to the trunk corridor or major destinations	feeders to the metro/suburban stations or CBDs
Requires a transfer at the end of the journey	Rail to bus transfers
Provides first / last mile connectivity	Shared 3-wheeler service at train stations
Extends the trunk corridor's area of influence	-
Vehicle type generally varies from the trunk mode	12-m standard buses
Operates amongst mixed traffic, without priority infrastructure or space	-
Bus stops are generally spaced within walking distance of each other	3 - 400m apart

Table 5 Typical Characteristics of a Feeder Bus System (EMBARQ India 2014)

TYPE OF INTEGRATION	DEFINITION
Physical (locational)	The physical ease with which the mass transit and feeder systems can be accessed; integrates land use generators with transport planning efforts
Service (timetabling)	Reduces wait times through synchronizing timetables of complementary modes
Fare (ticketing)	Aligns fare policies across all mode operators to ensure requirement of only a single ticket throughout the journey
Identity	Enhancing the overall perception and understanding of the system by closely relating the identities of multiple services of the same system
Institutional	Enables coordination between legal / government structures to ensure consistency

Table 6 Five types of Integration (EMBARQ India 2014)

Total Number of Routes	506
Feeder Routes (within 10km)	265 (52% of total number of routes)
Total Operational Fleet	4,011 buses
Feeder Bus Fleet	1,533 buses (38% of total fleet)
Number of Passengers	7,40,33,772

Table 7 Statistics on BEST's Feeder Routes (BEST 2014)

as a feeder to Mumbai’s key mode of transport establishes its significance in the urban transport network.

PLANNING OF FEEDER ROUTES

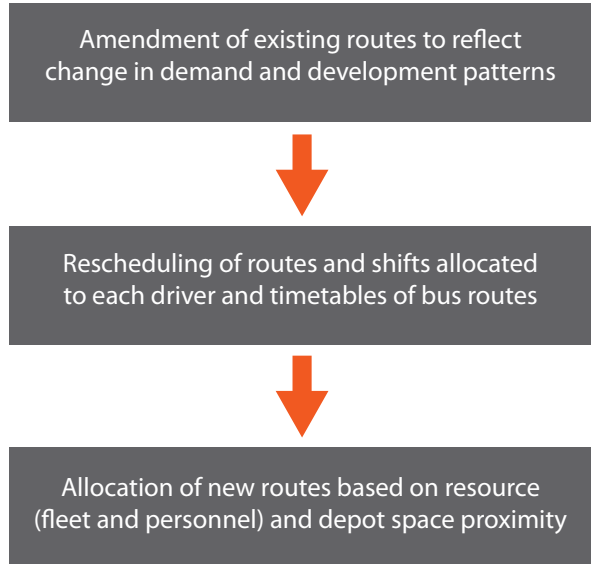


Figure 31 BEST’s Feeder Route Planning Structure (BEST 2014)

BEST currently undergoes a small-scale planning restructure every four months - March to June, July to November and December to February each year. A dynamic growth pattern in Mumbai requires BEST to constantly amend routes and schedules in order to remain relevant. Drivers and ticket conductors are similarly designated to new routes every rotation period. Routes are altered or new routes are allocated based on two primary considerations: resource (fleet and personnel) availability and

depot space proximity to prevent dead kilometers (see Figure 31). In other words, the planning and rationalisation processes are undertaken within the constraints of the existing system.

There are three main types of feeder systems that are currently operational in Mumbai. The lessons learned from these examples provide the basis for designing a good feeder bus system for other Indian cities.

TYPE #1: NEIGHBOURHOOD COLLECTOR ROUTES

Local neighbourhood collector routes provide first and last-mile connectivity to suburban railway stations. Buses collect commuters from housing colonies and connect them to the local train station, where they connect to other parts of the city. For example, Routes 343, 344, and 346 are neighbourhood collector routes that operate between Goregaon Station and the residential areas of Aarey Colony (statistics are indicated in Table 8). Goregaon East is primarily a residential area that generates significant demand for public transport, particularly due to the heavy congestion experienced during peak hours. The demand stems from the expanding residential colonies located around Nagari Niwari, with most passengers boarding at stops along Gen. AK Vaidya Road. The significant demand is managed by different types of services collectively running at a very high frequency.

Figure 32 depicts the routes and surrounding area of Goregaon. With growing demand, BEST introduced new routes and variations. This was used to offer high frequency services along the main road to suffice existing demand, with alternate services ending at different residential areas. While this was

ROUTE NUMBER	ORIGIN	DESTINATION	LENGTH (Kms)	FREQUENCY (Mins)	FLEET (No. Of Buses)	OCCUPANCY (Percentage)	CYCLE TIME AT PEAK HOUR (Mins)
343	Goregaon Station	Aarey Milk Colony	4.7	9 - 10	10	75	40
344	Goregaon Station	Goregaon Station	9.3	5 - 6	8	76	29
346	Goregaon Station	Nagari Niwara	4.9	6 - 8	8	72	28

Table 8 Characteristics of Neighbourhood Collector Routes (BEST 2014)

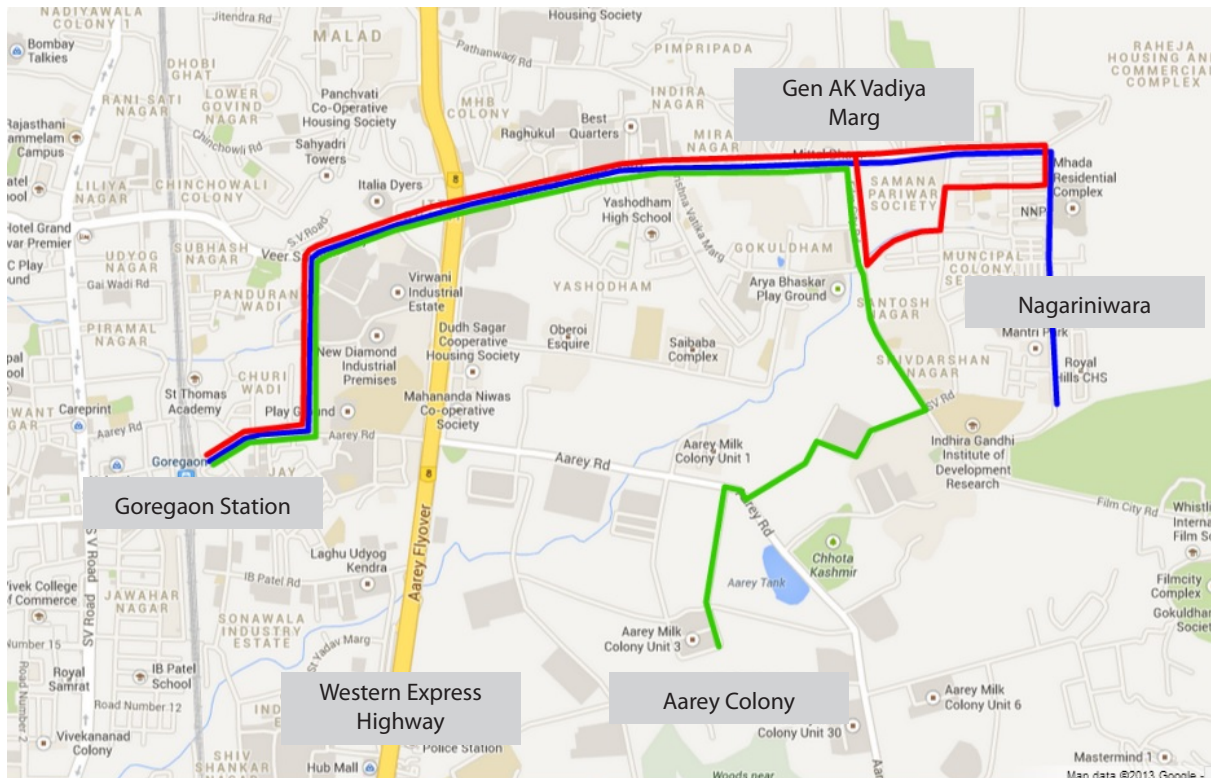


Figure 32 Examples of Neighbourhood Collector Routes in Goregaon, Mumbai (EMBARQ India 2014)

useful from an operational perspective, multiple routes can be complex for users to comprehend.

- Poor Physical Integration between Bus and Rail: the lack of bus stop infrastructure at the Goregaon Railway Station hampers traffic movement and bus operations.

CHALLENGES OF NEIGHBOURHOOD COLLECTOR ROUTES

The operator faces three primary challenges in designing Neighbourhood Collector routes:

- High level of Congestion: While the route lengths are short, peak hour congestion increases the cycle times³ drastically. Additional fleet along this corridor only adds to the existing chaos, further congesting the roads for BEST operations.
- Poor Integration between Transport and Land-Use: the location of a major retail outlet at the intersection of two major roads – Gen. AK Vaidya Marg and the Western Express Highway (WEH) – creates a traffic bottleneck, specifically during the evening peak period. In addition, the presence of auto-rickshaws and shared taxis makes buses less attractive.

TYPE #2: LONG FEEDER ROUTES

Long feeder routes are generally a combination of several routes that are merged together due to certain constraints. This results in trunk-like route lengths and operational inefficiencies.

BEST's Route #172 operates from Pratikshanagar to Mahalaxmi Station via Dadar (refer to Figure 33 and Table 9). This route provides the residents of Pratikshanagar and Antop Hill access to four suburban railway stations – Wadala, Dadar, Mahalaxmi and Byculla Stations – and to the business districts around Worli-Prabhadevi-Dadar. Each station adds further value to this route, since it provides access to various ends of the city through the use of three different railway lines – Wadala Station (Harbour Line), Dadar and Byculla Stations (Central Line) and Dadar and Mahalaxmi Stations (Western Line). The complexity of this route lies in

³ Cycle time is total time for a bus to ply a route from the starting point to the end point and back.



Figure 33 Route 172 (in blue) is a long feeder route made up of combinations of several smaller routes (EMBARQ India 2014)

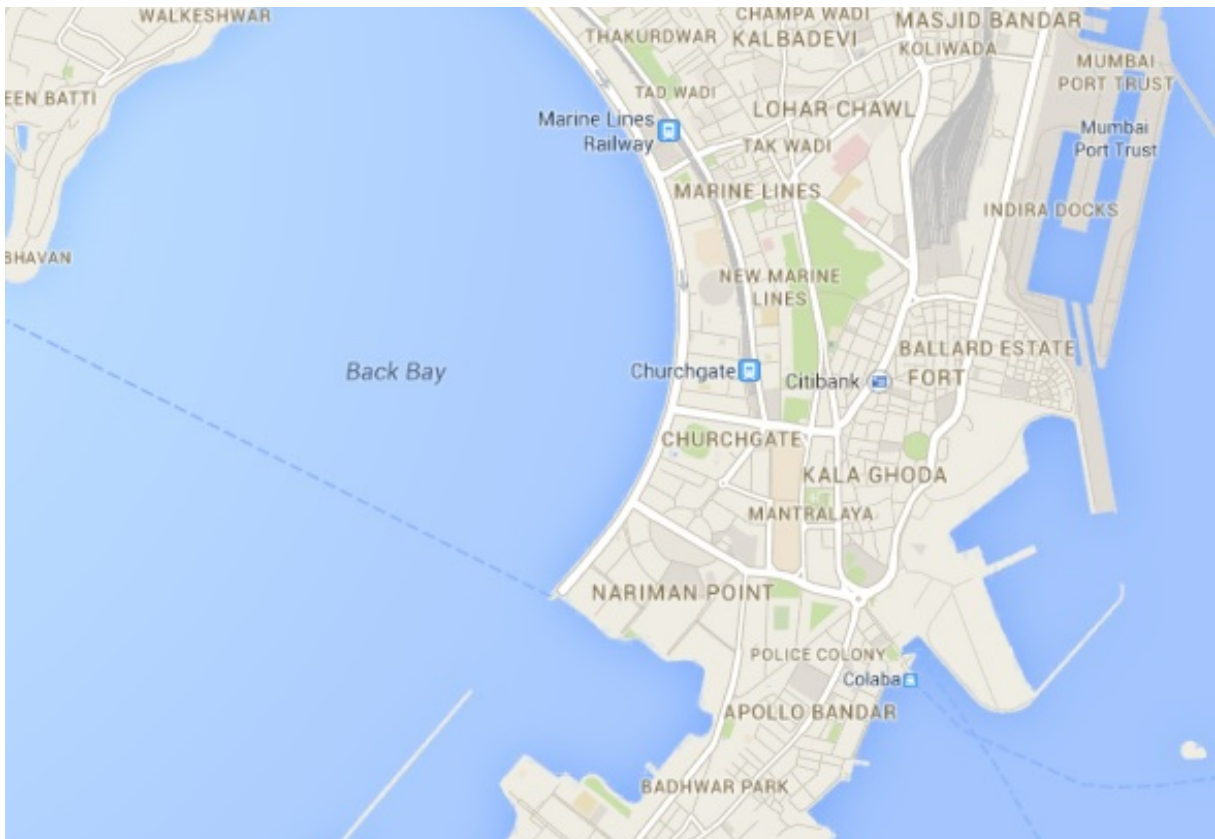


Figure 34 The Mumbai CBD is comprised of many smaller districts. (EMBARQ India 2014)2014)

these intricate details, wherein it offers commuters many possibilities for short-distance journeys.

Dadar marks the midpoint or the logical point at which the route should ideally terminate. Space restrictions at Dadar, however, prohibit dwell times and convenient turnarounds. As a result, the route was merged to create a 16-km feeder route. According to BEST, an ideal feeder route length ranges from 5 to 7 kms; however in the recent past, lengths have grown past 8 kms. The length results in three primary operational challenges – very high cycle times, high operating kilometers, and reduced service reliability. Buses can take up to 45 minutes to enter and exit a station area and drastically increase the cycle time. In this regard, the connection to multiple stations makes this route unreliable and highly vulnerable to congestion. Service reliability of a route is a key characteristic that influences ridership.

heavy movement of commuters within the South Mumbai CBD area. The CBD is comprised of several smaller districts – Ballard Estate, Fort, Nariman Point, Colaba, and Churchgate (see Figure 33). Movements are frequent between the districts and to the two terminus rail stations, Churchgate and Chhatrapati Shivaji Termini (CST). Examples of these services are shown in Table 10. In addition to BEST's peak hour services, the CBD is also served by the Fort Pheri Buses, which are localised, hop-on-hop-off buses that connect multiple key locations.

During peak hours, these services are operated in a convoy-style with high frequencies to target zero-waiting time. There is also a good level of physical integration at the 2 stations, with the provision of sufficient space for boarding / alighting and bus turnaround. The integration allows for safe dispersal of commuters from the two stations.

There are, however, several operational challenges that the BEST is attempting to address:

- 50% (or more) overlap in route structures adds to difficulty in managing and scheduling

TYPE #3: CENTRAL BUSINESS DISTRICT (CBD) PEAK-HOUR FEEDER ROUTES

The third category of feeder services caters to the

ROUTE NUMBER	ORIGIN	DESTINATION	LENGTH (Kms)	FREQUENCY (Mins)	FLEET (No. Of Buses)	OCCUPANCY (Percentage)
172	Pratikshanagar	Mahalaxmi Station	16	10 - 11	22	59
340	Ghatkopar Station	Agarkar Chowk, Andheri	8.8	6 - 7	28	100

Table 9 Characteristics of examples of Long Feeder Routes (BEST 2014)

ROUTE NUMBER	FROM	TO	ROUTE LENGTH (KMS)	FREQUENCY (MINS)
Special-1	CST	NCPA	3	2-4
Special-2	CST	World Trade Centre, Cuffe Parade	4.8	5
Special-3	Colaba Bus Station	Crawford Market	5	20
Special-4	CST	Freepress Journal Road, Nariman Point	2.9	10
Special-8	Churchgate	World Trade Centre, Nariman Point	7.6	7-8
Special-9	Churchgate	NCPA	3.5	2-3

Table 10 Characteristics of Peak-Hour CBD Feeder Routes (BEST 2014)

routes and adds to complexity from the user's perspective as well.

- Resources to maintain high-frequency are not always financially viable.
- A uni-directional flow of people during peak hours means that buses operate at full or overloaded capacity in one way and absolute

zero load in the reverse direction.

This case study demonstrates the multiple roles of a feeder service in the transport network and the challenges they can lead to. The key to a comprehensive network is to ensure a high level of integration of feeder routes, while planning for mass transit systems.

SECTION SUMMARY: Complementing Mass Transit Systems through Feeder Services

Feeder systems augment the influence of a trunk system, when designed cohesively. The key to a comprehensive transport system is to ensure a high level of integration of feeder routes. When planning feeders in the Indian context, agencies must consider the physical characteristics of the road, i.e. width and turning radius, and must also evaluate other constraints such as the lack of turnaround space.

BEST has three types of feeder routes: neighbourhood collector routes, long feeder routes and peak-hour CBD routes. The operator faces challenges including high congestion levels and the lack of turnaround space for routes to culminate, as required by a feeder service. Mumbai provides an interesting case study on the serious need to integrate feeders and mass transit systems, at the planning stage.

CHAPTER SUMMARY:

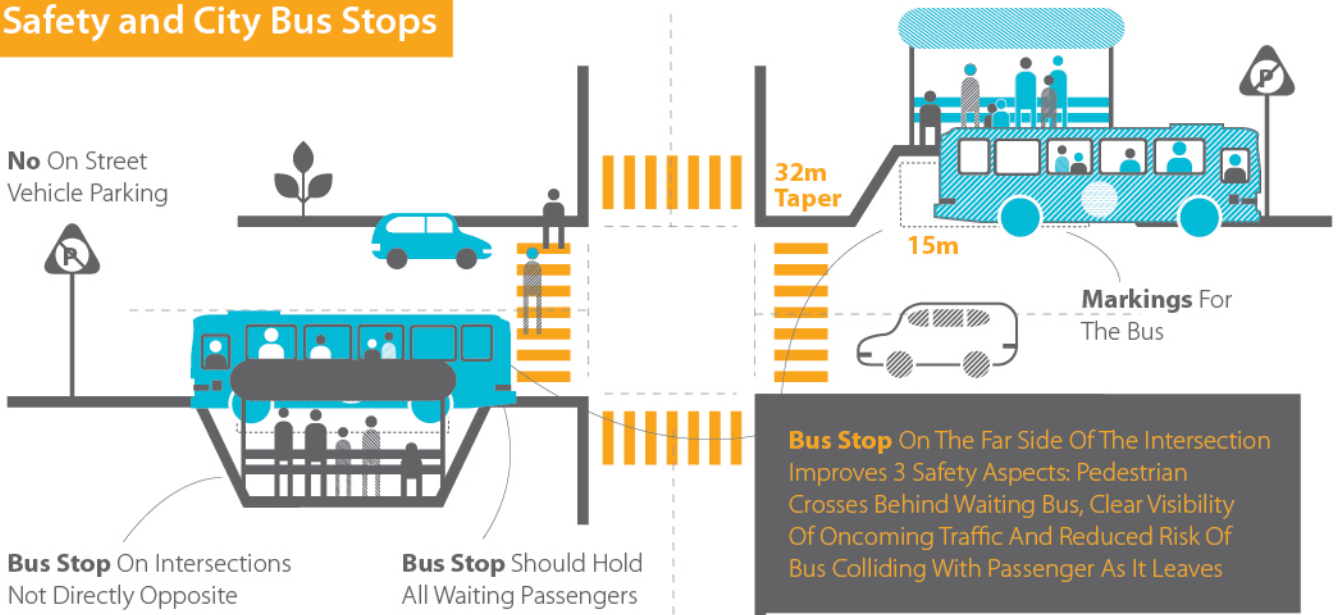
Cities are constantly changing; and the resultant shifts in transport patterns require a periodic review of the transport network. Data collection is a useful method to obtain information on system performance. It is a good practice for operators to collect data and use it to plan and improve services. For cities with no formal public transport system, basic data analysis can help establish a formal network. For a larger and well-established network, a system-level route optimisation is critical to update the system and make it responsive to changing demands of the city.

More recent trends also indicated a growth in the number of mass transit systems. There is a need to integrate feeder bus systems with new mass transit systems, during the planning phase. Feeders effectively provide the system with first and last-mile connectivity, strengthening the overall system.

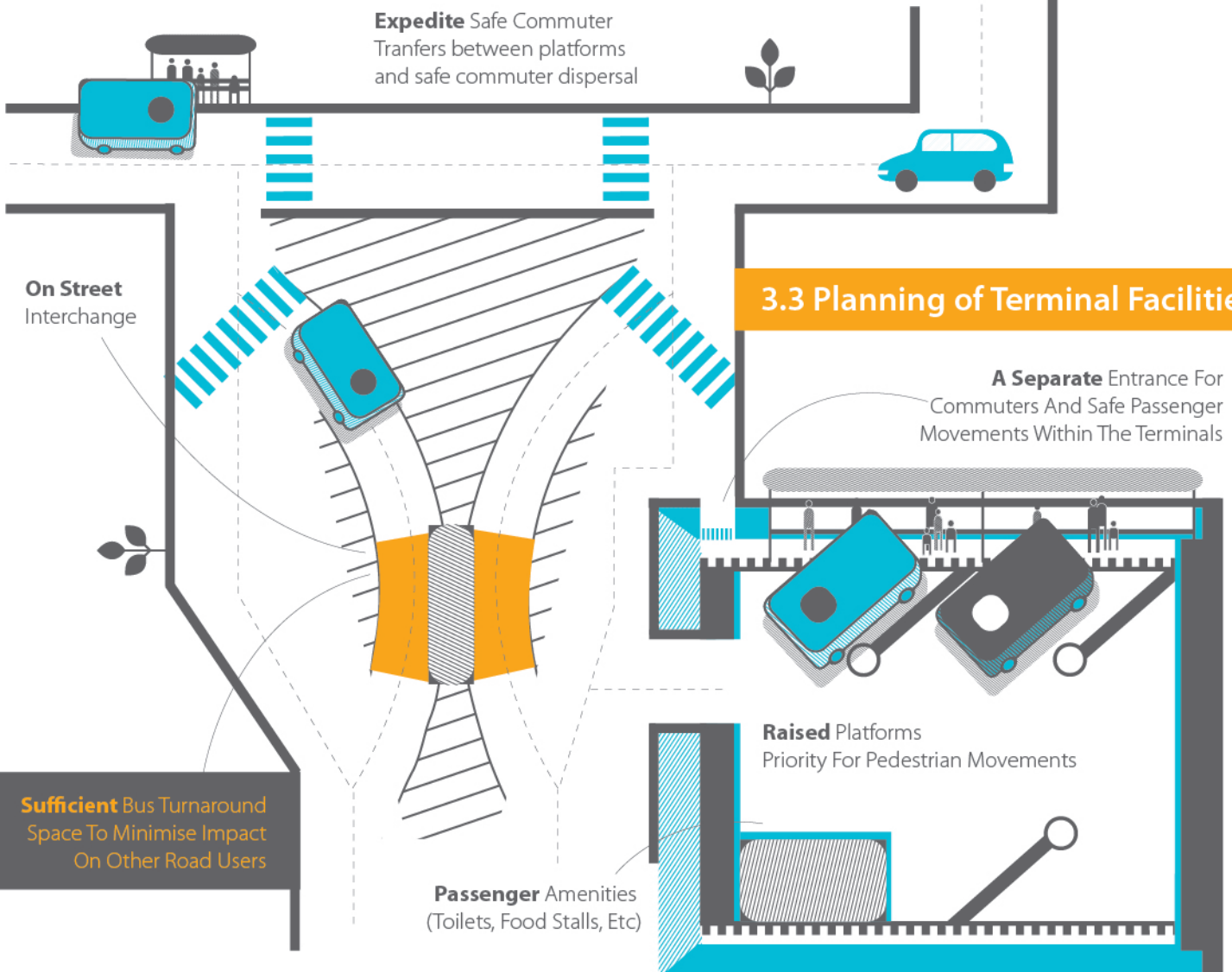
3

DESIGNING SAFE AND ACCESSIBLE INFRASTRUCTURE

3.1 Safety and City Bus Stops



3.2 On Street Interchange



CHAPTER THREE

DESIGNING SAFE AND ACCESSIBLE INFRASTRUCTURE

Transport infrastructure, such as terminals and depots, is a key component in establishing a comprehensive bus system. Planning and designing space as per operational requirements is critical for the expansion of service and maintenance of buses. The first round of JnNURM funding focused on increasing the number of buses available to public operating agencies across the country. Round two of the funding stipulated envisioning infrastructure requirements to support this additional fleet (Ministry of Urban Development 2011). Public transport agencies are being urged to plan and design space requirements for effective operations.

Cities are faced with an urgent need to plan for transport infrastructure as part of their development processes. However, a well-defined focus on design of safe and accessible infrastructure remains a critical barrier to a positive outcome. An added shortage of literature on city bus infrastructure design indicates a need to improve our understanding and formulate best practices for implementation. In the urban context, this calls for designing infrastructure to ensure safe access to bus services, seamless transfers between services and enhancing service quality for passengers.

There are three types of stop and interchange infrastructure that this chapter focuses on (see Figure 35). At a neighbourhood level, a bus stop is the primary element in a transport network. At a network-level, terminals are critical for seamless passenger connections. The intermediate infrastructure for bus stops in urban areas is the on-street interchange. This chapter highlights the passenger safety and convenience aspects of designing these infrastructural elements.

3.1 Safety and City Bus Stops

An important factor of any bus transport network is access to the system. When the commuter is walking to and from bus stops, safety becomes of utmost importance. Hence, in planning for safety and accessibility to city bus stops, there is a need for overall safe street design with special attention to pedestrians. This section is based on EMBARQ India's observations of bus infrastructure and its setting, as

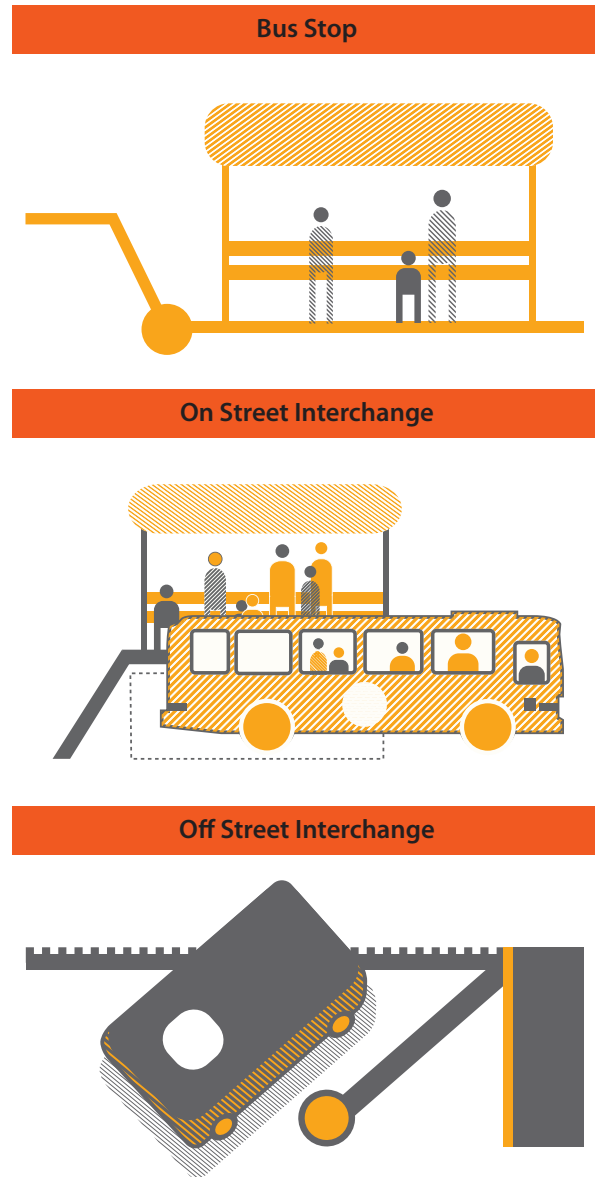


Figure 35 Safe and accessible infrastructure for transport networks (EMBARQ India 2014)

well as the applicability of common safety measures in local conditions. These guidelines can be used to inform bus operators on issues to consider when designing access to city bus services.

There are four factors that are applicable to enhancing pedestrian safety, while accessing bus stops (Nicolae Duduta 2012):

- **Speed management and traffic-calming:** The use of design features such as raised pedestrian crosswalks to manage vehicle speeds in pedestrian-rich environments.

- **Intersections:** The design of a safe intersection includes a simple intersection, short crosswalks for pedestrians and eliminating turns for vehicles, where possible.

- **Pedestrian crosswalks:** Reducing the crossing distance for pedestrians minimises the occurrence of pedestrian-vehicle conflicts. Pedestrian mid-block crossings are important to the safety considerations of design.

- **Dedicated and Prioritised Pedestrian Space:** Ensure a clear segregation of pedestrians and vehicles, reducing the occurrence of conflict.

According to the Transport for London’s Accessible Bus Stop Design Guide, there are eight factors to consider in the location of bus stops, as seen in Figure 36 (Transport for London n.d.).

The following section discusses the local issues and considerations and application of these factors can in the Indian context.

GUIDELINES for Bus Stop Placement

Based on EMBARQ India’s observations and applicability in local conditions, there are three features recommended to guide bus stop placement efforts by city agencies. These include intersection and mid-block bus stops, space and design factors and road environment.

- Close to main junctions without affecting road safety or junction operation
- Clear visibility of driver and prospective passengers to each other
- Where footpath width is sufficient
- Away from sites likely to be obstructed
- Close to (on the exit side of) pedestrian crossings
- Back-to-back on opposite sides of the road
- Where space is sufficient for a bus shelter

Figure 36 Eight factors to consider in bus stop location planning (Transport for London 2006)

STOPS AT INTERSECTIONS AND MID-BLOCK

Generally, bus-stops are placed close to intersections, as this is where there is maximum passenger demand. From a safety perspective, it is generally better to locate the bus-stop on the far side of the intersection, that is the bus has to first cross the intersection to reach the bus-stop (see and Figure 37b). If the bus stop is placed on the near-side of the intersection, pedestrians tend to cross in front of the bus, in order to access the intersecting street. Another safety risk is that rather than take a left turn, a bus will generally have to continue straight across the intersection; this movement can lead to a side-on collision with other vehicles taking a left turn. If placing a bus stop on the near side of the intersection is unavoidable, then it has to be ensured that it is placed some distance before the intersection. This will ensure that the waiting bus does not block the view of crossing pedestrians and that the bus is able to move out of the left lane before reaching the intersection, if it needs to continue straight.

A far-side configuration encourages three points:

- The pedestrian crosses the road behind the bus waiting at the stop, as normally pedestrians prefer to cross the road near the mouth of the intersection in order to access intersecting streets (Southeastern Pennsylvania Transport Authority 2012);
- Clear visibility for both the pedestrian and oncoming traffic (unhindered by the bus) of each other; and
- The reduced risk of a bus colliding with crossing



Figure 37a Placement of pedestrian crossing behind bus stops (Southeastern Pennsylvania Transport Authority 2012)

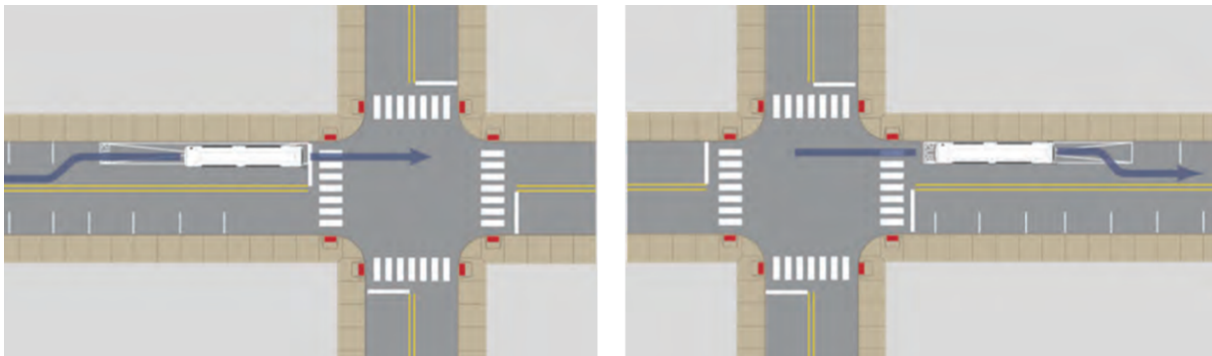


Figure 37b Bus stops located on the far side (right) are desirable (Southeastern Pennsylvania Transport Authority 2012)

pedestrians when leaving the bus stop.

In some cases, when block sizes are large or there is a high demand generator, such as a market, it makes sense to provide mid-block bus stops that are located at significant distance from the intersection. Midblock bus stops generally have the advantage of having more road/footpath width available than bus stops near the intersection, as typically additional turning lanes need to be provided at the intersection. When locating two bus stops for buses going in opposite directions, it is better not to place them immediately opposite each other, but slightly away from each other, so that a pedestrian crossing can be located between them. Locating a bus stop in a way that the crossing is behind the waiting bus of both bus stops reduces the occurrence of pedestrian-bus conflict and increases visibility of oncoming traffic (see Figure 38). Incorporating traffic-calming measures, such as a raised crosswalk, will further accentuate the safety of the pedestrian while crossing.

ROAD ENVIRONMENT

Buses generally ply on main urban arterials which are designed for higher speeds. While these areas also see a high density of vulnerable road users,

such as pedestrians and motorcyclists, it is another contributing factor to the high involvement of buses in accidents (Mumbai Traffic Police 2012, National Institute of Mental Health and Neuro Sciences 2008, Padmanaban J. 2010). There is a further need to focus on safety enhancements in areas like urban arterials. This section covers the safety implications of good road design.

Roadway design is a method of enhancing bus safety. This is especially true at intersections and pedestrian crossings, where the probability of conflicts is highest. Design should inculcate safe speeds with the use of traffic-calming elements: bulb-outs, speed bumps, chicanes, lane reductions, etc. Speed bumps have a greater impact on larger vehicles such as buses. Hence, it is imperative that they are well designed, according to the Indian Roads Congress (IRC) standards (The Indian Roads Congress 1988). In addition, other general aspects of safety design (see Figure 39) – lane markings, signage, traffic-calming, pedestrian crossings, median dividers, etc. – positively impact crash prevention.

For buses making left turns at the intersection, the kerb radius should be long enough to allow it to turn from the left most lane (see Figure 40). This will reduce some of the risk of a bus colliding with



Figure 38 Pedestrian crossings behind the waiting bus reduces the occurrence of pedestrian-bus conflict and improves visibility of oncoming traffic (EMBARQ India 2014)



Figure 39 General Aspects of Safety Design - lane markings, signage, traffic-calming, pedestrian crossings and median dividers.(EMBARQ India 2014)

vehicles when making a left turn. At the same time, the kerb radius should not be so generous as to allow the bus to turn at a high speed.

BUS STOP FEATURES

The availability of space to accommodate the bus stop is significant in determining the exact location of the bus stop. The bus stop should be wide enough to hold all waiting commuters, and they should not have to wait on the road way. At the same time, the bus stop should not block the footpath and force pedestrians to walk on the roadway in front of the bus stop. The pedestrian may get hit from behind by a bus arriving at the bus stop.

Generally, urban roads do not have enough space to accommodate a bus bay for buses to pull into, such that a waiting bus does not block traffic in the left most lane. The Indian Roads Congress (IRC) Guidelines (The Indian Roads Congress 1983) indicate that in order for a bus bay to be usable for the bus to pull in, it must be at least 79 meters long, (15 meters for bus docking plus 32 meters tapers on either end) and at least 5 meters wide (1 meter for passenger waiting and 4 meters for bus docking) for a single bus stop. The luxury of so much road space is very rarely available on Indian city streets. If the bus bay does not meet minimum design standards, they will not be used by the bus, and will only be wasted road space. Another prevalent issue is that commuters wait in the bus-docking zone, forcing



Figure 40 A tighter kerb radius at the intersection can reduce over-speeding (EMBARQ India 2014)

the bus to stop in a traffic lane and pedestrians to make their way across the street to board. This can result in conflicts with motorcycles or other vehicles overtaking from the left side.

There is also a chance that vehicles park in the bus bay or use it to overtake a waiting bus, putting the commuters getting in and out of the bus at great risk. In these cases, it is better to provide for the waiting area of the bus on the leftmost lane itself. In normal operations, the bus would stop for less than half a minute, and traffic would either have to wait behind the bus, (they would wait much longer at a signal), or overtake from the adjacent lane on the right side of the bus.

In some cases, a bus route street will have an on-street parking lane between the travel lanes and the footpath. Here, on-street parking should be eliminated near the bus stop to allow for the bus to move into this lane and align itself with the bus stop, thus not having to wait on the travel lane. In this case, there should be strict enforcement of no parking and no street-vending immediately before and after the bus stop, which should be indicated through signage and lane marking. However, experience shows that people rarely respect restrictions on parking near the bus stop, forcing the bus to wait on the leftmost travel lane itself. This causes all the safety problems as explained in the previous paragraph.

An option would be to extend the kerb at the bus stop to the edge of the leftmost travel lane (see Figure 41). This would make it easier for the bus to stop right near the stop, without a large gap between the bus and the footpath. Providing markings on the road to guide the bus driver will help to optimally position the bus at the bus stop to

ensure easy access for commuters to the bus. This prevents vehicles from overtaking the bus from its left side, causing a safety risk to passengers boarding and alighting from the bus. Further, unlike with a bus bay, the kerb extension needs to be only as long as the bus stop, which allows for more parking spaces. Also, the kerb extension can be used to accommodate the bus stop, and the footpath can be kept free of any bus stop infrastructure.

While the issues raised in this section are discussed from an infrastructural and design perspective, there is also a broader framework within which this falls. This framework also encompasses an enforcement and public awareness component on safety-related issues. For example, commuters waiting at the bus stop would rather stand on the road than at the stop, making them vulnerable and also affecting traffic flow. While infrastructure should be designed with a sizeable focus on safety, managing safe commuter movement through enforcement and public education is also critical to the planning process. As a next step in addressing safety and infrastructure issues, there is a need for overall street design, with a strong focus on these issues pertaining to pedestrian safety. Chapter 8 goes further into the external factors of safety and city bus services.



Figure 41 Extension of the kerb at the bus stop can make it easier for the bus to pull up closer to the stop (EMBARQ India 2014)

SECTION SUMMARY: Safety and City Bus Stops

Safety is a vital aspect of planning a commuter's journey to and from the bus stop. There is a need to incorporate safety and accessibility into the design of bus infrastructure. This chapter discusses 3 key factors to consider when designing infrastructure:

- As per observations, it is safer to place the bus stop on the far side of the intersection to improve the visibility of all users, including pedestrians, the bus and oncoming traffic.
- When locating two bus stops for buses going in opposite directions, it is better not to place them immediately opposite to each other, but slightly away from each other. This allows for a pedestrian crossing to be located between the two bus stops.
- As per calculations and IRC standards, bus bays need to be at least 79m in length and 5m in width to provide sufficient bus docking and tapering length.

3.2 On-Street Interchanges

Planning for transport infrastructure does not just encompass the larger terminals, but also mid-route, on-street facilities. It is sometimes preferable to have an interchange on-street for routes to start and terminate at an on-street location (The World Bank 2011). These facilities are generally required at intermediate points, where bus services intersect or user travel patterns change significantly. Due to space restrictions and the need for seamless transfers, providing for large terminals at these points is not possible.

The function of these facilities is similar to off-street terminals. Intermediate facilities provide sufficient space for the safe turnaround of buses or termination of routes that culminate on the street. This minimises any impacts of bus movements on general traffic.

On-street facilities are generally required at intermediate points, where bus services intersect or travel patterns change significantly.

The second consideration is to expedite safe pedestrian transfers between different services. In this case, naturally the safest type of transfer includes a movement within the same platform (Nicolae Duduta 2012).

To measure the convenience factor of the facility, a level of service (LoS) calculation is useful. This calculation considers the pedestrian space,



Figure 42 The grade-separated Chandapura Junction (EMBARQ India 2014)

average speed, and flow. It is desirable that the design process includes adequate space and the appropriate facilities for the projected peak pedestrian demand. A LoS measurement process estimates capacity based on the relative scale of pedestrian comfort and convenience. As per the Indian Roads Congress (IRC) requirement, walking and waiting areas within a terminal must adhere to a C grade LoS or higher (The Indian Roads Congress 1988).

The case study at Hosur Road in Bangalore provides a detailed example of how an on-street facility can be designed, in respect to the traffic flow conditions, bus route structure and passenger movements.

CASE STUDY: Designing an On-street Interchange at Hosur Road, Bangalore

In 2013, BMTC rationalised bus routes on Hosur Road as part of the Bangalore Integrated Grid (BIG) Bus Network (Bangalore Metropolitan Transport Authority 2013). This exercise resulted in direction-based services comprised of several trunk and suburban feeder routes. The intersection points of trunk and feeder routes required infrastructure to allow safe and timely transfers for commuters. With a prime focus on passenger comfort, critical interchanges were planned at major nodes of the route network.

The Chandapura junction lies on Hosur Road, a major arterial that transforms into an expressway and further on into a national highway. This is a grade-separated junction, created by the intersection of the NH-7 and Dommasandra-Anekal Road, where several trunk and feeder routes meet (see Figure 42). The two roads fall under different jurisdictions: the National Highway Authority of India (NHAI) and the Public Works Department (PWD). The land belonging to the NHAI was not available for construction.

The challenge was to design a safe and accessible on-street interchange that would accommodate all directions of passenger movements. The multi-directional movement of passengers and lack of median, created multiple points for pedestrian-vehicle conflicts. As illustrated in Figure 43, there are two considerations for passenger movements: connection between the trunk and feeder platforms, and pedestrian dispersal. The most dangerous pedestrian movement is crossing the NH-7. To facilitate safe movement and reduce the risk of conflict, feeder buses will stop on both sides of the street.

The high-frequency trunk services also have a low headway requiring the design to expedite better ease in bus movements. Therefore, the focus was to minimise bus manoeuvring when accessing the

platform and to ensure better operational efficiency. The feeder routes, however, are lower frequency services connecting to the suburbs. In this case, passenger waiting time became a critical design

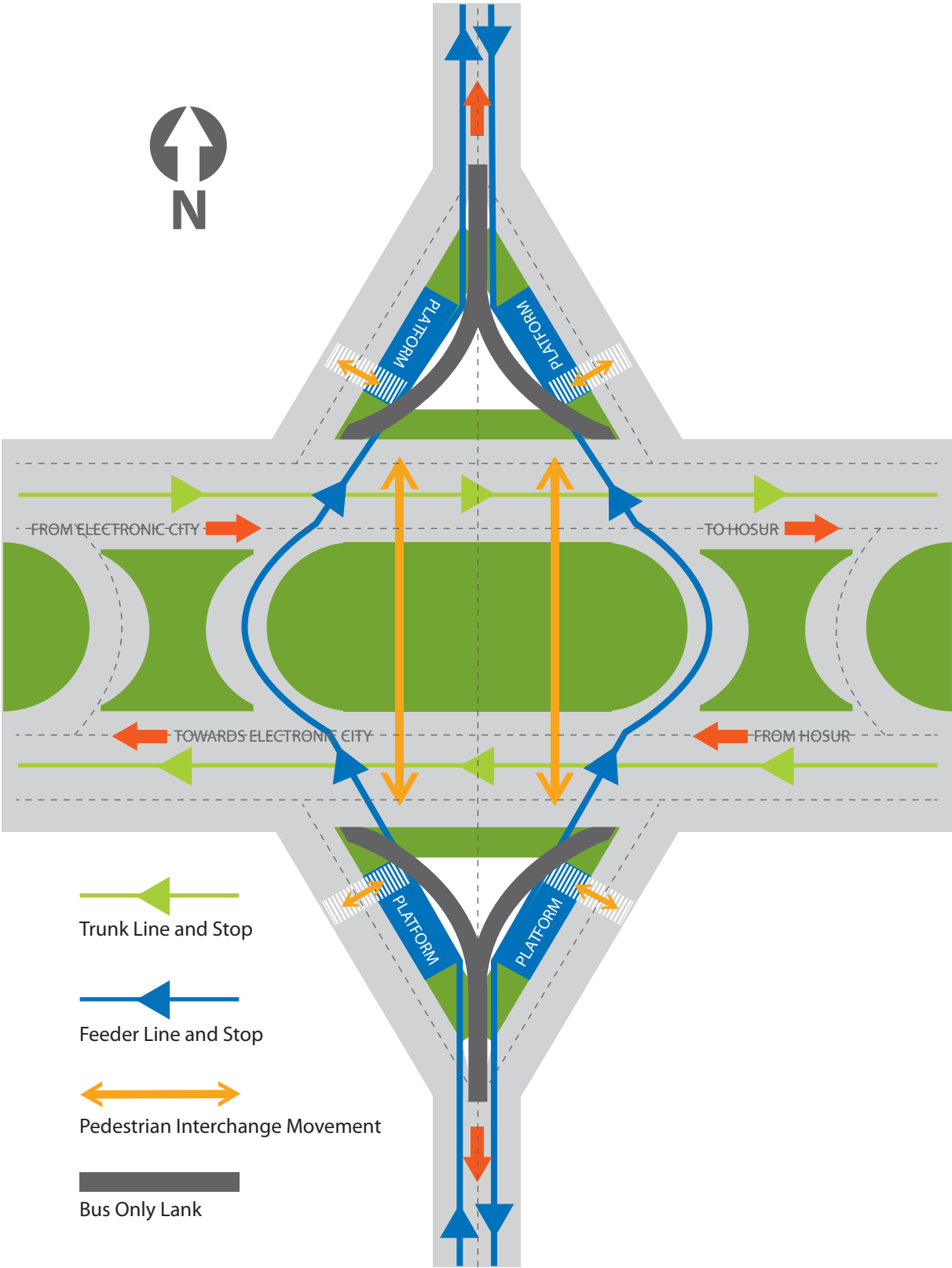


Figure 43 Interchange design at Chandapura Junction, Bangalore (Bangalore Metropolitan Transport Authority 2013)

consideration. The focus was to provide a high LoS for passengers waiting at the feeder platforms. The optimal location for the interchange was the median, as it satisfied these factors:

- Safe movement of passengers between trunk and feeder platforms
- Safe dispersal of pedestrians once they alight a bus
- Convenient distance from both sides of the highway, facilitating safe pedestrian movement
- Most direct route used for pedestrian access to interchange
- Segregated lanes for feeder buses entering the

interchange

- Smooth flow of vehicular traffic
- Single stop for trunk routes allowed efficient operation of buses and use of space
- High LoS for connecting passengers by reducing waiting times

The BIG services have begun operation, and the required spaces for interchange are yet to become functional. While BMTC is in the process of finalising the tenders for construction, the use of temporary platforms is presently being planned.

SECTION SUMMARY: On-street Interchanges

On-street interchanges are an intermediary requirement for bus routes, generally located where bus routes intersect or major travel patterns connect. Interchanges should provide sufficient space for safe turnaround of buses or termination of routes, and minimise impacts on general traffic. Their second objective is to facilitate seamless and safe passenger transfers between services.

3.3 Planning of Terminal Facilities

An integral factor improving a transport system's success is the quality of convenient transfers and the movement of passengers within terminal spaces. Interchange facilities are typically located at critical junctions of the route network where several types of services or modes intersect. Planning and designing terminals must consider two perspectives: the operator's and the users. A high level of service entails a safe and permeable environment outside the terminal and convenient movement within. There are five considerations when designing a good terminal, (see Table 11): terminal capacity, passenger level of service, accessibility, commuter safety, and passenger amenities. This translates into an environment that facilitates quick, comfortable, and safe movement of people within and around terminals.

In addition to these considerations, it is important to integrate terminal facilities into the physical surroundings. Agencies such as the BMTTC have utilized similar concepts to create a destination out of their bus stations, by introducing a commercial component. This adds convenience to the user experience by providing access to peripheral uses such as retail or educational activities. This can also make the transit facility a focal point and enhance

An integral factor affecting a transport system's success is the quality of convenient transfers and the movement of passengers within terminal spaces.

the commercial value of the property, in turn benefitting the agency.

The case study in this section describes the principles and design process of Gulbarga's Supermarket Station. An increase in operations resulted in the need to redesign the stop into a larger terminal. While upgrading the terminal for increased bus use, key aspects of passenger safety were also incorporated into the process.

CASE STUDY: Design Process of an Off-street Terminal at Gulbarga

With the growth in the Northeast Karnataka region, a substantial increase in demand necessitated an increase in capacity of the town's Central Station. In October 2012, North Eastern Karnataka Road Transport Corporation (NEKRTC) conducted surveys to determine the increase in use. Primary data⁴

TERMINAL CAPACITY	The number of bus berths that need to be planned to cater to projected peak-hour demand
PASSENGER LEVEL OF SERVICE	The level of service a passenger receives on the journey between the entry / exit points of the terminal and the boarding platforms
ACCESSIBILITY	Accessibility for buses entails the location of entrance and exit points, ensuring convenient and unhindered access to the terminal Facilities that propagate unobstructed, convenient, and universal accessibility while boarding and alighting at platforms
COMMUTER SAFETY	The design of high-visibility spaces to minimise pedestrian-vehicle points of conflict, particularly the high occurrence of conflict during platform transfers.
PASSENGER AMENITIES	The provision of facilities such as toilets, payphones, drinking water, and visible signage to add to passenger convenience

Table 11 Five components of good terminal design (Transit Capacity and Quality of Service Manual -2nd Edition, PART 7 n.d.)

⁴ 8-hr bus and passenger counts, boarding-alighting surveys, passenger perception surveys and bus occupancy surveys were undertaken at various times of the day

⁵ Universal accessibility entails provision for boarding and alighting for the differently-abled, including those on wheel-chairs and the blind.

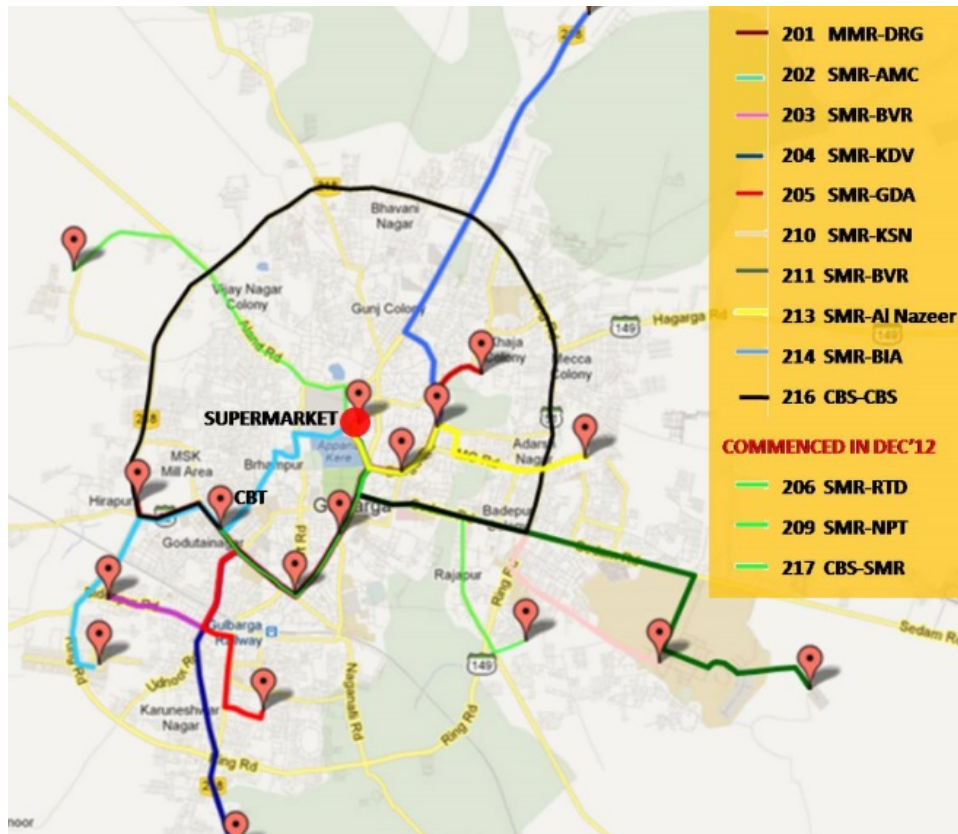


Figure 44 Supermarket Station was designed as a terminal to accommodate increased use. (Northeast Karnataka Road Transport Corporation 2014)

established the significance of Supermarket node in the Gulbarga transport network: 80% of passenger trips originated or terminated at this local transport hub, and 18% of commuters utilized the hub as a transfer point (see Figure 44). As a result, a decision was made to upgrade the facility at Supermarket Station. The aim was to integrate the terminal facility into the existing urban setting, in order to accommodate rise in demand. To facilitate this aim, the following five principles were established.

- **Terminal Capacity:** Increased flow and throughput of buses

NEKRTC introduced 50 buses and 10 routes to cater to an increased daily ridership of 46,000 passengers (Northeast Karnataka Road Transport Corporation 2014). The platform capacity needed to be increased from 9 buses/hr⁶ to 30 buses/hr, with a peak hour use of 2,300 passengers (see Figure 45). To facilitate

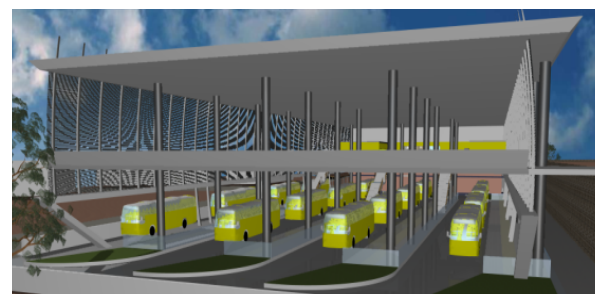


Figure 45 A proposed Bus bay configuration (EMBARQ India 2013)

the throughput of buses, the design incorporated two lanes for parking and an overtaking lane at each platform.

- **Passenger Level of Safety:** Well-defined and legible pedestrian spaces for movement⁷,

⁶ The average layover time for a bus was 13 minutes. In one hour, the existing facility (2 platforms) caters to 9 buses.

⁷ Spaces used for movement, such as corridors and paths.

⁸ Spaces where a passenger's decision takes priority, such as entrances, ticketing officers or corridor junctions.

⁹ Areas other than the decision and movement spaces, like those that accommodate retail areas or furniture.

decision⁸, and opportunity⁹

The site was constrained by the lack of space and a high number of users limiting the available space. To ensure a LoS as mandated by the IRC, the platform waiting area widths should be 2.3m and the width of the walking pathways should be 0.8m as per the calculations. Table 12 and Table 13 show the space requirement for each LoS grade.

- **Commuter Safety:** Enhanced pedestrian safety to minimise pedestrian-vehicle conflicts

For the commuter, good design pertains to prioritising infrastructure that minimises pedestrian-vehicle conflicts. An important type of conflict to consider in terminal design is the movement of transferring commuters from one platform to another. In this case, the design utilized traffic-calming measures to demarcate and create legible spaces at pedestrian crossings. Points where pedestrian and vehicle movements intersected, used raised platforms to ensure that safe pedestrian movement was emphasised.

- **Accessibility:** Improve passenger convenience through better site accessibility: multiple ingress and egress points

The site has a level-difference, which was initially thought to be a hindrance to a good design

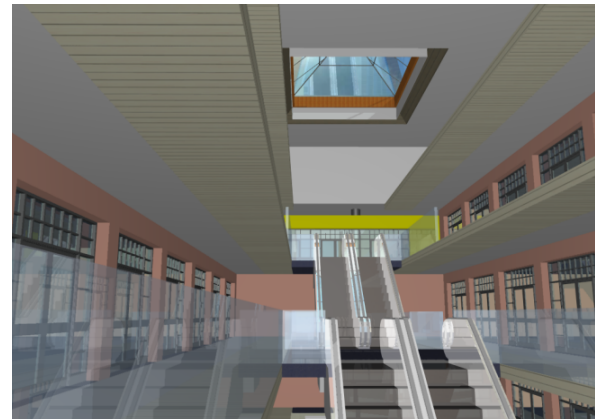


Figure 46 Escalators proposed for passenger convenience and fast movement (EMBARQ India 2013)

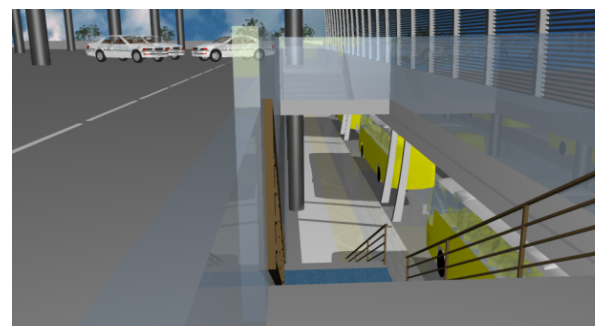


Figure 47 Proposed Park-n-Ride facility above the bus terminal (EMBARQ India 2013)

LoS	WAITING AREA (m ₂ / PERSON)	BUSES / PLATFORM	PASSENGERS / BUS	PASSENGER DEMAND	PLATFORM WAITING AREA (m ₂)	PLATFORM LENGTH (m)	WIDTH (m)
A	1.2	4	60	240	288	86	3.4
B	1.1	4	60	240	264	86	3.1
C	0.8	4	60	240	192	86	2.3
D	0.6	4	60	240	144	86	1.7
E	0.3	4	60	240	72	86	0.84

Table 12 Platform Waiting Area (Transit Capacity and Quality of Service Manual -2nd Edition, PART 7 n.d.)

LoS	PEDESTRIAN FLOW (PEDESTRIANS / m / mins)	DWELL TIME (mins)	BUSES / HOUR	BUSES / 15 mins	BUS LOADING POINTS	PASSENGER DEMAND	DEMAND / mins	PLATFORM WIDTH (m)
A	22	13	18	4	4	500	34	1.5
B	32	13	18	4	4	500	34	1.1
C	48	13	18	4	4	500	34	0.8
D	65	13	18	4	4	500	34	0.6
E	81	13	18	4	4	500	34	0.4

Table 13 Platform Walking Area (Transit Capacity and Quality of Service Manual -2nd Edition, PART 7 n.d.)

output. However, this was used to enhance site permeability and provide additional entrances for users. Commuters seek quick and direct access to platforms, ticketing facilities, transfers and convenient retail facilities; non-commuting visitors seek access to a range of peripheral activities such as retail, commercial, catering facilities, public spaces and visitor information. Hence, a commercial component was introduced in the terminal to allow for better viability and compatibility with surrounding land uses. The first floor entrance point allowed direct access to the park-n-ride facility

and commercial uses, with escalators to enhance passenger convenience (see Figure 46).

- **Integration of multiple modes**, i.e. auto-rickshaws, Kiss-n-Ride facility¹⁰, Park-n-Ride facility.

Direct access to a park-n-ride facility was provided above the bus terminal, establishing integration with private vehicles (see Figure 47). At present, NEKRTC is actively pursuing options to implement this project.

SECTION SUMMARY: Planning of Terminal Facilities

Terminal design must be approached from the perspective of both, operators and passenger. Design of good terminal facilities should focus on five key factors: terminal capacity, passenger level of service, accessibility, commuter safety and passenger amenities.

¹⁰ A kiss-n-Ride facility is a drop-off point at a transport station

CHAPTER SUMMARY:

Safety and access play a significant role in strengthening urban bus systems. There is a need to incorporate these two factors into infrastructure design, while ensuring that infrastructure is also integrated into the surrounding area. In the case of bus stops, this means placing bus stops to ensure safe passenger access. For intermediary infrastructure such as on-street interchanges, design must target ease of transfers and minimal impact on general road traffic. Off-street terminals require a similar design approach. From an operational perspective, infrastructure design must consider the peak hour usage to determine the capacity required.

4

FUEL EFFICIENCY TRAINING AND MANAGEMENT

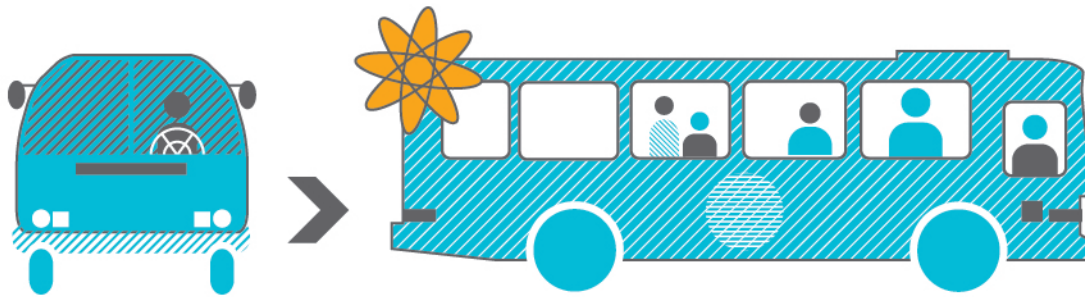


Fuel costs for an agency makes up 35-50% of overall costs and this makes higher fuel efficiency important for bus agencies to target.



Driving Technique

4.1 Driver Training



Driver Training

Vehicle Technology



Driver Motivation

4.2 Management Systems



Management Systems



Refresher Courses



Monitoring Drivers

4.3 Vehicle Maintenance



4.4 Incentive Schemes



CHAPTER FOUR

Fuel Efficiency Training And Management

The cost of bus operations comprises of fuel use, salaries, bus maintenance, etc. Fuel cost is one of the most significant components of bus operations. As a resource, fuel for buses typically accounts for 35% to 50% (Bhopal City Link Limited 2014) (AICTSL2014) (BMTc 2014) (DTS 2014) (APSRTC 2014) (Brihan Mumbai Electricity Supply and Transport Undertaking 2014) (NMMT 2014) of total cost of operations. In light of this, bus fleet companies are becoming increasingly aware of the need and responsibility towards improving fuel efficiency. Several agencies have started focusing on efficient practices as a means of optimising their expenditure. In the absence of subsidies, improving fuel efficiency can lead to significant cost savings and should be a strategy adopted by all operators.

Due to the complexity of variables that impact fuel-efficiency, such as vehicle technology and fuel type, it becomes difficult to set benchmarks, train drivers and offer incentives to promote fuel efficiency. A systematic framework can facilitate the achievement of practical improvements in fuel economy and comprises of four key areas: driver training, management systems, vehicle maintenance, and incentive schemes (see Figure 48).

In line with the needs of operators and ensuring a desirable level of fuel efficiency management, this chapter elaborates on each factor and an overall strategy for city bus agencies.

4.1 Driver Training

Driver Training combines two aspects: understanding the vehicle being used and understanding external conditions within which the vehicle operates. Drivers experience stressful conditions, particularly due to sitting and staying attentive for several hours while driving, severe traffic congestion and bad road conditions. These factors can have a negative effect on the health of drivers and in turn impact operations and customer perception (see Figure 49). Combined with the responsibility to manage passengers, their safety and adherence to their schedule, a driver's job becomes a herculean task. Keeping these issues in mind, a driver training session must include three components: motivation, vehicle technology and driving technique.

MOTIVATING Drivers

It is important to acknowledge that bus drivers enter the profession out of need for a livelihood. The social and environmental contributions of fuel usage are not widely understood. It is therefore fundamental that driver training focuses on motivation and stress reduction techniques that include:

- Acknowledgement of everyday challenges they face on the road

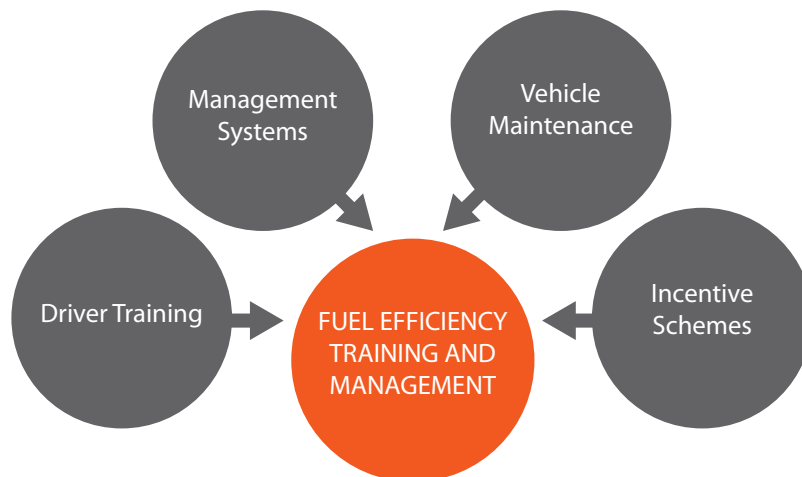


Figure 48 Four factors that impact Fuel Efficiency Training and Management

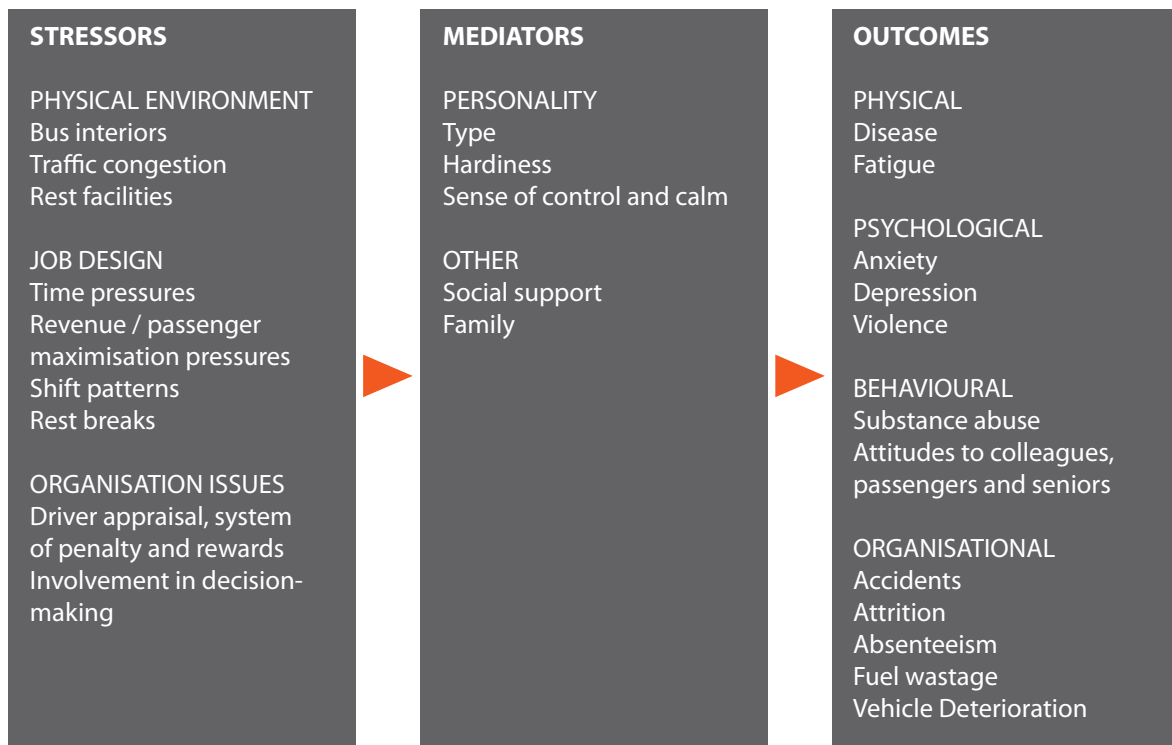


Figure 49 Bus drivers face stressful work environments, which can negatively impact operations (John L.M. Tse 2006)

- Importance of their role in creating sustainable cities and inculcating a sense of pride in the role they play towards this goal
- Drivers' responsibility for the comfort of passengers and safety of passengers and other road users
- Impact of their work on the sustainability of the organization
- Larger economic benefits to the country, through fuel efficiency

These points are a simple way to enhance a driver's self-respect and help them overcome their stress, while continuing to focus on their responsibilities.

VEHICLE Technology

With constant changes in bus technologies, it is important that a driver is aware of bus operations. Fuel efficiency is impacted by vehicle characteristics: fuel type (Compressed Natural Gas (CNG) or Diesel), location of engine (front or rear), type of bus (air-conditioned or non-air-conditioned), technology (mechanical or electronic), type of transmission (manual or automatic, number of gears, gear ratios), the manufacturer, model type, etc. Knowledge of the vehicle is helpful to drive in a fuel-efficient manner. Hence, training to the drivers should necessarily incorporate information about the functional aspects of various features of the buses and the

methods to reduce fuel consumption. While improving fuel efficiency, such training will also help the driver to flag the mechanical problems in the buses in advance and help in proper maintenance of the fleet.

DRIVING Technique

Driving technique significantly affects passenger comfort and safety, vehicle condition, fuel efficiency and emissions impacts. Emphasizing on any one of these points during the training sessions can have an impact in improving other factors. Ecological, economical and safe driving (eco-driving) is aimed at reducing fuel consumption, greenhouse gas emissions and accidents. Driving techniques have a significant impact on fuel economy (Barkenbus 2010). EMBARQ India's research indicates that the following principles help to propagate better fuel efficiency:

- Smooth driving: avoiding sudden stops and acceleration
- Safe driving: brake and slow the vehicle down ahead of time
- Cautious driving: anticipate traffic well in advance

Techniques such as sudden stops and starts and idling have a significant impact on fuel efficiency.

Drivers should be taught to deal with fuel efficiency by stressing these principles. In addition to this, maintaining an even driving pace, driving at or safely below the speed limit also impacts fuel consumption.

It should be noted that due to the innate complexity of the task, drivers have to manage multiple goals while driving, i.e. safety, fuel efficiency, and timeliness. As a result, the importance of certain goals may vary from time to time leading to priority being given to different goals during different circumstances. At times, some of these goals even compete with each other, such as avoiding traffic violations while in a hurry to reach a destination on time. This could be more in the case of urban driving as opposed to inter-city or regional routes. Hence, the driver training curriculum should incorporate

There are three components to a driver training session: motivation, vehicle technology and driving technique.

appropriate techniques to improve their awareness of the external environment in order to improve drive quality, fuel efficiency and safety, thus in turn also reducing the wear-and-tear of the vehicles.

CASE STUDY: Driver Training Sessions For Bus Agencies In Indian Cities

The impact of proper driver training is evident from the practical application of training in different cities: Delhi, Bangalore, Mysore, Mumbai, Chennai, Indore, Bhopal, Jaipur and Ahmedabad. Groups varying from 20 to 200 drivers were offered classroom training incorporating the following three components: technology, technique and motivation

(see Figure 50).

The training focuses on acknowledging the difficulties that a bus driver faces on a daily basis. Frustration and fatigue as a result of poor traffic conditions and disgruntled passengers are among the difficulties that a driver has to deal with. By acknowledging concerns and their impact on the driver, the session is designed to urge drivers to maintain patience and remain motivated.

The training component emphasizes the use of five smart driving skills to manage better fuel savings. The five actions cause the vehicle to use the required amount of fuel, hence referred to as fuel-efficient driving skills. They are also indicative of safe driving habits. These include:

- Avoid sudden starts and stops; the accelerator should be pressed down gradually and smoothly rather than in quick motion.
- Anticipate traffic in advance to minimize sudden breaking and acceleration.
- Use appropriate gear corresponding with the speed of the vehicle; for lower speeds, low gears are more suitable.
- Apply the power-point method, which entails the use momentum rather than additional fuel and driver efforts, to maintain the speed of the vehicle. Once the vehicle reaches optimum speed, the driver can release the accelerator by one-fourth, allowing momentum to take the vehicle forward.
- Stop accelerating at least 100m before every speed break, red-light or turn.

The classroom training was followed by practical sessions on regular routes. Table 14 shows kmpl results that were attained on the day of the practical training session, from each city. An immediate improvement of fuel efficiency on the day of the training, ranged from 20 and 100 percent.

Following the pilot training programmes, Mumbai and Navi Mumbai decided to incorporate the



Figure 50 Driving Training sessions (EMBARQ India 2014)

CITY	BUS TYPE	BEFORE TRAINING (KMPKG / KMPL)	AFTER TRAINING (KMPKG / KMPL)
Star Bus, Delhi	Tata Marcopolo Low Floor CNG Bus	2.45	2.7 (10%)
Metropolitan Transport Corporation, Chennai	Std. Bus - Diesel	4.7	5.78 (23%)
Bangalore Metropolitan Transport Corporation, Bangalore	BS IV Diesel Bus	3.56	4.2 (20%)
Brihan Mumbai Electricity Supply and Transport, Mumbai	Ashok Leyland BS III CNG Bus	2.7	5.4 (100%)
Atal Indore City Transport Service Co. Limited, Indore	Tata Marcopolo BS III CNG Bus	3.95	6.45 (63%)
Prasanna Purple Mobility Solutions, Bhopal	Tata 1512-C BS III Diesel Bus	3.1	4.1 (32%)
Navi Mumbai Municipal Transport, Navi Mumbai	Std. Bus - Diesel	3.67	5.71 (47%)
North West Karnataka Road Transport Corporation, Karnataka	BS III Diesel Bus	5.5	7.0 (27%)

Table 14 The results of Driver Training sessions (EMBARQ India 2014)

framework into their daily process. Both agencies are presently working on training their entire staff. Navi Mumbai is also advancing towards better management systems allowing them to monitor drivers and routes in a more accurate manner. Thus, a well-designed training programme can have a significant impact on fuel economy, cost of bus operations, and wear-and-tear of vehicles.

Accelerator Rest Pads for Driver Comfort

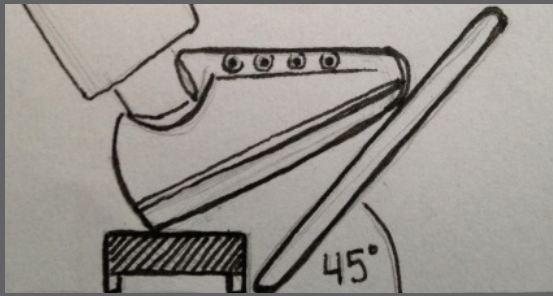


Figure 51 A foot rest pad adds to driver convenience and reduces the fatigue factor (Image Credit: Melissa Kim)

Stress and fatigue can be reduced by improving the driver's environment through comfortable seating, good ventilation, ergonomic form and proper shading. Recently, BEST equipped a part of their fleet with a foot pad located adjacent to the accelerator (as seen in Figure 51). Simple changes like the foot rest can make a significant difference in the driver's stress index.

SECTION SUMMARY: Driver Training

Driver Training combines two aspects: understanding the vehicle being used and understanding external conditions within which the vehicle operates. A training session must include three components: motivation, vehicle technology and driving technique.

4.2 Management Systems

While driver training can have far-reaching outcomes for transport agencies, experience indicates that drivers can easily fall back into old habits, resulting in the reduction of the benefits of the driver training

over time. This calls for the need to establish processes to maintain prolonged focus and monitor fuel efficiency. These management processes involve continuous data collection to analyse and monitor driver performance. Table 15 describes the steps, purpose and activities for monitoring purposes.

ACTION	PURPOSE	HOW THIS CAN BE DONE
Assigning drivers to buses and buses to routes.	Route familiarity will help bus drivers retain focus on safety and driving efficiency. It creates a sense of ownership with the vehicle, which helps with pre-empting mechanical issues.	Assign the same bus and route to the same driver each day. It is not always practical to achieve this due to driver weekly holidays, leaves, bus maintenance schedules, etc. Agencies should be able to achieve this up to 70 percent of the time.
Re-fuelling the bus at the end of the day.	Keep track of fuel efficiency on a daily basis	A driver log book maintained by the driver and the depot: this will record the vehicle number, route operated, distance driven, fuel consumed and fuel efficiency achieved
Bus malfunctions report	Assists in vehicle maintenance.	Drivers should record any problems at the end of their shift.
Management Information System Tools.	Analyse data for detailed information on driver and overall depot performance. This is useful in identifying critical areas that may need to be addressed.	Data collection from previous steps
Continuous training / refresher programmes	A constant reminder to 10% drivers that have achieved the least fuel economy and 10% of drivers that achieve lower fuel efficiency in comparison to their previous month records.	Refresher courses and / or Counselling to rectify driving techniques

Table 15 Management Processes that will facilitate data collection and monitoring (EMBARQ India 2014)

¹¹This number is calculated based on weekly holidays, casual and sick leaves, festival holidays, and an approximate 6 days of non-availability of bus.

SECTION SUMMARY: Management systems

Establishing systems to facilitate fuel efficiency management can be effective in monitoring and training individual drivers. For example, fixing routes and buses to drivers ensures that factors that affect fuel efficiency, such as the urban environmental conditions, remain constant. This allows the driver to focus more on his technique. Additionally, a system of data recording and analysing can be used to track an individual's improvement or decline in fuel economy. This data can help determine which drivers should be further incentivised to perform well and which drivers require further training.

4.3 Vehicle Maintenance

Optimising fuel efficiency is a function of the driver and the condition of the vehicle; vehicle maintenance is a third component that assumes a critical role in maintaining fuel economy. Current maintenance practices typically fall into either preventive maintenance or corrective procedures. While preventive maintenance procedures are based on the known fault rates of individual parts, some agencies undertake more stringent practices such as daily inspections, weekly check-ups, monthly minor services, major services every quarter and a comprehensive annual service that includes painting

In addition to procedures usually undertaken for bus maintenance, procedures such as tending to the daily malfunction reports, regularly checking tire pressure and air-filters and employing a fuel economy mechanic can ensure better fuel economy.

of the bus exterior and refurbishing interiors. In addition, other efforts to ensure better fuel economy include:

- Night inspections that attend to any issues flagged in the daily malfunction report, to avoid breakdown of vehicles and ensure maximum fleet utilization.
- Regular checks of tire pressure and changes to air-filters that provide the best returns in fuel efficiency.
- A fuel-economy mechanic who specializes in tuning vehicles to achieve maximum efficiency in the given condition of the driving environment (APSRTC 2014).

PERFORMANCE Indicators for Vehicle Maintenance

Maintenance has far-reaching impacts on bus operations and more specifically, fuel efficiency. Poor maintenance measures can result in low fleet usability, a high number of breakdowns, low ridership levels and consequential impact on revenue, poor operational efficiency, reduced service reliability, increased headways, etc. These

can cost transport agencies much more in resource expenditure through:

- Low Usage Of Assets And Idling Of Resources
- Additional Overhead Costs
- Extra Operational Costs Due To Worn-Out Parts
- Unattended Problems, Reducing Fuel Efficiency

For example, in the case of Thane Municipal Transport (TMT) and Navi Mumbai Municipal Transport (NMMT), the fleet usability is at 68 and 79 percent respectively. Of the 313 buses, 213 buses are operational in Thane, resulting in very low fleet utilisation (TMT 2014). In addition to the major overhead costs, the agency faces difficulty in parking the non-operational buses, with limited space for operational buses. NMMT's low fleet usability indicates a need to introduce better efficiency in the use of buses (NMMT 2014).

Despite these efforts, bus maintenance is an operational aspect that is lacking, resulting in the depreciated condition of buses, which adversely affects bus operations. Several agencies externalize maintenance activities, while using in-house expertise to monitor. To ensure a robust monitoring process to engage external agencies, four parameters that indicate the performance of the maintenance procedures can be effective:

- **Fuel Efficiency:** fuel consumption per kilometer
- **Missed mileage:** the ratio of kilometers performed, against the scheduled kilometers equates to the amount of kilometers missed
- **Fleet utilisation:** ratio of operational vehicles to the entire fleet
- **Cost / bus / day:** an understanding of the expenditures over a period of time

As newer bus types enter the market, engaging in maintenance contracts becomes expensive due to strict penalties posed by operating agencies. Additionally, the lack of expertise in the general market can also be a hindrance to finding an external contractor. As a result, there is a dearth of quality maintenance contractors in this field. It is therefore necessary that public transport agencies develop their in-house capacity to undertake bus maintenance by learning from bus manufacturers. The APSRTC undertakes in-house vehicle maintenance through a vigorous system of checks and monitoring process, which engages multiple levels of management. The case study in section 4.4 discusses APSRTC's vehicle maintenance procedures and their resultant fuel efficiency levels.

SECTION SUMMARY: Vehicle Maintenance

Maintenance has far-reaching impacts on bus operations and more specifically on fuel efficiency. Despite existing efforts, bus maintenance is an operational aspect that is lacking, resulting in the depreciated condition of buses and adversely affecting bus operations. A system of performance indicators that validate the quality of vehicle maintenance are important.

4.4 Incentive Schemes

A key component to encourage consistency in fuel efficiency is motivation; and a good way to motivate drivers is through incentive schemes to encourage continued performance. Experience indicates that it is necessary to design a monetary-based program to incentivise practical fuel-efficiency targets among employees (APSRTC 2014). There are three types of incentives that can be applicable:

- **Revenue Incentive:** Revenue is a clear measure of passenger acceptance of the service; hence a fixed percentage of the revenue should be shared with drivers and conductors. Apart from

The image shows two pages of a handwritten fuel efficiency booklet. The left page is titled 'Route target 5.00' and the right page is 'Route target 5.80'. Both pages have columns for date, kmpl, and other metrics. The data is recorded daily for a period of 17 days in March.

Figure 52 Fuel efficiency booklet: drivers record their daily achieved kmpl (APSRTC 2012)

A key component to encourage consistency in fuel efficiency is motivation; and a good way to motivate drivers is to create an incentive scheme to encourage continuous performance.

motivating, this reduces the tendency to pilfer and improves customer service.

- **Fuel Efficiency Incentive:** Achieving better fuel economy over the set benchmarks for the route / schedule are awarded. Cost savings acquired due to improved fuel efficiency can be shared with drivers and the mechanical staff, in pre-determined percentages. This further balances the tendency to make frequent, unauthorized stops to pick up passengers to maximize revenue incentive.
- **Spare Parts Incentive:** This incentive is devised to reduce frequent replacing of parts to maximise on fuel economy (which will result in excess maintenance cost to the organisation).

This stimulus should be restricted to mechanics. It is important to note that these incentives should be carefully calibrated to ensure that staff do not attempt to maximise one at the cost of another. For instance, where the Revenue Incentive can urge

The image shows a handwritten driver list for counseling. The table is divided into two columns: 'Low Kmpl Drivers for the month of March' and 'NEGATIVE TRANS Low Kmpl Drivers for the month of March'. It lists driver names, SLN, and Rate Kmpl.

Figure 53 Driver list for counseling - those that consistently achieve low fuel efficiency, must undergo refresher courses (APSRTC 2012)

drivers to stop and collect commuters mid-route, this actually increases fuel use. To address this, the Fuel Efficiency Incentive counter-urges the driver to reduce frequent stoppage. Introducing strict disciplinary action can be effective in this regard.

CASE STUDY: Management Practices and Incentive Schemes for Fuel efficiency at APSRTC

The Andhra Pradesh State Road Transport Corporation or APSRTC is one of the largest operators in the world, with over 22,000 vehicles in its fleet (APSRTC 2014). In India, it is considered a pioneer for having successfully implemented an incentive scheme for its staff to improve fuel efficiency. The fuel efficiency programme is strong on two main aspects of management: maintenance practices and incentive schemes.

MANAGEMENT SYSTEMS

A main component of the programme is the management of the system. APSRTC maintains daily records of each driver's fuel efficiency reading. At the end of each month, the kilometers / litre or KMPL reports indicate the low and high-performing drivers (see Figures 4.5 and 4.6). For high-performing drivers, the records are used to calculate incentives. For the low-performing drivers, due importance is given to those who operate on low kmpl achieving routes and on urban conditions that drastically affect fuel efficiency. The drivers are then counselled by the depot manager and at the end of each month, drivers are further assessed.

The programme employs the following aspects of management: assigning drivers to buses and buses to routes, re-fuelling buses at the end of the day, bus malfunction reports, management information system tools and continuous refresher training sessions. In addition to this, a rigorous system of checks is undertaken by the regional and depot managers, to ensure proper implementation of the fuel efficiency programme.

ELABORATE MAINTENANCE PRACTICE

APSRTC follows five scheduled maintenance procedures, which range in frequency from daily to yearly. To ensure maximum fleet utilization, daily inspection is carried out and a bus-wise report is prepared. A fuel-economy mechanic who specializes in tuning the vehicle for better fuel economy is employed at every depot. Since maintenance of buses plays an important role in the overall

operations of the system, maintenance incentives are given to the mechanical staff.

A key component of the agency's maintenance practice includes a robust monitoring system which involves supervision at all management levels including the depot supervisors, depot managers, and regional managers. This indicates to drivers and managers the seriousness of their and their teams' performance in fuel efficiency.

MOTIVATIONAL MEASURES AND INCENTIVE SCHEMES

Drivers and mechanical staff earn incentives for achieving fuel efficiency beyond a set benchmark. A proper monitoring system is put in place to identify reasons of poor kmpl performance (see Figure 52 and Figure 53). The fuel efficiency incentive is accumulated on a daily basis for the calendar month.

Revenue Incentive: To ensure drivers and conductors carry passengers from all bus stops, APSRTC pays 4% incentives (2% for the driver and 2% for the conductor) for earnings beyond fare-box benchmark (APSRTC 2014).

Fuel Efficiency Incentive: This incentive is based on the reduced number of breakdowns, higher fleet operability and reduced spare parts costs. As a result, APSRTC's average fuel efficiency is 5.15kmpl (APSRTC 2014).

Spare Part Incentive: Apart from that, mechanical staff also earn a tyre incentive. A benchmark for tyre life is set at 160,000 kms (including 3 to 5 treads). If the tyre life is higher than this benchmark, the mechanical staff earns 30% of the saving (APSRTC 2014).

In addition to cash incentives, the agency also displays names of high and low achieving drivers and slogans on fuel conservation to motivate drivers.

DISBURSEMENT OF INCENTIVES

The computation of incentives is a data-intensive process and requires comprehensive implementation to enable full transparency and consistency in the procedures. APSRTC decided that simply disbursing incentives as part of the salary was not as effective, as staff may not understand how their actions have benefited themselves. To overcome this, the agency pioneered the following schedule (APSRTC 2014):

- The Revenue incentive is paid out to the drivers and conductors on a daily basis, at the end of their shift.
- The fuel efficiency incentive is accumulated and paid to staff on a monthly basis. It is paid separately, however, from the salary.
- Incentives for spare parts are either calculated monthly or quarterly.

The adoption of eco-driver training, in conjunction with smart monitoring technologies and a proper incentives system, can be effective in addressing the fuel-economy and emissions issue for any agency's urban fleet of buses. Motivated drivers with a form of reminder or incentive such as offering a portion

of savings, garnered through the reduction of daily fuel consumption, combined with other emotional/psychological mechanisms, will tend to retain the positive effects of eco-driving (Barkenbus 2010) (Civitas 2008).

The implementation of a structured framework that incorporates the four levels can indicate to the staff the seriousness of fuel-efficient and safe driving. The next step in strengthening the fuel efficiency system is to evaluate the parameters that impact bus and depot-level monitoring. Further to this, the application of technological advancements in this field would also add considerable accuracy to the system.

SECTION SUMMARY: Incentive Schemes

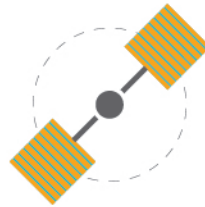
Financial incentive schemes can be effective in targeting better fuel efficiency. APSRTC's fuel efficiency programme is a well-structured programme that incorporates elaborate maintenance procedures and incentives schemes to instil the importance of fuel efficient driving. A strong system of monitoring which includes each management level, in addition to continuous training and strict maintenance measures, resulted in substantial fuel savings for the agency.

CHAPTER SUMMARY:

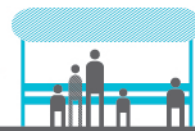
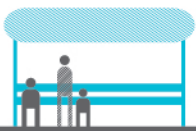
Fuel costs comprise a significant portion of a city bus agency's expenditure. As a result, agencies understand the need for optimising fuel use. As a forefront agency in managing its fuel efficiency, APSRTC undertakes a four-pronged approach to fuel efficiency management. This includes driver training, management systems, vehicle maintenance and incentive schemes. These components work together to motivate and incentivise fuel efficient driving for drivers, conductors, and mechanics, towards establishing sustained improvements.

5.1 ITS and Applications for City Bus Operations

Data Analysis Of Driver Behaviour, Passenger Information And System Performance



Automatic Vehicle Location System (AVLS)



Passenger Information Systems (PIS)

ETA: 3 Mins

Route Diversion

ETA: 15 Mins



Driver and Fuel Monitoring system

Traffic Signal Priority (TSP) Systems Such As Intelligent Traffic Signals Minimise These Delays



Planning and scheduling software Involves Preparation Of Work Schedules Of Drivers And Conductors By Assigning Them To Specific Depots



Automated Fare Collection System (AFCS)

5.2 Challenges in ITS Implementation



5.3 Way Forward for ITS in India



CHAPTER FIVE

INTELLIGENT TRANSPORTATION SYSTEMS IN CITY BUS SERVICES

The application of Intelligent Transport Systems (ITS) in city bus systems helps agencies to improve services by improving the reliability and efficiency of operations. Through data analysis, agencies can provide better information to passengers, improve in-house resource productivity and take concrete decisions for overall operations and management. At present, in the Indian context, ITS includes a wide variety of technologies with applications in navigation, traffic management, parking, surveillance, etc. Over the last few years, public transport agencies have been able to implement ITS technology at varying scales.

Various ITS components are in use in the Indian market; essentially adaptations of systems deployed in the freight and logistics industries. A lack of experience and expertise among transport agencies has resulted in sub-optimal utilisation of the technology deployed, thus not achieving its full potential. This is due to several factors (DTS 2014) (BEST Undertaking 2014) (NMMT 2014) (Finn 2014):

- Limited market share of applications for public transport
- Complexity involved in urban bus operations
- Budgetary limitations of operating agencies in this segment
- Limited functional and technical specifications to guide the development of ITS in this field; and
- The need for knowledge and experience among agencies

Agencies implement software solutions for asset management, procurement and inventory management, human resource solutions, etc. However, these are not included as part of this chapter as these applications are not specific to operations of public transport, i.e. city bus services. ITS can be adapted in various forms to enhance

the performance and the level of transit services to passengers, thus attracting them towards public transport. At the same time, technology uses can improve operational efficiency. This chapter begins with describing six ITS components that are prevalent in city bus operations in India.

Through case studies, the potential uses of these components in terms of data extraction, analysis and implementation in operational efficiency planning are discussed in detail. The latter part of the chapter focuses on the challenges of ITS implementation, the lessons learned and the way forward for ITS in the Indian context (see Figure 54).

5.1 ITS and Applications for City Bus Operations

Presently in the Indian context, there are six ITS uses that are relevant to urban bus transport operations and security (Figure 55).

AUTOMATIC VEHICLE LOCATION SYSTEM (AVLS)

AVLS technology uses a combination of a Global Positioning System (GPS) receiver and a General Packet Radio Service (GPRS) communication module to transmit the location of a vehicle to the control centre, in real time (AFTEK 2011). This technology was initially used by the military and gradually found its way into freight and logistics services, where drivers were monitored for unscheduled stoppage and route deviations. The solution helps the operators monitor drivers for unscheduled stoppages, deviations from routes, over-speeding, etc., which have adverse impacts on the delivery schedule as well as finances. The same system was



Figure 54 ITS in the Indian Context

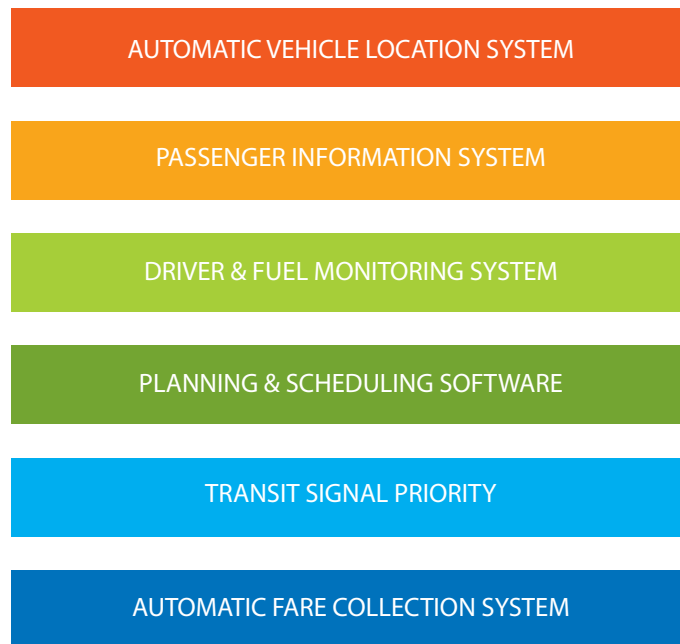


Figure 55 ITS Components actively used in bus transport in India

later adapted to urban bus systems as a way for operators to monitor these aspects, which affect operations as well as finances.

Since the monitoring requirements of an urban bus service is much different from that of the freight industry, bus operators have not been able to take the full benefit of the application. For example, buses in urban areas pass through congested streets which do not permit them to reach higher speeds; hence the relevance of report on over-speeding is limited. Similarly, each bus driver has to follow a specific schedule throughout the day. Since

Technology applications are presently used to facilitate operations planning, monitoring and communication for urban bus transport systems.

passengers travel along these routes, drivers do not deviate from the scheduled path unless directed by the traffic police or other authorities. However, for the case of urban bus operations, AVLS can provide specific analyses, such as travel time monitoring between consecutive stops at various times of the day, schedule adherence, and driver behaviour analytics.

Due to the limited market for ITS use in public

transport, these analyses have not been explored adequately. Further, the inability of bus operators to raise capital for advanced analytics solutions has also prevented any breakthrough in this direction. As the ease of movement around urban areas becomes increasingly affected by congestion, ITS applications become crucial in strengthening bus systems.

PASSENGER Information Systems (PIS)

In the case of public transit, PIS refers to an information system, which provides real-time, dynamic information for passengers. This may include both predictions about arrival and departure times, and information about the nature and causes of disruptions. The system utilizes vehicle location data from AVL systems to disseminate information on the current location of the bus to passengers and predict arrival times at bus stops (Green City Streets n.d.). This is particularly useful on low-frequency routes and when buses deviate from scheduled



Figure 56 PIS Board used in Mysore (EMBARQ India 2014)

times due to unforeseen circumstances.

The first generation of PIS involved the use of light-emitting diode (LED) display boards at bus stops to indicate estimated arrival times for the next bus (see Figure 56). Through the urban bus specifications recommended by the Ministry of Urban Development (MoUD), this system was used inside buses to announce next-stop information; however general observations (EMBARQ India 2014) indicate that several systems remain unused or non-functional. Few cities experimented with the option of communicating this information via SMS, but with limited success. Current advancements in telecommunications, such as smart phones, create the potential to track buses in real time through mobile phone apps, which is still quite unexplored in India.

CASE STUDY: AVLS And PIS In The Indore BRTS

In January 2006, the first implementation of AVLS for public bus operations was undertaken as a build-operate-transfer (BOT) model in Indore. After 3 years of operation, when the fleet size increased from 37 to 100 buses, Atal Indore City Transport Services Limited (AICTSL) purchased the system and contracted out operations and maintenance services to reduce costs (AICTSL 2014).

The system generated all the reports that were typical to the freight solution, such as unscheduled stoppages, deviations from routes, and over-speeding, and introduced two specific advancements: the schedule adherence report and the PIS. The schedule is saved on the server, while the AVLS software tracks the movement of vehicles with respect to their schedules. The report generated for each bus each day indicates the scheduled time and actual time of arrival of the bus at each stop. While this is useful to ascertain the performance of private operators, the report was very cumbersome and did not allow AICTSL to monitor drivers that did not perform. The report however, did provide a summary of the operated kilometers, allowing AICTSL to ascertain the number of buses on road on each single day.

In addition to the AVLS, the major advancement in the ITS implementation in Indore was the PIS display and customer service centre, which allowed passengers to acquire information on expected arrival times. The typical headway between buses on most routes in Indore is more than 10 minutes. AICTSL installed over 50 PIS displays at prominent stops across the city. At stops that did not have a PIS

board, people could call the customer service centre to obtain this information.

Since 2006, Indore city buses also employed Electronic Ticketing Machines (ETM) for ticket-issuing. Though the data collected belonged to the private operators, some key performance indicators, including the ridership, on the state of the system were easily accessible.

DRIVER & Fuel Monitoring

Chapter 4 underscores the need to establish processes to save fuel and reduce emissions. To facilitate this, the use of technology can go a long way in monitoring driver behaviour. With the introduction of electronic engines in buses, the Vehicle Monitoring Unit (VMU) in the buses captures a significant amount of diagnostic and status information during the course of operations. An additional interface can be used to access this data about the drive cycle and transmit it to the central server through the GPRS module. However, there are no known applications in India yet. Data analysis of speed changes, variation in engine rotations per minute (RPM) and frequency of braking, provides information pertaining to the driver's behaviour.

This information can be used further in the customisation of training needs for drivers. This is also helpful in identifying whether low fuel efficiency readings are due to driving patterns or the mechanical condition of the vehicle. One way to integrate this is as an add-on module to AVLS systems resulting in a minimal increase in cost.

CASE STUDY: Use of Fuel Monitoring Data in Bhubaneswar

In 2010, the city of Bhubaneswar started its bus operations with 100 buses with Dream Team Sahara (DTS) as the private operator (DTS 2014). DTS used a system very similar to the one in Indore, with the notable advancement of the fuel tank monitoring sensor. The sensor is used to measure the fuel tank level; however turbulence during movement of the bus results in erroneous readings. Nonetheless, the system has the capability to reduce disturbances and record accurate levels when the bus halts either at bus stops or at intersections. Figure 57 graphically depicts the fuel tank level throughout a day. This equipment was effective for DTS in preventing fuel theft by the bus staff.

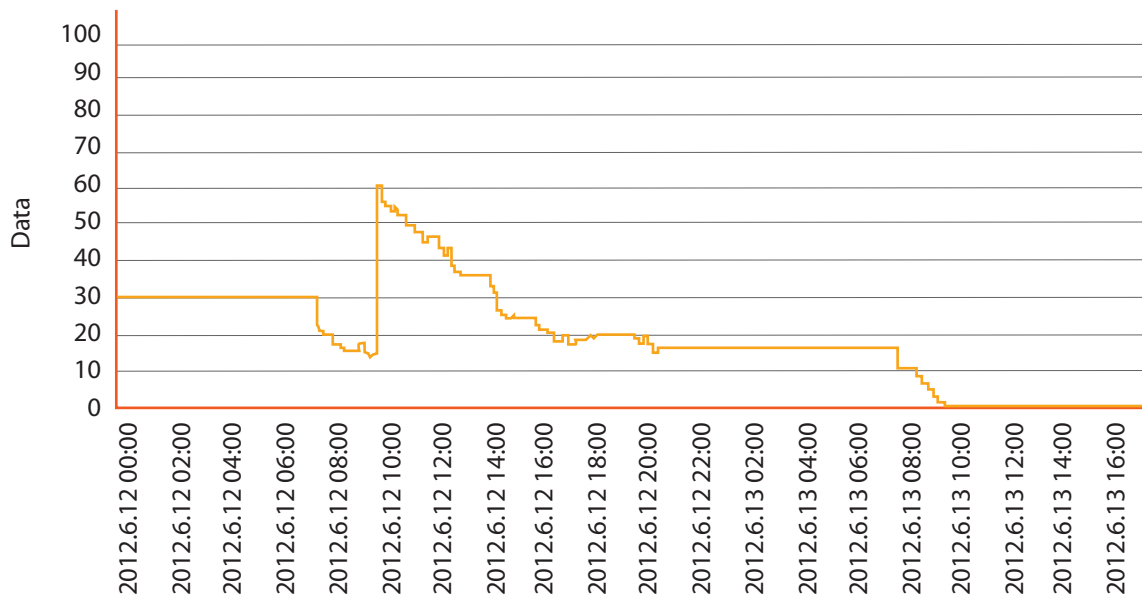


Figure 57 Fuel Level Monitoring data is useful to prevent fuel theft (DTS 2014)

PLANNING & Scheduling Software

The ITS tools mentioned earlier provide large amounts of valuable data that need to be analysed to generate travel times and identify route patterns. All these form the basis of inputs to the next process of planning and scheduling of services that result in improved service reliability and passenger experience. Route planning involves providing connectivity to different origins and destinations in a city to meet the travel needs of potential passengers. Scheduling involves the preparation of timetables for buses and routes and work schedules for drivers and conductors by assigning them to specific depots and routes based on the availability of buses. This exercise becomes extremely complex with the scale of operations in a city with a large fleet size, multiple routes and the requirement to assign drivers and conductors to multiple shifts on a daily basis. Currently, all the agencies in India use manual processes for creating schedules. Software solutions can allow the creation of operation plans that result in more uniform headways between buses travelling towards the same destination. However, these solutions are complex and very expensive at this point.

CASE STUDY: Scheduling of Driver and Conductor Duties in BEST, Mumbai

The BEST Undertaking (BEST) manages around 506 routes, 23,000 drivers and conductors, and around 4,200 buses in the Greater Mumbai area (BEST Undertaking 2014). Among agencies that typically

have a staff (both driver and conductor) to bus ratio of around 4.5 - 4.8, BEST's ratio is higher at 5.5. For large agencies like BEST, scheduling resources becomes of utmost importance to the operational efficiency of the system. Similar to most agencies, for years BEST has manually managed driver and staff schedules. BEST adopts the London model of scheduling staff to the buses, where different segments of schedule are allocated to different staff. This is done to use the fleet effectively, even while the staff gets rest-breaks. For example, a driver is manually allocated a two-way route that would take around four hours to complete. The compulsory break within 5 ½ hours of a shift's start, required the agency to provide the driver with a break after the first four hours since doing another trip of the same route would cross the 5 ½ hour mark. Therefore in some cases drivers effectively work only for 6 hours due to the inefficiencies of manual scheduling.

In 2013 BEST adopted a scheduling software to transfer to a computerised scheduling system. The software was programmed according to BEST's requirements. By further adding in criteria specific to duties, including the duty start / end times and starting / ending depot, the software matches staff to depots and work duties, to provide the most cost-effective and time-efficient shift for each employee. The programme has the ability to provide numerous duty combinations for BEST to choose the most suitable for drivers and conductors, which was impossible for a manual scheduler. Furthermore, it reduces the human error factor in allocation. In July 2013, this system was first introduced on a pilot basis at two depots. This resulted in a 4% reduction in crew requirements (BEST Undertaking

2014). Following this, the system was introduced to an additional 10 depots in November. The agency expected to implement across all their 26 depots; however, internal misperceptions led to the implementation being postponed.

Internal conflicts led to the perception that a driver duty can be increased up to 12 hours with the new system. In addition to this, concerns related to the lack of amenities and rest areas were also raised. As a result, in March 2014, the agency was taken to court and faced multiple flash strikes, affecting transport all around Mumbai (Aklekar 2014). By the end of July 2014, once the outputs of the system were understood and discussed further, the system was implemented at all 26 depots.

One major lesson learnt is the need for the transit agency to thoroughly understand the impact of any new technology, particularly to the end user. Another important factor is to follow the due process of communication to ensure that such systems can be implemented and are widely accepted in a positive manner. It is important to facilitate negotiations with the staff and unions at the appropriate stage to ensure an inclusive approach. While BEST is presently discussing the way forward with the unions, it remains to be seen how the scheduling system will impact its overall operations.

TRAFFIC Signal Priority (TSP)

The five ITS components listed previously are technologies that help monitor and improve the performance of the transport system. The overall performance of the bus service is constrained by the external environment, in terms of the traffic conditions on urban streets. As roads get more



Figure 58 Movement of the Indore BRTS is prioritised through TSP technology (EMBARQ India 2014)

congested, transit performance is bound to diminish with travel speeds, hence reducing the average fleet utilisation, unless provided with a dedicated right-of-way. This is an aspect of ITS that is typically outside the control of the transit agencies; hence, improvements in this dimension require action from the municipal and traffic authorities.

A key impediment to faster movement of buses is intersection delays. Signal priority systems such as intelligent traffic signals minimise these. TSP is an intelligent traffic signal system that takes external input, in the form of video or loop-based vehicle detectors, in order to identify the arrival of a bus at an intersection (see Figure 58). This information is used to prioritise bus movement by expediting the green phase for buses alone at a signal (Green City Streets n.d.). This significantly reduces the delays at intersections, minimising passenger trip times. This also maximises fleet utilisation and reduces driver stress in maintaining schedules.

TSP works in conjunction with a bus-bay or dedicated bus lane at the approaches of an intersection. Bus movement can be prioritised and improved by providing a separate lane for buses at the intersection, to operate as a queue jumper. For example, a bus carrying up to 60 persons can cross a typical intersection in 10 seconds, whereas it takes more than twice the time to throughput the same number of persons on private vehicles in the same amount of space. Thus, traffic flow can be improved by providing a separate lane for the buses at the intersection, to operate as a queue jumper.

In most cities, BRT systems exist in dense, urban settings, where intersections with crossing roads are unavoidable. Typically in Indian conditions, observation indicates that signal cycle times may vary between 90 and 150 seconds, depending on the number of arms at the intersection. A planned headway of around 1 to 2 minutes in each direction, equivalent to the signal cycle times, results in bus bunching at the intersection. Furthermore, each intersection adds recurring delays to the overall journey time.

CASE STUDY: Signal Priority For Buses At Intersections Along The Indore BRTS Corridor

The Indore BRTS employed a pan-corridor wireless traffic signal system (WiTrac) developed by the Centre for Development of Advanced Computing (CDAC). WiTrac signals are solar-powered and minimise the requirement for any underground conduits and tedious cabling work. Each signal

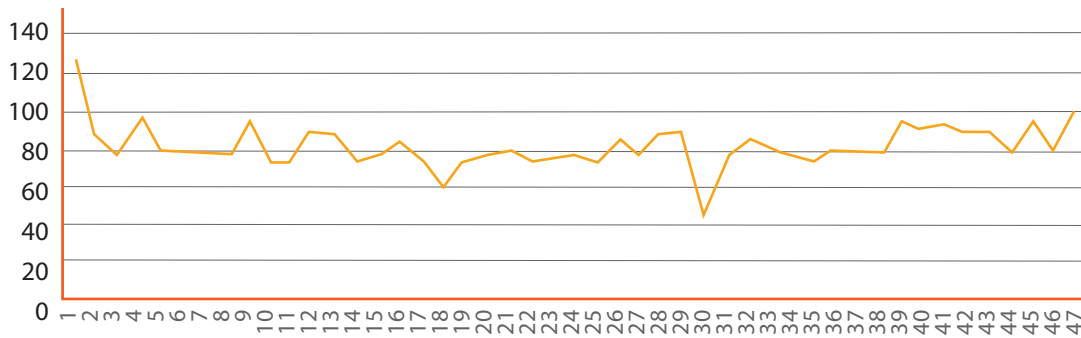


Figure 59 Variations in cycle time achieved at the intersection (AICTSL 2014)

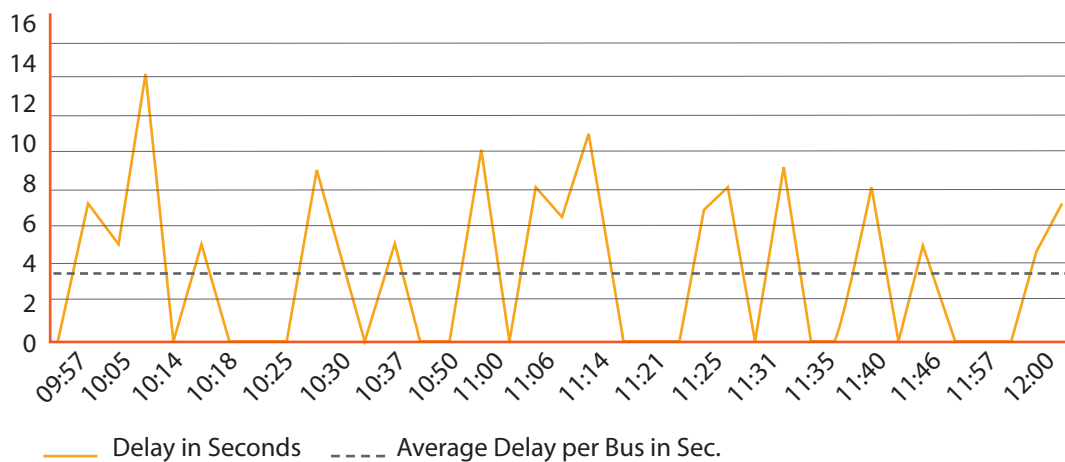


Figure 60 The waiting time for buses across successive time periods, after the TSP plan was introduced (AICTSL 2014)

post can be erected independently to enable rapid installation. The network is fitted with camera-based virtual traffic detection technology, allowing the system to detect BRT vehicles and adjust cycle times according to the traffic conditions.

Under normal conditions, it was observed that a waiting bus at the edge of the intersection, usually takes about 10-12 seconds to cross the intersection completely. TSP for BRT buses was taken up on a trial basis at the MR-9 intersection along the BRT corridor. The signal plan at this intersection was configured to a virtual actuation mode, with a minimum and maximum cycle time specified. When tested, it was observed that the overall cycle time for the intersection varied between 45 and 90 seconds, depending on traffic conditions. Figure 59 illustrates the variations in cycle time achieved at the intersection across a set of consecutive cycles.

While this signal plan in itself minimized intersection waiting time for all traffic, the benefit for buses was a significant improvement over pre-TSP conditions. For TSP, the automated controller was set to detect traffic in the bus lane twice during each signal cycle.

Before the introduction of the TSP plan, on an average a BRT bus would have to wait about 45-90 seconds before getting a green phase. By conservative estimates, 45 seconds at each of the 13 intersections across the BRT corridor would constitute approximately 10 minutes (about 25%) of the total trip time.

Figure 60 illustrates the waiting time for buses across a number of successive time periods, after the TSP plan was introduced in the signal plan. It can be observed above, that post TSP implementation, the average waiting time for the buses reduced to about 3.57 seconds, with the maximum delay faced by any bus at 14 seconds. Even at a maximum delay of 14 seconds at an intersection, this is reduced by two-thirds (from 45 seconds before TSP). This further minimized the trip time for buses, thereby increasing the travel time saving that the BRT is able to offer to its passengers.

AUTOMATED Fare Collection System (AFCS)

AFCS consists of a fare media (such as smartcards) that allows the storing of monetary value and enables commuters to undertake a cashless transaction and self-pay (AFC Technology 2010). Electronic devices or readers are used to read data on the smart card and communicate this information to the central server and revenue clearing house for settling funds and generating data reports.

AFC systems are commonly used in rail systems and for off-board fare collection in BRT systems. Globally, this technology is used for on-board ticketing with validators on buses. In India however, AFCS is limited to metro-rail systems only, with the exception of Ahmedabad's BRTS, called Janmarg. Nonetheless, cash payments and manual ticketing remains the prevalent fare payment mode in Janmarg.

The common fare collection mode in urban bus transport systems is on-board and authorized by a conductor who issues a paper ticket after collecting cash. Agencies such as BEST in Mumbai are now using Electronic Ticketing Machines (ETMs) to issue custom-printed tickets for travel. There is no direct improvement to passenger convenience, unless the machines are smart-card enabled, which allows passengers to undertake a cashless transaction, reducing the hassles of carrying correct change. Smart card also offers the possibility of compensating passengers for transfer penalties.

In 2011, Purple Mobility Solutions, the single private operator in Bhopal, functioning on the net-cost model, introduced Radio Frequency Identification (RFID)-enabled smart-card payment media (Purple Mobility Solutions 2014). This system allows passengers to store credit and undertake cashless transactions. The system incorporates a discount to smart card users in order to reduce the possibility for corrupt practices by the staff and ticketless travel by passengers. Additionally, the use of smart cards was effective in creating a dedicated customer base.

From an operator's perspective, ETMs simplify back-end processes in record-keeping for the agency and add further value when they collate data. This data can be used for the analysis of route performance and improvements in route planning, thus improving the quality of services to passengers and attracting more users to the system. The following case study discusses the integration of an AFCS into the Ahmedabad BRT system.

CASE STUDY: AVLS and AFCS Integration into the Ahmedabad BRTS

Ahmedabad's Janmarg BRT system is the first to implement a fully integrated ITS solution for bus operations in India that includes AVLS and AFCS along with financial settlement systems. Janmarg incorporated all the components: GPS, on-board computers, driver consoles, two-way voice communication, PIS inside the bus and at all bus stations, fare-gates, RFID smart-card fare payment media, and a dedicated control centre with large video wall (see Figure 61).

One of the significant and essential improvements to the Janmarg AVLS implementation is the possibility of assigning buses to pre-defined schedules in real time. Individual buses are not fixed to a specific schedule, allowing for spare buses to replace scheduled buses while they are in maintenance. Further, if bus schedules need to be exchanged due to operational reasons, the system tracks the bus against its current operated schedule rather than a fixed one.



Figure 61 Janmarg BRTS Control Centre (EMBARQ India 2014)

The on-board driver console clearly displays the number of minutes by which the bus deviated from its schedule. This conveys to the driver the need to slow down or make up for lost time, thus resulting in better service reliability. A two-way line also enables communication between the driver and the control centre, in case of alerts.

Since the BRT operates on a fixed, dedicated right-of-way, the planning needs and the travel time variations by time of day are much less, thus reducing the analytics that are necessary to create schedules.

Table 16 highlights the ITS features of bus systems in Ahmedabad, Indore, and Mysore.

	AHMEDABAD	INDORE	MYSORE
TYPE OF SYSTEM	BRTS	BRTS	City Bus Services
AGENCY	Ahmedabad Janmarg Limited	AICTSL	KSRTC
ITS FEATURES	AVLS PIS AFCS Driver Console Control Centre	AVLS PIS ETM Customer Service Call Centre Driver Console	AVLS PIS ETM Control Centre Driver Console
USE OF DATA	<ul style="list-style-type: none"> • Real-time passenger information at bus stops • Real-time assignment of schedules to buses • Schedule adherence monitoring • Two-way communication between driver and control centre • Financial settlement system 	<ul style="list-style-type: none"> • Real-time passenger information at bus stops • Route selection display 	<ul style="list-style-type: none"> • Real-time passenger information at bus stops • Route selection display • Real-time assignment of schedules to buses • Two-way communication between driver and control centre

Table 16 ITS features and uses of data at Ahmedabad, Indore and Mysore

SECTION SUMMARY: ITS Applications for City Bus Operations

There are presently six ITS features that are in use: Automated Vehicle Location Systems, Passenger Information Systems, Driver Monitoring Systems, Planning and Scheduling Softwares, Traffic Signal Priority and Automatic Fare Collection Systems. These are used to facilitate operations planning, monitoring and communications for urban bus systems.

5.2 Challenges in ITS Implementation

As seen in the previous section, several public transport agencies have implemented ITS technology at different scales with varying degrees of success. These systems focused on isolated deployments of several ITS components, thus not giving the complete benefit of the technology. Some of the challenges of ITS implementation include:

- Lack of resources for operation and maintenance of ITS technology
- Lack of in-house technical capacity to process, understand and analyse the data
- Lack of advanced analytic solutions in the public transport industry
- Lack of knowledge on its systems and capabilities to specify suitable terms when contracting its services to vendors
- Lack of knowledge among vendors on the specific needs of public transport operations, which significantly affects the utility of the end product
- Lack of understanding about the implications of procuring a certain technology in a fast-changing ecosystem
- Awarding of its contracts purely based on the lowest costing proposals rather through a quality and cost-based criteria

The following case study demonstrates how the lack of coordination between different stakeholders, management challenges and a poor understanding of issues associated with implementing a particular technology, can result in complete failure of ITS technology.

Case Study: ITS Implementation Challenges in Jaipur City

In August 2011, Jaipur City Transport Services Limited (JCTSL) signed an agreement with UTI Infrastructure and Technology Services Limited (UTIITSL) to provide Intelligent Transport Management Systems for common mobility cards in Jaipur (JCTSL 2013). Initially, the project was to introduce an entire system including AFC, a vehicle tracking system, management information systems reports, a central financial settlement, a settlement

In implementing ITS, agencies face several challenges related to the lack of funding, resources, technical capacity, analytic solutions and knowledge on ITS.

house, etc. UTIITSL's role was to design, procure, develop, install, operate and maintain the project.

The project was to be implemented in a phased manner and ultimately result in a comprehensive system that included ETMs, AVLS and PIS technologies. The system however, was not launched due to three main issues: the lack of coordination, management issues and the breakdown of hardware. The National Common Mobility Card (NCMC) system requires all agencies involved to comply with standard technology requirements in order to ensure a cohesive system.

In the first phase of the project, several issues came up. The ETMs were introduced by UTIITSL in February 2013 and within a few months were operating on all the bus routes. Serious issues started emerging fairly early after ETMs were put into operation, some of which are listed below:

- **Poor battery life:** The battery of the ETM did not last for more than 4-5 hours. To rectify the issue, UTIITSL provided battery back-up, which needed to be connected and attached to the ETM, adding considerable weight to the machine (>800 gms). This made it cumbersome to handle and operate by the conductor.
- **Additional work load:** This led to 80,000-90,000 paper tickets being issued daily, which was nearly 70-75% of the total ridership. This created extra work for the agency, to manage two systems – paper tickets and the ETM-issued tickets.
- **Non-Functional ETMs:** 150 out of the 221 machines were non-functional and could not be used, requiring additional paper tickets to be issued.
- **Revenue Leakage:** The use of paper ticket posed a problem of potential revenue leakage.

These issues led to a complete failure of ITS technology. Finally, JCTSL withdrew ETMs from 17 of a total of 18 routes.

SECTION SUMMARY: Challenges in ITS Implementation

In adopting ITS into city bus operations, agencies face several challenges due to the lack of funding, resources, technical capacity, analytic solutions and expertise on ITS. These challenges in ITS implementation indicate a strong need for agencies and vendors to work together to provide tailored solutions. It is important that agencies are aware of the type and representation of data they require and how to utilize it for performance monitoring and service improvements. The vendor's role is to also understand the needs of the agencies and develop solutions that can clearly demonstrate tangible benefits over and above the costs of investment.

5.3 Way Forward for ITS in India

While Indian cities have been successful in implementing ITS technology, the usage of the information has found limited applicability by different public transport agencies. There is a substantial gap between the solutions provided by ITS vendors and actual need of transport agencies to use the technology in improving the operations. As a result, the technology is not used to its full potential. There is a clear need for transit agencies to better understand the potential of ITS, in order to specify their requirements during the procurement, testing and installation process. There is also a need to enhance knowledge among vendors about ITS applications in public transport operations. ITS implementation is still in its infancy in public transport agencies in India. Based on the learnings from various agencies, there is immense opportunity to improve the applicability of ITS for public transport. Further, it may be worthwhile for agencies to start small with service contracts on ITS, in order to test the applicability of the solutions, rather than make full procurements without understanding their utility. Some of EMBARQ India's key recommendations include:

- Need for a national ITS standard for different applications and components
- Need for deploying a system with protocol sharing between the bus manufacturers and system vendors
- Introduction of appropriate clauses in the

The real benefits of ITS are only apparent once the transit analytics are incorporated with the ITS solution, to generate a large quantum of accurate and useful data.

bus procurement documents to ensure data-sharing between ITS service provider and public transport agency

- Setting up fully functional Traffic Management Centres for coordinating ITS activities
- Effective communication between all stakeholders

In addition, the real benefits of ITS are only apparent once the transit analytics are incorporated with the ITS solution to measure performance indicators and generate information from the electronic data generated (refer to Chapter 2 on data collection and uses ITS).

While some analytics can be very expensive, simple improvements to the ITS reports, such as the inclusion of graphical representations, can make the reports easier to interpret. This section discusses a few experiments from Bhubaneswar, Bangalore and Visakhapatnam.

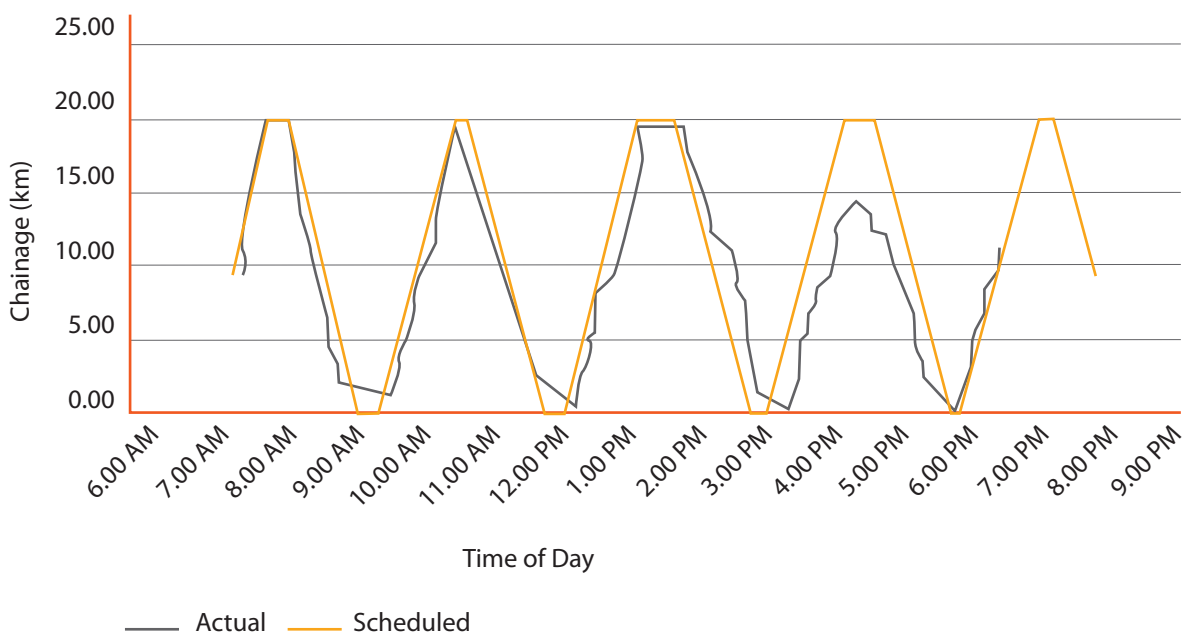


Figure 62 Schedule Adherence Report, Vehicle No. OR-02-BQ-3718(DTS 2014)



KSRTC Mysore ITS Schedule Adherence Report

Date From : 01/05/2013 00:00

Date To : 01/05/2013 23:59

Sno	Depot Name	Route/ Schedule	Bus No	Trip No	Stop Name	Schedule Departure Time	Actual Departure Time	Time Difference	Driver Name / Number	Conductor Name / Number
SCHEDULE DATE : 01/05/2013										
1	BMT	116V/5	KA01F-2019	1	Bannimantap Depot OUT Gate	09:15	14:32	05:17:45	HUMAYUNPASHA/2199	KEMPAIAH /1439
2	BMT	116V/5	KA01F-2019	1	City Bus Stand	09:27	14:42	05:15:38	HUMAYUNPASHA/2199	KEMPAIAH /1439
3	BMT	116V/5	KA01F-2019	2	City Bus Stand - PF 1	09:27	15:10	05:43:45	HUMAYUNPASHA/2199	KEMPAIAH /1439
4	BMT	116V/5	KA01F-2019	2	ESI Hospital	09:47	15:32	05:45:26	HUMAYUNPASHA/2199	KEMPAIAH /1439
5	BMT	116V/5	KA01F-2019	2	CITB Choultry	09:59	15:41	05:42:35	HUMAYUNPASHA/2199	KEMPAIAH /1439
6	BMT	116V/5	KA01F-2019	2	LnT	10:14	15:51	05:37:35	HUMAYUNPASHA/2199	KEMPAIAH /1439
7	BMT	116V/5	KA01F-2019	3	LnT	10:20	16:09	05:49:15	HUMAYUNPASHA/2199	KEMPAIAH /1439
8	BMT	116V/5	KA01F-2019	3	Mayura Circle	10:34	16:22	05:48:50	HUMAYUNPASHA/2199	KEMPAIAH /1439
9	BMT	116V/5	KA01F-2019	3	PK Sanitorium	10:46	16:33	05:47:20	HUMAYUNPASHA/2199	KEMPAIAH /1439
10	BMT	116V/5	KA01F-2019	3	City Bus Stand	11:06	16:50	05:44:30	HUMAYUNPASHA/2199	KEMPAIAH /1439

Figure 63 Mysore's Schedule Adherence Report (KSRTC 2013)

SCHEDULE Adherence Report

Raw GPS data from Bhubaneswar was used to graphically represent the assigned and observed schedule of a bus (see Figure 62). This representation clearly illustrates the planned bus schedules and deviations from it. For better scope of service improvements, the report can be developed for each driver. This will allow the transit manager to closely monitor and take action against drivers that deviate beyond a certain threshold.

CASE STUDY: Format and Use of Schedule Adherence Report in Mysore

In 2012, KSRTC implemented an ITS system named Mysore Intelligent Transport System (MITRA) with funding support from the Sustainable Urban Transport Project (SUTP). The system primarily consists of AVL and PIS solutions, similar to that of Indore, with additional functionality of assigning schedules to buses in real-time, as in case of Ahmedabad. A snapshot of the schedule adherence report can be seen in Figure 63.

KSRTC uses the AVL data to analyse the travel times at various times of the day and thus improve their operating schedules. Further, KSRTC also pilot-tested a planning software on a limited number of routes to create schedules taking into consideration the

overlapping segments between the routes, thus improving the level of service to the passengers.

HEADWAY Analysis

Using GPS data from all the buses on a particular route, a simple graphical representation of the arrival patterns of buses at a particular stop can be created to understand the reliability of the transit service. Figure 5.8 shows the variation in headway between buses at a particular stop. In a scenario where the planned headway is uniform all through the day (in the case of very few trips on the route), the reliability is best when the standard deviation is zero. The blue line indicating scheduled arrivals, also shows bus bunching occurring; like services 4 and 5 for instance, which arrived at the same time.

PASSENGER Demand Analysis

Most often, the only analysis that is undertaken with ETM data is the financial performance of the route in terms of earnings per kilometer. However, the ticketing data can be used for other analyses: to visualise the load patterns and the Origin-Destination relationships;

- To identify transit hubs where most passengers transfer from one bus to another; and

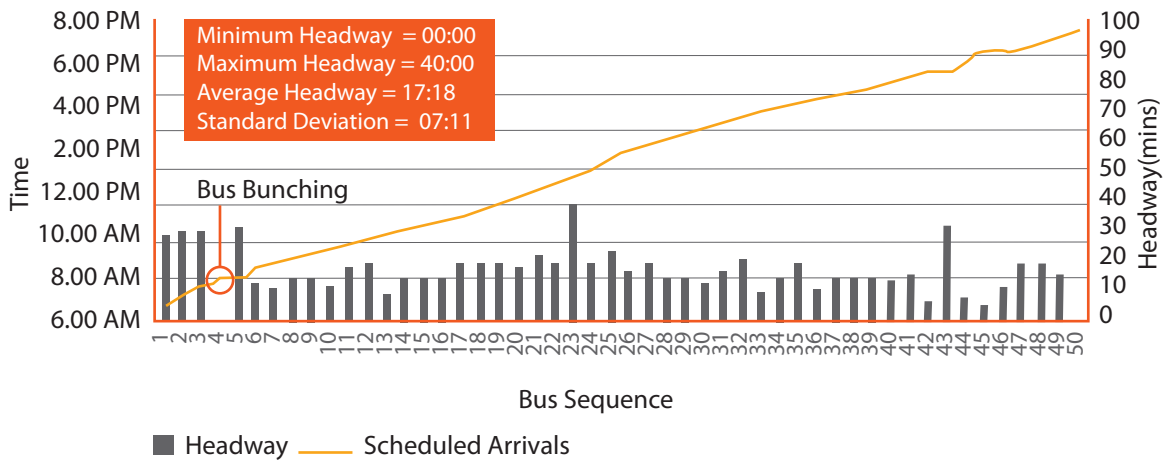


Figure 64 Bus Arrivals at Jaidev Vihar towards Nandankanan Route 207 (DTS 2014)

Representation of ETM Data

The city of Lucknow manages to use ETMs that transmit ticketing data to the control centre in real-time. However, there is no practical benefit for the passenger itself or the transit agency. One possible application for such a system is to transmit the passenger load in the bus to the bus stop PIS, so as to indicate to the waiting passengers what to expect when the bus arrives at the stop. Some visualisations of ETM data from various cities are shown in Figures 65 - 67. Figure 65 indicates the passenger load variation during different times of the day. This depiction is helpful in designing specific service plans and deploying additional buses, particularly for increased requirements during peak hour operations.

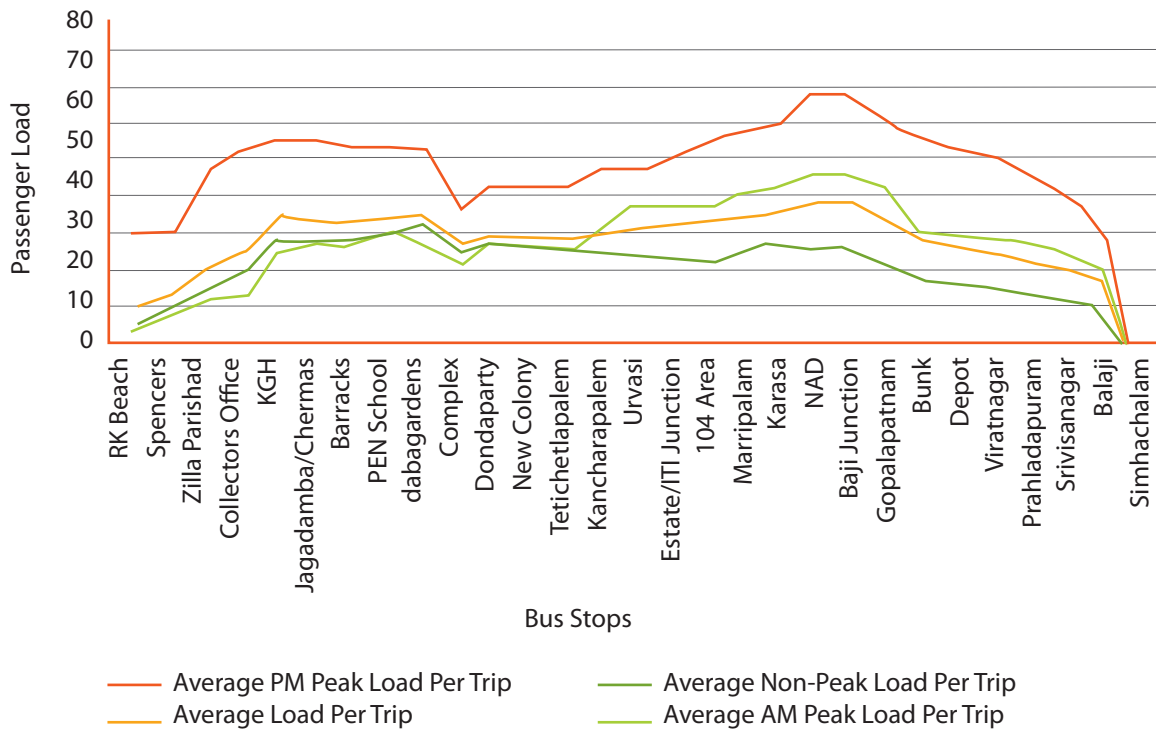


Figure 65 Route 28 Average Passenger Load – RK Beach to Simhachalam (DTS 2014)

- To plan for transport projects in a city, similar to a comprehensive mobility plan Representation of etm data

The city of Lucknow manages to use ETMs that transmit ticketing data to the control centre in real-time. However, there is no practical benefit for the passenger itself or the transit agency. One possible application for such a system is to transmit the passenger load in the bus to the bus stop PIS, so as

to indicate to the waiting passengers what to expect when the bus arrives at the stop. Some visualisations of ETM data from various cities are shown in Figures 65 - 67. Figure 65 indicates the passenger load variation during different times of the day. This depiction is helpful in designing specific service plans and deploying additional buses, particularly for increased requirements during peak hour operations.

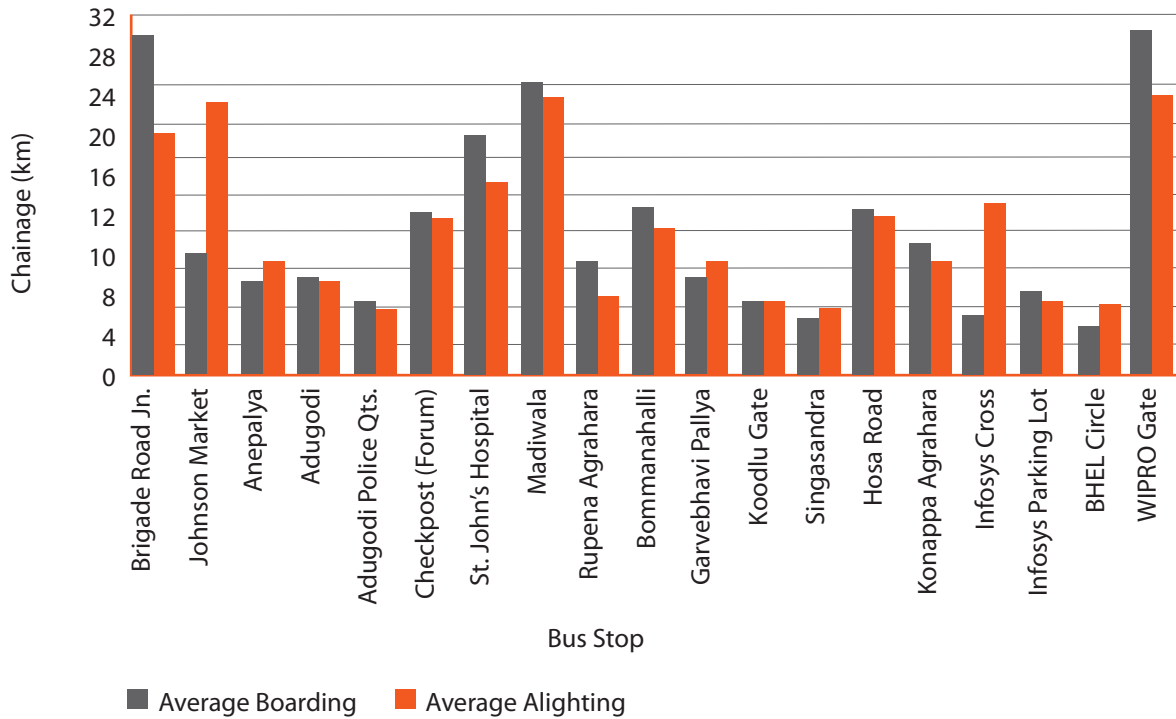


Figure 66 Boarding - Alighting Pattern on Route G2, Bangalore (BMTc 2014)

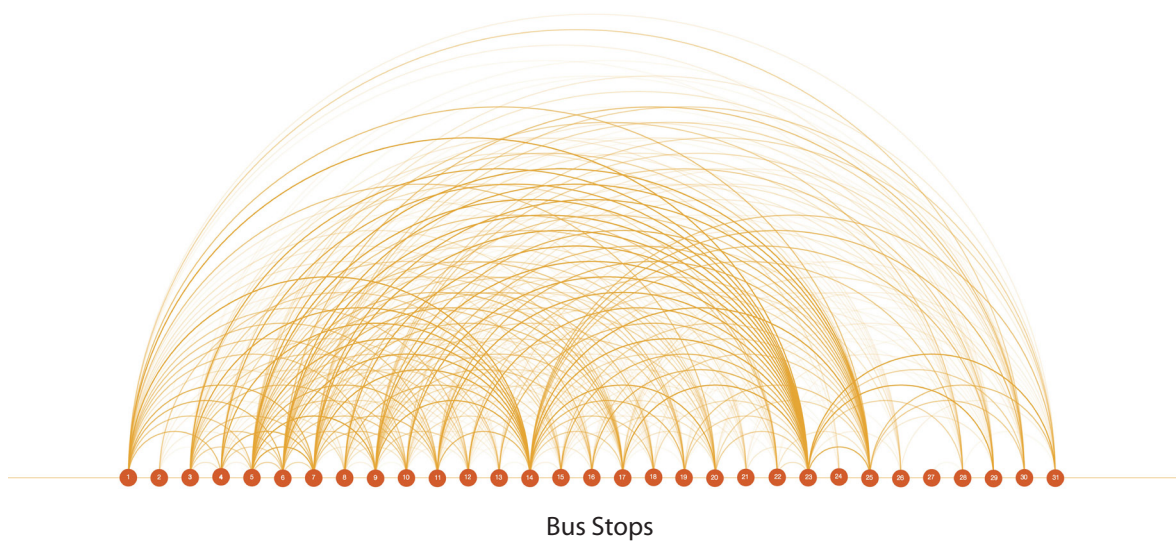


Figure 67 Origin-Destination Distribution (Data Source: DTS 2012)

Figure 66 depicts the passenger load for a specific route at different bus stops. This helps in identifying critical bus stops that serve as either major origin/destination points or transfer points for multi-modal integration. Figure 67 represents yet another way to illustrate origin-destination trends. This visualisation is effective in indicating new route patterns and the need for express or direct services.

Figure 13 Boarding - Alighting Pattern on Route G2, Bangalore (BMTC 2014)

Great benefits can be gained from the investments made for ITS procurement, by way of specifying the analysis needs in the tender documents and also by partnering with the vendors to help create solutions to deliver value to the system and ultimately to the passenger. At the same time, improvements

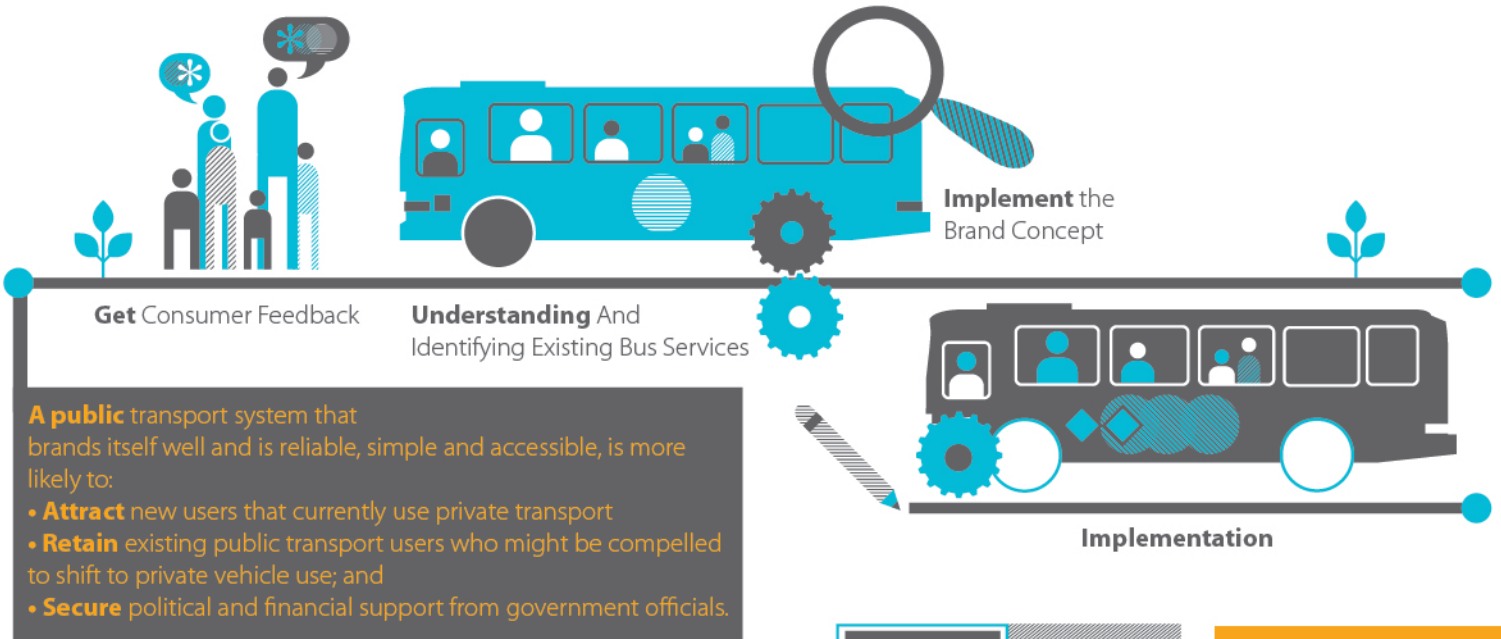
in technology such as CLOUD-computing, allow ITS solutions to be delivered as a service, rather than a product, and save on the capital costs of infrastructure. Vendors should explore such service-oriented options for ITS deployments that will reduce the investment costs for transit agencies. Furthermore, a greater focus on training to use the tools, collect and gather data and to make continuous improvements to ITS applications is critical.

CHAPTER SUMMARY:

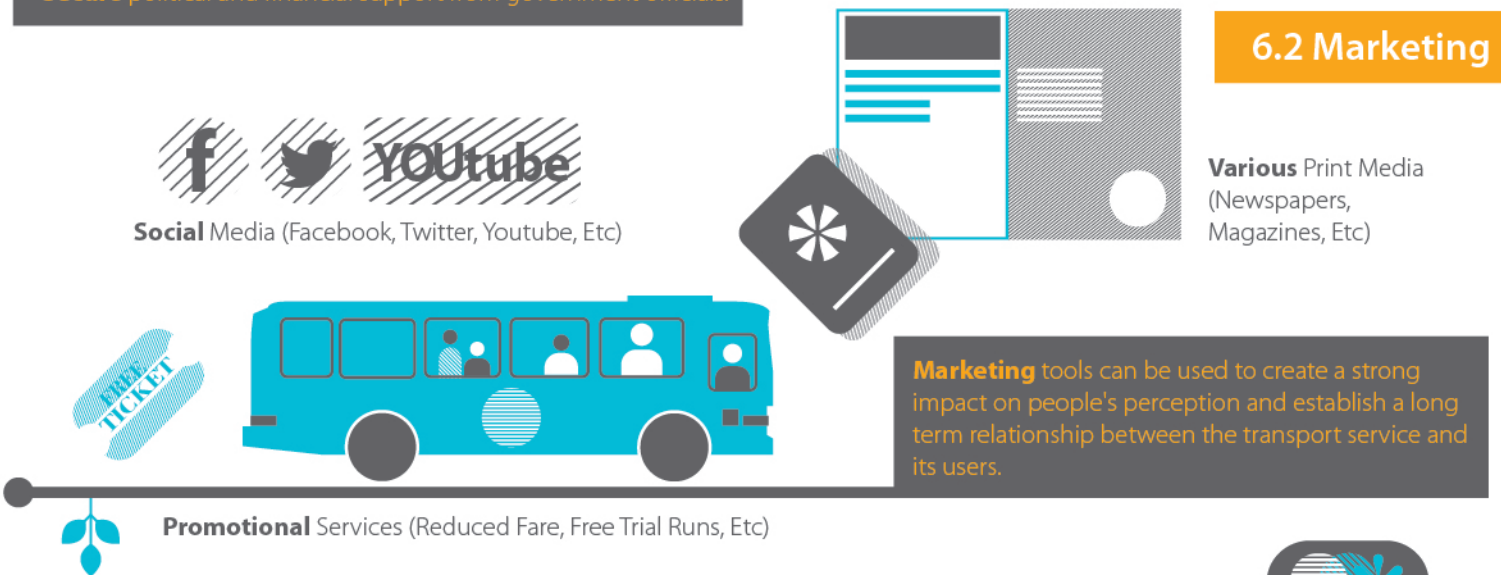
There are currently six ITS features largely used for data collection, ticketing, and communications. These features offer a significantly larger potential to analyse this data to determine mobility trends and inform key decisions in operations planning. This calls for more research and technical capacity to create analytic solutions to significantly enhance public transport operations.

6.1 Branding in Public Transport Operations

How To Brand Public Transport



6.2 Marketing



6.3 Communication

A robust communications plan can be effective and facilitate project delivery, stakeholder awareness and information and in the long run, ensure continued investment in public transport.



CHAPTER SIX

BRANDING, MARKETING, AND COMMUNICATIONS

Branding, marketing and communication are core components of an outreach strategy of a public transport agency. They serve as tools for drawing people’s attention, facilitating recognition of the transport system, providing information to users, and establishing public perception about the system. Branding helps in building the perception of the agency and the services offered among users. Marketing is the outreach strategy for an agency to connect with different customers to meet their needs. Communication should focus on delivering the message that can be easily understood (see Figure 68). These activities are important for a public transport agency because they:

- Reflect a service people will be happy to use; Market new services, innovations, changes, benefits of public transport, etc.;
- Communicate services clearly, so that people can use the system better; and
- Make information readily accessible, since the advancement of technology has led to people wanting their information upfront.

The use of branding, marketing, and publicising in public transport carries special significance in India. A large proportion of the automobile industry advertising is aimed at emerging economies like India, and the results are telling. In the past few decades, India has witnessed a twenty-fold increase in the number of on-road vehicles (Erik Weber 2011). An added problem is that private transport has an aspirational value for many Indians. Owning a personal vehicle is a status symbol and an indication of economic stability and social acceptability. In comparison, public transport, typically being erratic, infrequent, and overcrowded, carries the image as a service for the poor. With improvements of city bus services, there is a need to communicate a

strong, meaningful message in order to facilitate a shift in mind set of people, to establish long-term user satisfaction, and environmental and social sustainability.

With the modernization of city bus services and the arrival of new systems such as the Bus Rapid Transit (BRT) in India, there is an increasing need for proper public communication. Branding and communicating information on way-finding and orienting users to new systems is critical to the success of public transport.

Using the examples of the initiatives taken in Indore and Bhopal, this chapter discusses the importance of branding, marketing and communication techniques for public transport systems to expedite service improvement and growth in ridership.

6.1 Branding in Public Transport Operations

Branding is an essential component of city bus service modernization. However, most city bus services in India do not meet quality standards. Hence, branding in the Indian context must be accompanied with improvements in passenger safety and comfort and reliability of bus services. Creating a brand of high-visibility, efficient and reliable bus services can serve to improve the reputation of bus services in the eyes of potential commuters. A clear brand with an attractive message – one that testifies to the advantages of the bus service – will help riders connect with the brand and system (see Figure 69).

A public transport system that brands itself well and is reliable, simple and accessible is more likely to:



Figure 68 The purpose of branding, marketing and communications in the Public Transport sector (EMBARQ India 2014)



Figure 69 LA’s Metro Orange Line includes both a metro and a BRT corridor. Its colour scheme is highly visible, making it clear to users that they are parts of the same network. (STV 2013) (Richard 2009)

- Attract New Users That Currently Use Private Transport;
- Retain Existing Public Transport Users Who Might Be Compelled To Shift To Private Vehicle Use; and
- Secure Political And Financial Support From Government Officials (Erik Weber 2011).

Branding for public transport entails a simple three-step process - getting feedback about the existing system, identifying which part of the system to brand, and implementing the brand.

Branding is also useful in that it can simplify the travel experience. Apart from capturing the attention of thousands of potential users, a strong, visual brand provides legible commuter information, especially to new users. Branding can be of an overall public transport system in a city perceived as an efficient service, serving the needs of the people and the city’s mobility. Branding can also be done for specific components of a system, to help users understand the system easily, resulting in a positive

impact on how people use the system. For example, BRT corridors can be branded to ensure that the system is perceived as a high quality efficient bus network and not just as separate buses.

Branding for public transport entails a simple three-step process: getting feedback, identifying the aspects to brand and implementing the brand.



Figure 70 Identifying how the user perceives the service is an important step for public transport branding (Nanni 2012)

GETTING Feedback about the Existing Public Transport System

Prior to undertaking a branding exercise, it is essential to understand the user perception of the existing service (see Figure 70). This pertains to user satisfaction with service quality, routing, speed, accessibility, fares, etc. The branding can then be targeted towards changing this perception. This data provides information on specific areas that have a negative perception, and can be used to direct branding existing services.

Many transport operators obtain feedback by conducting passenger surveys to understand the level of satisfaction. More recently, operators around

the world have also been obtaining feedback through the use of social media, with platforms like Facebook and Twitter.

IDENTIFYING Aspects of the System to Brand

After obtaining user feedback of the existing network, a transport agency needs to identify the aspects of its system that need to be rebranded. In small cities, it may be feasible to rebrand the entire bus network or public transport system. In larger cities, however, rebranding large bus fleets can be expensive and complicated. For example, if public perception is that the city bus system is slow and inefficient, rebranding the entire system might not work unless there are immediate, tangible changes associated with service quality. In such a case, introducing a new, efficient service – such as BRTS or a high-quality AC service – with visible branding, can be more effective. Once the service creates a positive perception amongst the public, the brand can be extended to other services.

IMPLEMENTING the Brand

The next step is to implement the brand and improve user perceptions. In large cities, with several bus routes and corridors, using branding strategies to differentiate between service types and corridors can simplify the user experience. For example, branding through colour-coding or numbering buses can enable the user to differentiate between bus routes on different corridors. However, it is important to ensure that the various brands, though discrete, are identifiable as part of the same system.

This lets users know where to switch buses or services. Brands should be coherent, and care should be taken to avoid creating too many confusing brands.

CASE STUDY: Branding the BIG Bus Network, Bangalore

BMTC has been a pioneer in operating differentiated services in India. Prior to the previous decade, the agency did not concentrate on creating differentiated services. Initially, it offered two types of services – the ‘black board’ and ‘red board’ buses. There was no qualitative difference between the two – both were ordinary, non-AC buses – except that the black board buses served within city limits and the red board services connected villages on Bangalore’s periphery.

BMTC used branding as a tool to achieve effective marketing of the differentiated services, targeting different sections of society to meet specific travel needs. The Pushpak Services were the deluxe, non-AC services that charged a marginally higher fare. The Vajra Services were red, AC Volvo buses that charged a premium fare and are fairly successful in drawing the more affluent commuters and the working Information Technology (IT) crowd, away from private transport. Following the launch of these services, BMTC attempted to launch three additional services – the Suvarna deluxe services; low-cost, AC Suvarna Services; and discounted Atal Sarige Services.

It later simplified all non-AC services (except the Atal Sarige service) into a single-fare structure. Continuing the branding effort, BMTC is using



Figure 71 The four elements of the proposed BIG Bus Network (BMTC 2014)

NAMING the IBus

To choose a name for the Indore BRTS system, the Atal Indore City Transport Services Ltd. (AICTSL) held a public competition in 2011 (AICTSL 2014). The aim of this competition was to promote ownership of the system by the residents of Indore, and create a name that was accepted by the public. The name was selected as iBus in the English language while the tagline was selected as, SatatVikas Atal Vishwas in Hindi, meaning 'continuous progress, constant trust' (see Figure 72). While the 'i' denoted Indore, it also represented intelligence and innovation for a system that was easy-to-use and new for Indore residents.



Figure 72 Strong use of Branding (AICTSL 2014)

branding effectively as a complement to the implementation of the BIG Bus System reforms. BMTC's attempt at creating a distinct 'brand' of bus service and a direction-oriented system was the introduction of BIG10 and the K-Series routes in 2009 (BMTC 2014). These services were a great success, both financially and in terms of customer satisfaction. Presently, BMTC is creating a brand of bus services with the BIG Grid with the following components (see Figure 71):

- BIG Trunk routes will provide high-frequency services on Bangalore's 12 major arterial roads;
- Big Circle routes will provide high-frequency services along the city's Outer Ring Road (ORR);

- Big City routes will provide high-frequency services along high-density and high-demand corridors in the city centre; and

- BIG Connect routes will provide high-frequency services between arterial roads beyond the ORR.

This builds upon the previous BIG10 system and thus benefits from the initial, positive association commuters have with direction-oriented services. A unified, though not identical livery scheme, enables the user to identify that the services are part of the same system.

SECTION SUMMARY:

Branding for Public Transport

Branding is used to create better visibility of public transport and its components. The aim of branding is to help users understand and connect with the service. This process entails a simple three-step process: getting feedback, identifying the aspects to brand and implementing the brand.

6.2 Marketing Public Transport

Once a distinct identity is formed, the next step is to design an outreach strategy to market the brand. The aim of marketing is to create a strong impact on people's perception and establish a long-term relationship between the transport service and its users. An effective strategy begins by studying the needs of the market and creating a strategy according to the needs of the users and potential users. Once ridership is established, customer feedback provides direction for service improvements. Customer satisfaction eventually leads to loyalty, in turn increasing revenue for the agency (see Figure 73). Marketing is most powerful when the claims are backed by actual service quality.

Several Indian cities, including Bhopal, Indore and Ahmedabad, have utilized similar strategies to spread awareness and create public support for their BRTS services. The Indore and Bhopal BRTS teams designed strategies appropriate to their potential user base and achieved success through their own approach. This next section outlines the various marketing tools adopted by these cities.

CASE STUDY: Marketing the Indore BRTS

The Indore BRT system was a new state venture

and marketing this transport mode was all the more critical to its success (AICTSL 2014). It was expected that the public would be apprehensive at first; hence, a rigorous and engaging strategy was required. The project team adopted three strategic focus points: engaging the press, spreading the word through social media, and promoting the BRTS experience through free trial runs.

The aim of marketing is to create a strong impact on people's perception and establish a long-term relationship between the transport service and its users.

ENGAGING THE PRESS

Engaging the press was focused on addressing negative misconceptions about the project, specifically the inconvenience caused to the people due to significant project delays. It was decided that the media needed to be provided with information on the vision of a fully developed and integrated BRT system. The intention was to ensure that the media had access to accurate information about the project and its implementation. To this end, a focus group

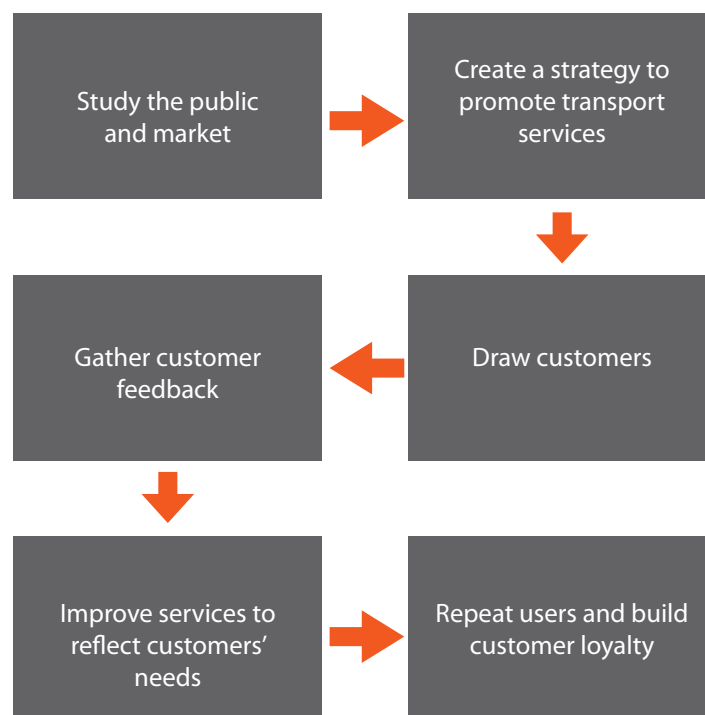


Figure 73 Approach to Marketing Public Transport Modified from (The Marketing Institute 2013)



Figure 74 Highly interactive sessions were aimed to address negative perceptions (AICTSL 2014)

seminar led by an international BRTS expert was held with senior journalists of various media houses (see Figure 74). The expert drew on his experience from other cities facing challenges similar to Indore's and reinforced the strength of the project.

In April 2013, around 30 journalists were taken on a study tour of the Janmarg BRT system in Ahmedabad, a project that had received wide recognition for its success. Participants were able to experience and learn about a full BRTS that carried over 140,000 riders and is set in a context similar to that of Indore. The tour enabled the media team to better visualise the Indore plan.

SPREADING THE WORD THROUGH SOCIAL MEDIA

Since the location of the BRTS corridor was adjacent to numerous schools and education institutes, a vital part of the marketing strategy involved targeting the student and young adult demographic. In March 2013, the team created an iBus page on Facebook (see Figure 75). Once the page was functional, it proved to be popular even among the general public, with almost 936 likes to the page today. The page provides service and construction updates to the general public. It also enables two-way

communication between the iBus team and the public to receive feedback as well as post comments, complaints and suggestions.

During public engagement activities such as focus groups and passenger trials, participants often requested to have their photos tagged online. As the number of followers increased, the media began to pay attention to the page, often referring to it for project information, updates and photographs.

PROMOTING THE BRTS EXPERIENCE THROUGH FREE TRIAL RUNS

Passenger trials of the BRTS service began on the 10th of May 2013 (see Figure 76). The free trial rides were a strategic decision aimed to attract as much of the public as possible, to experience and understand the system. This strategy was also used to boost ridership in the initial days. The uncharged trial runs continued for three weeks, during which system patronage increased significantly, reinstating positivity among the public.



Figure 75 The Facebook page reaches 810 likes and carries a wealth of project information (AICTSL 2014)



Figure 76 Post-launch reactions from citizens (AICTSL 2014)

The satisfaction expressed by those who experienced the system led to a highly positive reaction from the press. This resulted in stalling any possibility of the court taking adverse decisions on the project. The free trial period also proved to be a key strategy in allaying misconceptions about the functioning, comfort and safety of the iBus commute. Initially, AICTSL had decided to continue free trial runs for 2-3 months. However, the overwhelming response from the commuters necessitated the introduction of fares to control overcrowding in buses. Therefore, on the 12th of June 2013, ticketed operations commenced. Although this resulted in an immediate drop in ridership at first, it began to steadily increase. Marketing and building a connection between the system and its customers played a significant role in creating a success out of the iBus story. Following the strategy adopted by the project team, the

Indore system was entrusted with land for corridor development worth around INR 270 crores under the Transfer Development of Rights (TDR) scheme.

CASE STUDY: Marketing MyBus, Bhopal

The strategy adopted by the MyBus project was focused on bringing visibility to the system and creating the identity of a superior transport mode (BCLL 2014). To this aim, the marketing plan was bold, attractive and impactful to the user. The project outreach exhibited high quality imagery as a way to attract public attention and display key messages (see Figure 77).



Figure 77 The marketing utilized bold signage to attract public attention to the BRTS (BCLL 2014)

USING STRONG IMAGERY

The Bhopal BRTS project defined a new paradigm by introducing high quality aerial photographs and video shots of the corridor and stations. The innovation behind this was a never-before-seen and unmatched strategy for public transport projects in the state of Madhya Pradesh (see Figure 78). (BCLL) employed a helicopter and a highly-skilled photography crew to photograph and film high-definition shots of the project. The view from a high altitude sent out a powerful message, portraying the corridor against the urban backdrop of the city of Bhopal. These were used in promotional and informative materials such as leaflets, videos and newsletters. They were also shared with the local print media, who used them in news articles, which had an even wider geographical reach.

Although this exercise was of high cost for the project, it was highly successful in instilling a great sense of pride and ownership among the public. Through numerous news and social media articles, these photographs were able to significantly change the way people perceived the BRTS project prior to its launch.

MARKETING THROUGH PERSONNEL

Another key marketing strategy utilized by the MyBus team was focused on the image portrayed

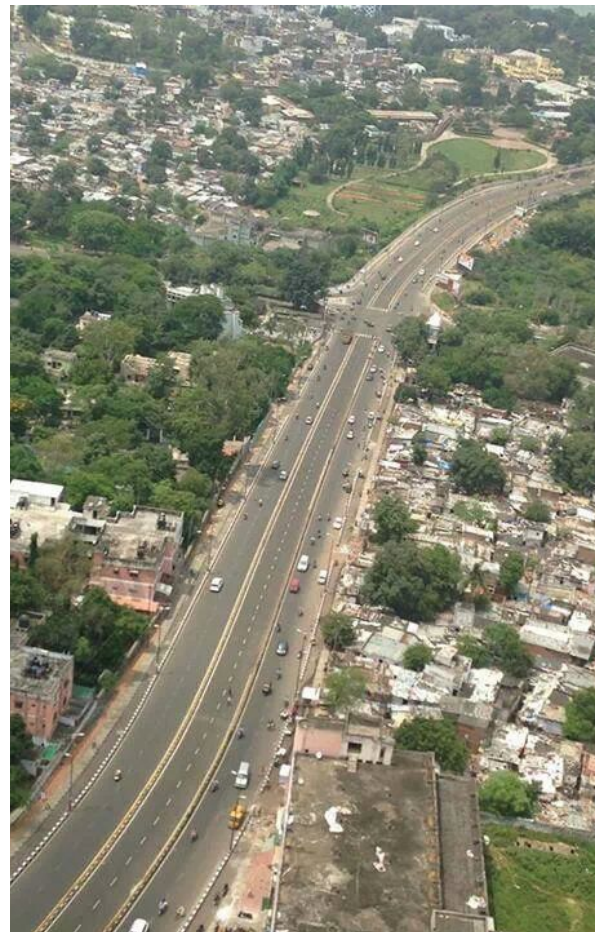


Figure 78 The MyBus marketing team used high-quality imagery to send out key messages (BCLL 2014)



Figure 79 The BRTS Police vehicle brought additional visibility to the project (BCLL 2014)

by the staff. Personnel including drivers, ticket inspectors, vendors, policemen, etc. are the primary point of contact for customers. From customer service to providing information post-launch, the frontline personnel become an important factor in establishing project image.

In Bhopal, this marketing tool was implemented differently. The police department established a special task force to manage encroachment and enforce parking along the BRTS corridor (see Figure 79). While operational improvements brought great visibility to the system, the involvement of the police also attracted public and media attention.

SECTION SUMMARY: Marketing for Public Transport

The objective of marketing public transport is to create an outreach strategy to significantly impact people's perception and establish a relationship. Marketing is most powerful when it is backed by actual service quality. Effective marketing techniques adopted in public transport include press engagement and the use of social media. In the case of the iBus and MyBus projects, the team implemented never-before, crucial strategies to market the BRTS.

6.3 Communications for Public Transport

The previous section discussed the marketing strategies that can be used to garner public support and create awareness of the project. While marketing aims to enhance the outreach efforts of a project through focused strategies, a communication plan develops the content and tailors it toward targeted audiences. In practice, the line between marketing and communications is skewed, with both activities occurring simultaneously for maximum effectiveness.

Public agencies need a robust and effective structure for their communications and customer engagement plan. This facilitates project delivery, keeps stakeholders and customers informed, and in the long run, ensures continued investment in public transport. Additionally, all stakeholders have the right to scrutinise the public transport system. Hence, communications is most effective through close collaboration between the transport agency and its users (Transport for London 2010).

Table 17 lists the different communication modes that can be used to achieve multiple objectives.

The following case studies discuss the different

ways Indore and Bhopal used to communicate with the people. The workshops, trial runs, and public meetings were catered specifically to disseminate information to the stakeholders and the public as well as to receive feedback from them. Each of these modes of communication focused on the delivery of a message to the public.

CASE STUDY: Indore BRTS

At an early stage, the Indore BRTS team understood that the success of the project could be significantly multiplied through educational and community outreach (AICTSL 2014). The need was to anticipate demand, improve services, attract ridership and address the negative perceptions of the public and the press. To address these aims, the plan was to engage, inform and involve the public at various points. Three approaches were adopted to satisfy their objectives: informative public workshops, impactful outreach materials and a phased system launch.

PUBLIC MEETINGS AND WORKSHOPS

During the initial stages of construction, there was a lack of public awareness about the project details. AICTSL held a public workshop in June 2012, and the general reaction among attendees ranged from

MODE OF COMMUNICATION	USES
Newsletters / Pamphlets	Periodic updates of events, needs, successes and plans Create awareness Engage the community
Public Forums / Seminars / Workshops	Engage stakeholders and focus groups Address questions and doubts
Study Tours	Provide information Develop relationships with the media
Interactions with the Media	Increase project visibility Address criticism
Online Channels (websites, Facebook, email, etc.)	Two-way communication between users and agency Receive User Feedback Collect data
Trial Runs	Experience the system Initial feedback

Table 17 Modes of communication for different uses (EMBARQ India 2014)

strong opposition to enthusiastic support. Without much public engagement, numerous delays in the construction process had set a negative tone for press reports, resulting in poor public opinion. This gradually led to negative perceptions among the political and administrative leadership of Indore. The reactions indicated the need for additional outreach to educate the public.

It became apparent that concerted efforts in communicating project updates to the public, media and administration teams are a critical aspect for project success. Better understanding among potential users would also help boost ridership, justifying the need for higher service frequency and route expansion in the future.

Various types of outreach materials were also utilized to communicate information and create project familiarity among residents. The communications team developed content using various mediums such as informative pamphlets and videos (see

Public agencies need a robust and effective structure for their communications and customer engagement plan. This facilitates project delivery, keeps stakeholders and customers informed, and in the long run, ensures continued investment in public transport.

Figure 80). To avoid any misconceptions that the project would take road space from personal vehicle users, graphics illustrating before and after versions of the corridor highlighted the improvement brought about by the BRTS. This focused on pedestrian walkways and cycle tracks along the AB Road corridor, which benefits all types of road users. A comprehensive video was also produced and used to convey key information about the project. The



Figure 80 A variety of pamphlets were used to communicate information to the public (AICTSL 2014)



Figure 81 Specialized Focus Groups are intensive sessions targeting different groups of people (AICTSL 2014)

video included an animated rendering of the iBus in action and was played on regional bus services, local cable channels, during focus group sessions and at other public presentations.

LAUNCH PUBLICITY

During the execution phase, the project faced several delays, and the enthusiasm among Indore's residents gradually fell despite efforts to increase awareness and communicate with the people. A phase-wise system launch helped reinstate public interest and create the impact required. The system was launched in distinct phases, each with its own outreach strategy.

Dry Runs: On April 19th 2013, dry runs without passengers began along the corridor. The primary purpose of these was to identify and mitigate any operational issues and ensure smooth running throughout the corridor. The dry runs indicated to the public that it was possible to run buses along the median and across intersections.

Reach out to Specialised Focus Groups: In the first week of May 2013, various community groups participated in three days of focus group sessions (see Figure 81). These intensive sessions reached out to more than 850 people, including students, professionals and communities. These meets were two-way communicative sessions that entailed informational presentations, rides on the iBus and question-answer sessions with the team members. As the project advanced towards launch time, the sessions proved to be effective, resulting in positive developments. They allowed the opportunity to further educate and correct misconceptions among the public. The residents had the opportunity to experience the BRTS first-hand and understand how it functions and benefits their community.

A group of prominent lawyers from Indore was invited in an effort to counteract the negativity from lawsuits surrounding the project. In addition to this, comments and suggestions that were received became an excellent learning opportunity for the team. The press was a part of these focus groups, and they reported on the positive interactions at these sessions, bringing good visibility to the project.

CASE STUDY: Communication Strategy for Bhopal BRTS

The communication for MyBus focused on maximizing awareness across the city (BCLL 2014). The strategy involved an awareness-raising workshop, periodic newsletters and constant media interaction to reach out to a large portion of the public.

AWARENESS-RAISING WORKSHOP

Prior to launching the system, BCLL organised a workshop to raise awareness and substantiate the positive impacts and benefits of the project. Several prominent citizens of the city, public representatives, officials from city and state departments and urban transport experts from within and outside the country, were invited to the launch (see Figure 82).

The city mayor's presence helped build confidence that once operational, the city would benefit from the project, and traffic would effectively be addressed. Two highly renowned urban transport and BRTS experts were also invited to present at the workshop. They shared experiences from other cities in India and around the world, where BRT systems are functional. Numerous national and international examples were used to explain how



Figure 82 The awareness-raising workshop in Bhopal (BCLL 2014)

the project would be advantageous for Bhopal and its sustainable growth.

The workshop was well attended and was covered extensively by the local media, both print and television. This helped considerably in keeping the general public informed about the development of the project and also reassured them.

QUARTERLY NEWSLETTERS

A third type of outreach method used in communicating information was the newsletter, which served to increase awareness, educate the public and establish credibility of the project. As part of the MyBus project, a four-page newsletter was published by the BCLL (see Figure 83).

This contained narratives, articles on technical aspects, messages from eminent city politicians, comments and inputs from the general public and numerous images and graphics. This medium was used to provide the public with large amounts of information on a periodic basis.

The newsletter gained immense popularity through an innovative feature – a free pass that entitled any reader to a single BRTS journey of any length by answering two simple questions (see Figure 84). The answers to the questions are found easily within the various newsletter articles, thus encouraging readers to read the articles in order to claim the prize. While this is a good tool to create excitement among readers, it also ensures that the key aspects of the project are communicated and understood by readers. The newsletter had a significant impact in reaching out to the general public of Bhopal and created a fundamental identity for the system among the people.

BCLL's post-launch efforts created further awareness through various direct and indirect channels (see



Figure 83 The quarterly newsletter brings constant project updates to the public (BCLL 2014)



Figure 84 A free MyBus pass (BCLL 2014)

बदल गई तस्वीर... संकरी सड़कों की जगह अब चमचमाता कॉरिडोर



Figure 85 Comparative images of before and after the project implementation sent a strong message to the public (BCLL 2014)

Figure 85). The agency constantly participates in press conferences to apprise the media about latest developments, passenger experiences, emerging technologies, etc. These short discussions are helpful in sustaining positive and continuous media coverage for the project. In the case of Bhopal, this is one of the key factors that shaped public perception and served as a powerful tool to reach out to the masses.

CASE STUDY: Branding, Marketing and Communication Strategies for Janmarg, Ahmedabad

In order to publicize and reach out to their stakeholders and users, the Janmarg team undertook a six-fold marketing and communication strategy. Examples of these strategies are shown in Figure 86, Figure 87, and Figure 88 (Manish 2014) (Lokre 2014). The strategy included the following components:

- Creating an identity
- Circulating critical information
- Learning from international visits

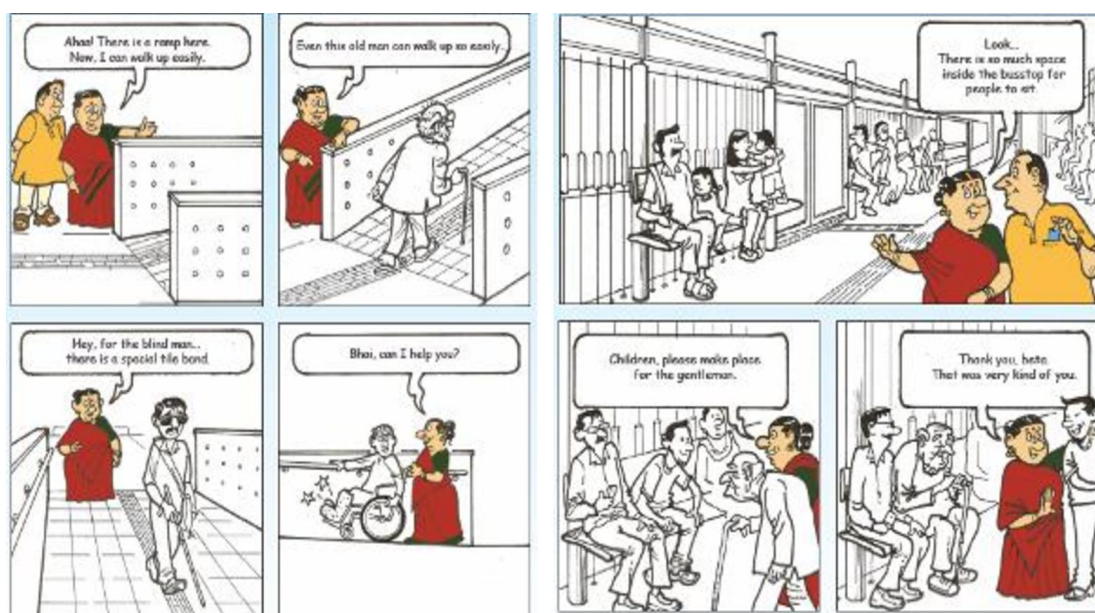


Figure 86 Easy and fun-to-read booklets were designed to attract various types of readers (Lokre 2014)

- Conducting workshops, seminars
- Meetings, incorporating prototypes
- Conducting trial runs, and working with the media

LEARNING FROM INTERNATIONAL VISITS

Delegates from the municipal corporation, the Standing Committee, members of the planning and designing teams, and municipal councillors visited several BRTS cities such as Bogota, Seoul and London. The aim of these visits was to understand the meaning of high-quality infrastructure and use the lessons learned in the Janmarg system.

INCORPORATING PROTOTYPES AND TRIAL RUNS

A prototype station was built at the Gujarat Mineral Development Corporation (GMDC) stop. This allowed the public and other stakeholders to inspect the planning and designing aspects of the system and the project team to gain useful feedback. Users were also able to study and understand the many ITS components of the project, such as automatic door

synchronisation and public information systems.

Trial runs were undertaken for three months prior to project launch and entailed free rides, practice bus manoeuvring, docking at stations and testing physical aspects of the system. The operational aspects were upgraded after receiving feedback. As an added publicity strategy, the chief minister was invited to test the system, allowing the public to interact and discuss their perceptions.



Figure 87 Exhibitions were significant in providing information to the public.(Lokre 2014)



Figure 88 Prototype stations were built and open to the public prior to the system's launch (Lokre 2014)



Figure 89: Prioritize information on the signage(Transport for London 2010)

Figure 90: Use symbols and pictograms where possible (Transit Research Board 1996)

Figure 91: Indicate information spatially (Sound Transit 2004)

Improving Public Transport Accessibility through Wayfinding and Signage

It is critical to design information systems that provide precise information, at the right time and at the required location. Wayfinding is a process by which a user interacts through visual clues and non-verbal communication with the environment. This interaction makes it easier for the user to navigate across the transport system, from finding the bus station, to selecting a specific mode, to boarding the right bus. By identifying the paths of travel and the design points at a facility, agencies can provide a more user-friendly environment.

Clear visual communication, precise graphic design and the way it influences the user response, form the basis for designing an effective information display system. The most complex information display system can be implemented through nine principles (see Figure 92).

<p>MAINTAIN HIERARCHY IN THE ORDER OF THE INFORMATION DISPLAYED</p>	<ul style="list-style-type: none"> • Ideal signage provides multiple pieces of information in a proper sequence • For clear readability, information should be categorised from top to bottom
<p>SIMPLIFY THE SHAPE OF THE SIGNAGE</p>	<ul style="list-style-type: none"> • A simple shape can be easy to recognise
<p>USE SYMBOLS AND PICTOGRAMS</p>	<ul style="list-style-type: none"> • Pictorial symbols can communicate quick and effectively • Correct symbols that are universally understood should be used
<p>ALWAYS INDICATE INFORMATION SPATIALLY</p>	<ul style="list-style-type: none"> • Route maps are a good way to indicate location and access • Indicate places of modal transfers, high-frequency lines, etc.
<p>SELECT APPROPRIATE FONTS AND CHARACTER DIMENSIONS</p>	<ul style="list-style-type: none"> • Fonts should be clear and easy to read • Text sizes should be visible from a range of distances
<p>SELECT AN APPROPRIATE COLOUR PALETTE</p>	<ul style="list-style-type: none"> • A colour scheme for all components should be carefully selected to improve contrast and legibility
<p>PLACE SIGNAGE FOR MAXIMUM VISIBILITY</p>	<ul style="list-style-type: none"> • Signages must be placed at a comfortable and convenient viewing distance • Consider visibility from the waiting area and from the moving mode of transport
<p>INTEGRATE SIGNAGES WITH BETTER WALKABILITY</p>	<ul style="list-style-type: none"> • Signage is a powerful tool promote non-motorized transport within the surrounding area of a transport facility
<p>CHOOSE AN APPROPRIATE FORM OF SIGNAGE</p>	<ul style="list-style-type: none"> • The form of the signage depends on the function • To represent critical information, larger boards / kiosks should be used

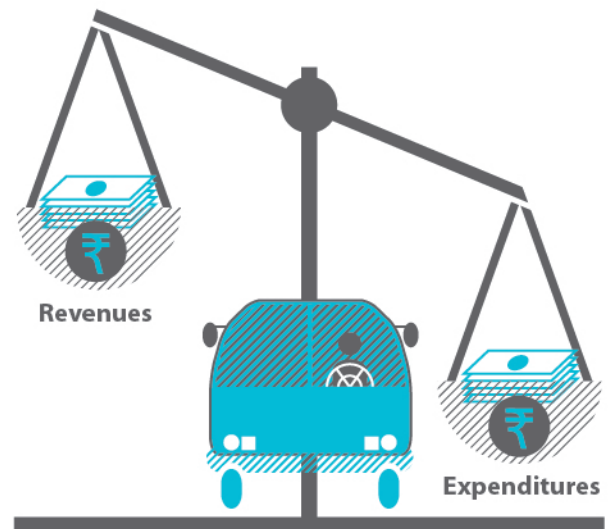
Figure 92 The 9 principles of wayfinding (Adopted from: (Sound Transit 2004)(Transit Research Board 1996)(Transport for London 2010))

CHAPTER SUMMARY:

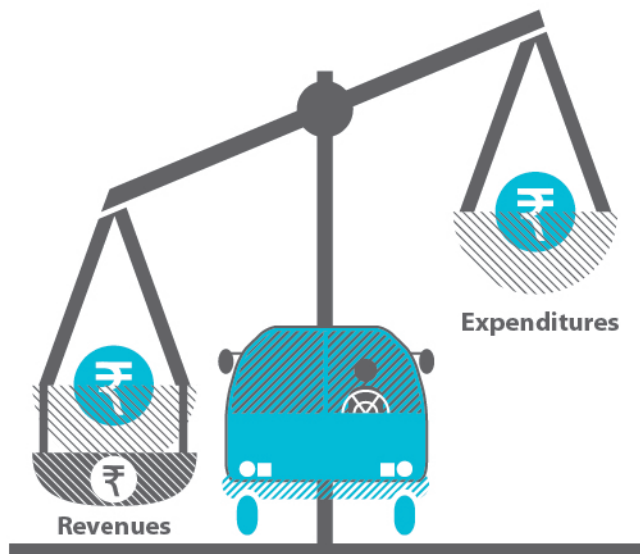
Amidst the growing importance of private vehicles, there is a need to boost the image of public transport use. Branding, marketing and communications play a significant part in enhancing the image and establishing a positive perception towards public transport. Cities including Indore and Bhopal used effective outreach efforts to create and market a strong brand and implement a robust communications plan to build awareness and visibility around BRT services.

7.1 Cost And Revenues: Understanding Bus Operations

Revenue streams such as the JnNURM scheme, provide much-needed funding for operating agencies. However, it is important that the significant operations and maintenance costs also be accounted for.



7.2 Fare Setting



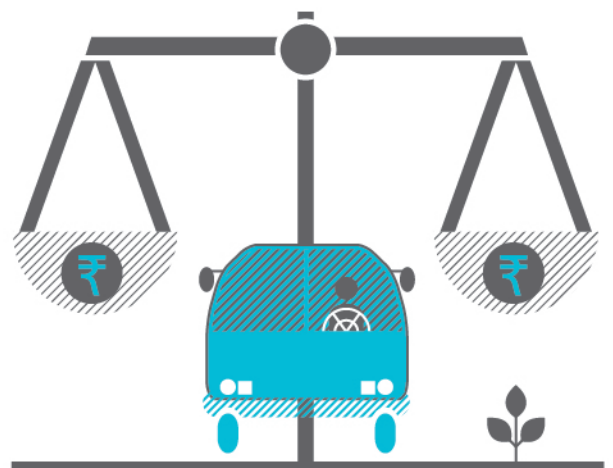
Farebox revenues are the primary source of revenue for an operating agency; hence fare setting becomes a critical process. The aim of price policy is find the right balance between the user's needs for the affordable public service and the commercial perspective of the agency, while pursuing the transport authority's social objectives. A scientific approach to setting fares can ensure better financial sustainability of the operating agency.



Significant Increases in Fares Makes Users Unhappy

7.3 Alternate Ways To Finance Public Transport

As urban areas expand, an effective finance strategy is to explore alternate revenue streams. For example, the Traffic and Transport Management Centres in Bangalore were a mechanism to leverage land holdings and to solve two challenges: to provide infrastructure for bus services and to generate non-fare revenues.



CHAPTER SEVEN

FINANCING PUBLIC TRANSPORT

Public transport faces a paradox: while its vital role in urban mobility and sustainable development is recognized, the financial resources allocated to its maintenance and development are scarce. Today, ensuring proper financing mechanisms is vital not only for the development of public transport networks, but also for the sustainable development of cities and urban areas (Zadra-Veil 2010).

Public transport agencies the world-over, face financial challenges due to the imbalance between costs and revenues. Many agencies find that fare box revenues do not cover all the costs. In many cities, either subsidies or alternate revenue sources are used. In India, the subsidies for public transport agencies are rare or ad-hoc, so developing alternative revenue sources is even more important.

The bus is the principal public transport mode available to commuters in the majority of Indian cities, especially Tier I and II cities. The JnNURM central government funding schemes have been successful in providing buses for public transport operations. However, inputs from major bus operating agencies indicate that the cost of procuring buses constitutes less than one-fourth the overall operational costs. Once buses are procured, there remains a gap of funding for approximately three-fourth of the remaining operational costs of an agency. A critical need exists to understand this financial load and to manage revenue inflows to provide for it.

The first section of this chapter establishes the typical inflow and outflow of funds for a public transport agency. Case studies from this section discuss the disproportionality between the operational costs and revenues. The latter sections explore the farebox and non-farebox revenues sources and the innovations in financing in public transport that are proving successful in establishing the financial longevity of agencies. Figure 93 depicts

the structure of the chapter.

7.1 Costs And Revenues: Understanding Bus Operations

Transport costs are a monetary measure of what the public transport agency incurs for providing transportation services. In order to promote public transport use in Indian cities, it is often typical for agencies to maintain low fares, in spite of fare subsidies being provided to several groups. This means that people who can afford higher fares, pay very low fares for poor quality service. This results in a vicious circle, where people switch to private modes, forcing the agency to reduce fares to attract more users. This section focuses on the existence of an imbalance between major operating costs for a bus transport agency and the farebox and non-farebox revenues.

TYPES of Costs

Transport costs come as fixed (infrastructure) and variable (operating) costs. They depend on a variety of conditions related to geography, infrastructure, administrative barriers, energy, and on how passengers and freight are carried. A wide variety of transport costs can be considered, but public transport operations largely distinguishes cost in two categories:

1. CAPITAL AND OPERATION & MAINTENANCE COST

Capital funding in public transit pertains primarily to the costs of buses. This only entails procurement of the vehicle, while costs depend on the type of vehicle to be procured. For bus operators, obtaining capital funding is conveniently available through

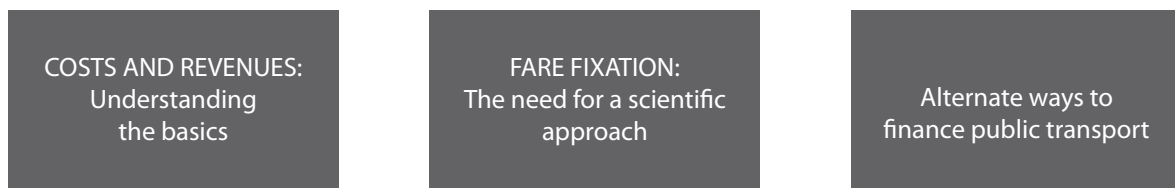


Figure 93 Chapter Structure

Public transport agencies face an imbalance between major operating costs and revenues brought in through farebox and non-farebox methods.

programmes like the JnNURM scheme. Additionally, capital costs can also include infrastructure such as depots and stations. Government funding is also available for ancillary infrastructure.

Operation and maintenance (O&M) cost are related to the (annual) maintenance and operation expenditure on the infrastructure or assets. Some operating costs vary with traffic volumes, but other factors, such as weather conditions, geographical settings, and topographical features, also play an important role.

EXAMPLE: CAPITAL AND OPERATING COSTS IN NAYA RAIPUR

Table 18 lists costs typically related to bus transport, operating under a gross cost model. This case study is very peculiar as private procurement of services is an exception. Generally, public transport agencies invest in procuring the buses and employ private operators for running the service. In this case, the following two points are assumed:

1. The private operator will pay 20% of the bus cost as an upfront premium to the city agency; and
2. The private operator will receive 70% of their share as debt and balance and 30% as equity.

While capital costs or vehicle procurement is the lowest in terms of percentage of overall costs, fuel costs remain the highest investment for bus operations.

The analysis from the above table is summarized in Figure 94. The graph indicates that only 12 percent of the overall cost can be covered through Central funding schemes, including the JnNURM. The agency is required to finance the remaining 88 percent of costs. The distribution indicated is based on 150 km daily average per bus; hence, any increase or decrease of bus operations will impact the percentage distribution of the costs.

2. VARIABLE AND FIXED COSTS

Variable costs are costs that relate to the usage of the vehicle, such as fuel or spare part. Fixed costs, on the other hand, do not depend on the use of the vehicle; rather they include depreciation, insurance and registration (Litman 1999).

CAPITAL COST PARAMETER	VALUE (RS.)	OPERATING COST PARAMETER	VALUE (RS.)
Total cost of bus (Rs.)	30,00,000	Mileage (kmpl)	3
Share of operator (20%)	6,00,000	Diesel cost (Rs / Lt)	46
Initial loan amount (Rs.)	6,00,000	AMC (per km)	2.5
Equity %	30%	Bus km per day	150
Equity (Rs.)	1,80,000	Bus km per month	3,300
Loan amount (Rs.)	4,20,000	Other monthly expenses	
Interest rate	13.50%	Insurance + Accident comp.	7,500
Term of payment (yrs)	5	Diesel	50,600
No. of EMI	60	Salaries	20,000
EMI loan (Rs.)	9,664	Other expenses	1,000
EMI per km (Rs.)	2.93	Annual maintenance contract	8,250
Investment (Rs.)	1,80,000	Tires	12,000
Return rate	15%	Total expenses per month	99,350
Term of payment (yrs)	5	Operating cost (Rs. / Km)	30.11
No. of EMI	60	TOTAL COST	
EMI investment (Rs.)	4,282	Capital cost (Rs. / Km)	4.23
Equity (Rs. / Km.)	1.3	Operating cost (Rs. / Km)	30.11
Capital Cost (Rs./ Km.)	4.23	Total Cost (Rs. / Km)	34.34

Table 18 Typical cost for bus operation under gross cost model (Naya Raipur Development Authority 2013)



- Fuel Cost , 15.33 Rs./km, 45%
- O&M Cost , 8.41 Rs./km, 24%
- Manpower Cost , 6.37 Rs./km, 19%
- Capital Cost, 4.23 Rs./km, 12%

Figure 94 Distribution of bus operation cost under major heads for every bus kilometer travelled (Naya Raipur Development Authority 2013)

REVENUE

Revenue is income that an organization receives from its normal business activities, usually from the sale of goods and services to customers. In the case of public transport operations, revenue can be derived from the following sources:

Farebox revenue is the most important source of revenue for transportation services, and therefore, user fare is a critical component of transportation services.

AGENCIES	COST	REVENUES RS. / KM (2013)	VIABILITY GAP
Ahmedabad Municipal Transport Service (AMTS)	58.38	26.56	-31.82
The Brihan Mumbai Electric Supply & Transport Undertaking (BEST)	77.53	53.75	-23.78
Bangalore Metropolitan Transport Corporation (BMTC)	36.99	35.42	-1.57
Chandigarh Transport Undertaking (CTU)	47.55	30.64	-16.91
Delhi Transport Corporation (DTC)	120.67	37.57	-83.1
Metro. Transport Corporation (Chennai) Limited. (MTC)	39.76	36.38	-3.38
Navi Mumbai Municipal Transport (NMMT)	45.92	39.51	-6.41

Table 19 Cost and earnings for major STUs (Association of State Road Transport Undertakings 2014)

bus services, public transport agencies run the risk of excessive financial burden resulting in heavy losses. It is important for agencies to recognise and understand this financial consequence. Table 19 details the costs and revenues of seven Indian public transport services, indicating that each of these seven agencies needs to increase their earnings in order to improve overall financial performance.

COST	RS. / KM
Payment to owner Rs. 800/day)	5.33
Fuel	8.8
Conductor remuneration	2.2
Miscellaneous	0.22
Total Cost	16.5

Table 20 Operating costs under the owner-rents-vehicle model (World Bank and EMBARQ India 2014)

COST	RS. / KM
EMI	3.13
Maintenance and depreciation	0.88
Permit, insurance and taxes	0.33
Fitness	0.03
Fuel	8.8
Conductor remuneration	2.2
Miscellaneous	0.22
Total Cost	15.6

Table 21 Operating costs under the owner-operates-vehicle model (World Bank and EMBARQ India 2014)

Minibus Operations in Bhopal

Public transport in Bhopal consists of formal and informal sectors: The Bhopal City Link Limited (BCLL) manages the city bus services, the Bus Rapid Transit (BRT) System and the Tata Magic and minibus services that make up the informal sector. The minibus services cater to an average daily ridership of 95,000 passengers, or 30% of the total public transport ridership (World Bank and EMBARQ India 2014).

Data collected from minibus operators indicated that the average revenue per minibus is roughly Rs. 3,500, with an average daily ridership of 300-350 passengers per minibus. With an average 180 kms operated per bus per day, this equates to Rs. 19.44 earnings per km. In comparison, the cost components of minibus operations include the capital costs (financing costs), operating costs (permits, salaries, fuel costs, etc.) and maintenance costs (repair and maintenance costs). The two models currently being followed are the owner-operates-vehicle and the owner-rents-vehicle for a fixed fee. The costs vary slightly for these two models, as shown in Table 20 and Table 21.

SECTION SUMMARY: Costs and Revenues - Understanding Bus Operations

Central government funding, like the JnNURM scheme, is available for financing the initial investment required for public transport services. While these funds have facilitated bus procurement, agencies are faced with the challenge of higher expenditure in comparison to the incoming revenue. There is a need for agencies to recognise this imbalance and plan adequately for the costs relating to operations and maintenance.

7.2 FARE SETTING

In principle, public transport can be operated as a fully commercial service, and farebox revenue may be sufficient to cover the total cost plus a reasonable profit. However, public transport is implemented pursuing social objectives. Consequently, price policy should find the right balance between the value of the service, users' need for an affordable public service, and the willingness to pay, while pursuing the transport authority's social objectives (Mezghani 2008).

FACTORS Affecting Fare Structure

There are four important factors that affect fare structure:

- **Operating Cost:** These are the direct costs involved in the operation of vehicles, such as fuel, spare parts, labour, etc. and have a direct influence on determining fare structure.
- **Level of Service:** This ranking is determined by the frequency of service, reliability, travel time, and bus stop location. Higher fares may be charged for better levels of service.
- **Competition:** Healthy competition is desirable for an affordable fare structure, to lower the need for subsidies, and to encourage innovation in the field.
- **Subsidy:** Subsidy is necessary as in the majority of cases, fares do not cover economic cost. It is important to note that subsidies are required to improve the quality of service and not to cover inefficiencies.

Revenues = System Expenditure



Figure 95 Technical Fare Calculation (EMBARQ India 2014)

Pricing policy should find the right balance between users' need for an affordable public service, commercial interest of the operators, while pursuing the transport authority's social objectives.

The fare model of any transportation system starts with a concept of equality between the revenue and expenditures of the system (refer to Figure 95).

Where,

- Bus Operators' payments include fixed cost (bus investment) and operational costs (bus maintenance, station cleaning, fuel, taxes, and profits);
- Fare Collection Costs includes system hardware and software, communication network, scheduling, and controlling;
- Staff salaries include payments made to conductors, drivers, and system administrators; and
- Technical Fare = Payments made to Agents / Sold Trips.

Public Fare vs. Technical Fare: Self-Sustainability is when Technical fare = Public fare.

The Technical Fare is the outcome of a combined evaluation of fare model and business plan that subsumes all capital and operational costs. In equilibrium, the technical fare covers the real cost of each passenger without operational subsidies; thus does not take into account the affordability of commuters. The technical fare continuously changes,

Self-sustainability is when the technical fare equals the public fare.

in order to control the financial sustainability of the system.

However, Public Fare or User Fare (i.e. the fare that commuters pay) is in accordance with political decisions. Public fare policy often forces the public transport fares to be kept low, which implies that the public fare is below the technical fare. Hence, if the revenues are less than the operational costs, it is necessary to receive subsidy. In such a scenario, the city transport system approaches the city authority with the technical fare projections and the number of passengers it aims to transport. The city authority then decides the amount of operational subsidy to be granted to the commuters.

In Indian cities, the user fare is determined by a political rationale and hence does not equal the technical fare. With high operational costs and insufficient farebox revenues, the agency falls short of funds available to provide services. This requires the agency to calculate every operational cost divided by the ridership, in order to determine the gap. The agency applies for government subsidies according to this shortfall, to ensure that public transit remains affordable.

SETTING Fares

Decision-making with respect to fare setting varies from case to case. There are generally three situations: authority’s decision, operator’s decision (observed in open market regimes), or operator’s proposal but authority’s decision. Table 22 illustrates

the divergent interests of the transport authority, operator, and passenger. Even if users are not directly involved in the decision-making process, they influence it indirectly because fare levels take into account the user affordability. A high fare is perceived as anti-social if it reduces public transport use.

Any transport fare structure should consider the financial sustainability of the system, customer convenience, and ridership, without prioritising one at the cost of another. The aim is to possibly recover 100 percent of the O&M cost in the short term, and 100 percent of capital cost along with acceptable profits in the long run. The fare structure should:

- be revised on a regular basis to effect changes in customer fares;
- create contingency funds to meet all short falls in revenue due to fluctuating costs, travel demands, or any other performance parameters;
- be passenger friendly. The tariff structure should not only ensure the full recovery of all input costs, but also take into account the fluctuations over a period of time; and
- be priced so as not to cause hardships to low-income commuters and in turn cause socio-political problems.

The following are two case studies detailing the scientific approach used for fare setting and revision in Ahmedabad and Bangalore. In Ahmedabad, the scientific formula considers the change in diesel prices, while in Bangalore the fare hike reflects the change in diesel prices and staff costs.

In terms of percentage of fare increase, hikes in both cities depend on the type of service, i.e. air-conditioned service users bear a higher fare hike in

TRANSPORT AUTHORITY	OPERATOR	USER
<ul style="list-style-type: none"> • Increasing the number of commuters using public transport to avoid road congestion • Setting low prices and simple tariff structure • Balancing prices and encouraging social inclusion • Minimizing public subsidies • To ensure the provision of high-quality public transport 	<ul style="list-style-type: none"> • Appropriate pricing mechanism that covers costs and results in reasonable profits • Operating an efficient public transport system 	<ul style="list-style-type: none"> • Minimizing transport cost • Quality and time saving travel experience

Table 22 The interests of the transport authority, operator and passenger (EMBARQ India 2014)

Ahmedabad. In Bangalore however, the Undertaking can revise fares as they deem fit for differentiated services; any fare revisions for ordinary services (which constitutes 85 percent of services), require government approval.

CASE STUDY: Fare Setting and Revision Policy for Ahmedabad BRTS

In January, 2012 the Government of Gujarat issued directions on maximum and minimum fare setting for the Ahmedabad Janmarg BRTS plying on areas within Ahmedabad city limits and its surrounding area (Trivedi 2012). The schedule for the base fare is shown in Table 23.

Under these directions, the actual fare is calculated through the following formula:

(1) Revised Fare for non AC buses = Base Fare + 1.2 ((Base Fare *0.5* percentage change in fuel price) + (Base Fare*0.5* percentage change in Whole Sale Price Index))

(2) Revised Fare for AC buses = 1.25 * Revised fare of Non AC bus for same stage.
Where:

(1) Base Fare = (As indicated in Table 24)

DISTANCE (KMS)	BUS FARES FOR PASSENGERS WITHIN CITY LIMITS (RS.)
0-2	2.00
2-4	5.00
4-6	6.00
6-8	7.00
8-10	8.00
10-12	11.00
12-14	11.00
14-16	12.00
16-18	12.00
18-20	14.00
20-22	14.00
22-24	15.00
24-26	15.00
26-28	17.00
28-30	17.00
30-32	17.00
32-34	19.00
34-36	19.00
36-38	19.00
38-40	21.00

Table 23 janmarg Base Fare (Trivedi 2012)

(2) Base Fuel Price: Rs. 65.68 per litre for diesel bus (As on September 2014)

(3) Base Whole Sale Price index: 184.6 (As on July 2008)

(4) Change in Fuel Price = (Current fuel price- Base fuel price) / Base fuel price

(5) Change in Whole Sale Price Index: (Current Whole Sale Price Index – Base Whole Sale Price Index) / Base Whole Sale Price Index

Actual fare is applied with the following conditions:

- Tax, as under the Gujarat Motor Vehicles (Taxation of Passenger) Act, 1958, shall be applied to all revised fares, with the exception of student fares.
- Operators are legally bound to carry out the above fare revisions.
- In calculating revised fares, any fraction of a Rupee less than 50 paise shall be rounded down to the nearest Rupee.
- The State Transport Authority will be given the

DISTANCE (KMS)	BUS FARES FOR THE PASSENGER WITHIN CITY LIMIT (RS.)	FREIGHT PER ARTICLE OF LUGGAGE (RS.)
0 - 2	2.00	3.00
2 - 4	5.00	4.00
4 - 6	6.00	4.00
6 - 8	8.00	4.00
8 - 10	9.00	5.00
10 - 12	11.00	5.00
12 - 14	11.00	5.00
14 - 16	12.00	6.00
16 - 18	12.00	6.00
18 - 20	14.00	6.00
20 - 22	14.00	7.00
22 - 24	15.00	7.00
24 - 26	15.00	7.00
26 - 28	17.00	8.00
28 - 30	17.00	8.00
30 - 32	17.00	8.00
32 - 34	19.00	9.00
34 - 36	19.00	9.00
36 - 38	19.00	9.00
38 - 40	21.00	10.00

Table 24 Base Fare and Freight (Trivedi 2012)

Fare Setting Policy for the TransMilenio BRT System in Bogotá, Colombia

The TransMilenio BRT system, put into service in December 2000, is a public-private system that is designed for private operation under government oversight (Bogota, Colombia: Brief: Transmilenio BRT n.d.). It is based on two general objectives – improving citizens' quality of life and improving the city's productivity.

Private operators provide services within strict conditions set through concession contracts and central control. Through bidding processes, contracts are awarded and payments are calculated through fees, as stated in the bidding document. This is typically a per-kilometer fee, which is adjusted at pre-determined time intervals through the use of a scientific formula.

This system is designed for full farebox recovery and operates without any subsidies from the public agency. The risk is completely on the private operator: any increases or lags in ridership and revenue, remains with the operator. National and city governments only cover capital investments (Bogota, Colombia: Brief: Transmilenio BRT n.d.).

When Mayor Enrique Penalosa launched the Transmilenio system, he decided that it should receive no operational government subsidies. Instead, it was decided that those funds would be dedicated to other sectors (education, security, and health, among others). Thus, the fare of 1,700 Colombian pesos (roughly USD \$1) was unaffordable for many low-income citizens, who earned around USD \$3 per day (Hutchinson 2011). The use of fixed fares functions was a form of cross-subsidisation between passengers who lived in the city centre and travelled shorter distances (higher-income passengers) and passengers living further away (lower-income passengers). Additionally, free transfers (within the BRT corridor and from the trunk to feeder routes which connect to lower income neighbourhoods) enabled passengers to save around USD \$0.60 per day, which constitutes a significant percentage of the average daily income of the urban poor (Special Unit for South-South Cooperation 2012). Policy experts also suggested a peak-hour congestion tax to finance a BRTS subsidy and help bridge the accessibility disparity.

opportunity to annually revise fares as deemed appropriate, following a review of operational costs on March 31 each year.

The trade-off between the controlled low price and affordability by the poor should actually be tackled through scientific management decisions.

CASE STUDY: Fare Revision Process at BMTC, Bangalore

BMTC operates all bus services in the city of Bangalore, and fares are based on a stage system, with a telescopic structure (BMTC 2014). In other words, fares increase as distances increase, with the cost per marginal unit of distance decreasing as the trip length increases. Each stage is approximately equal to 2 km, although they can be shorter on particular routes. BMTC operates several differentiated services, each with its own fare structure. These services are indicated in Table 25.

Table 26 illustrates the fare structure through 10 stages for these different services.

Figure 96 displays the historical changes in BMTC fare rates (price per km). The graph indicates that the price per km travelled of bus transport in Bangalore increased by about 75 percent in the past decade. During that period, BMTC fares changed 11 times, roughly once a year on average.

With respect to fare setting, BMTC services may be categorized as follows: ordinary services (roughly 85 percent of all services) and other differentiated services (15 percent of all services). In both cases, BMTC utilizes a formula to determine the fare hike (per passenger km) to neutralize the burden of diesel price rise, and dearness allowance (DA) hike for STU employees. In other words, the formula is dependent on two factors, fuel prices and staff costs. BMTC conducts a review twice a year to determine whether a change in the fare structure is necessary. In the case of other differentiated services (i.e. Vajra, Atal Sarige, etc.), BMTC has the authority to

unilaterally change fares as and when it deems fit, without requiring the approval of any higher authorities. For ordinary services, however, state government approval is required for fare hikes. BMTC makes fare change proposals, which are taken to

the state government for approval via the Principal Secretary of Transport. The State Transport Minister then needs to approve the change in fare structure. Tariff changes can be made either for tickets or passes. BMTC can unilaterally change pass rates

SERVICE	DESCRIPTION
Ordinary	The basic city bus service - accounts for the vast majority of routes and fleet.
Big10	A high-frequency trunk service, running on the 12 major arterial roads in Bangalore. This is the first step in a proposed direction-based trunk-and-feeder service for Bangalore, as opposed to the current destination-to-destination configuration.
Vajra	A high-end air-conditioned service initially designed to serve high-income professionals working at Information Technology and other office parks.
Suvarna	A branded service with higher quality buses - positioned between Ordinary and Vajra services.
Pushpak	Another branded service with high-quality vehicles with a one-person driver only operation.
Atal Sarige	A service designed for lower-income users, with lower fares and routes connecting low-income settlements to commercial areas.

Table 25 Different types of BMTC bus services (BMTC 2014)

Gross-Cost Model vs. Net-Cost Model

Public-private partnership (PPP) can be operated as a Gross Cost Model or Net Cost Model. In a Gross Cost Model, private operators are paid on the basis of kilometers of service and all the revenue is with the public transport agency. In a net cost model the operator pays a fee for the permit or license to operate a route and collects and keeps all the revenue. The operator has to cover all the costs for operating the service. Thus under a net-cost model, the private operator assumes the entire risk (Patwardhan 2014). While fares are regulated by the government, due to strong socio-political reasons in India, fare hikes are very uncommon. Even an increase in diesel prices or the rate of inflation does not ensure a rise in bus transit fares. This model becomes highly unsustainable for the operator, eventually resulting in reduced operational quality. From the perspective of the Special Purpose Vehicle or SPV, funds are received from the government in an ad hoc manner, without any financial planning undertaken. The penalty availed from the private operator is not always utilized to improve operations. Rather, the penalty is utilized for the day-to-day functioning of the SPV.

Under a gross-cost model, the risk remains completely on the SPV, which provides a per-kilometer payment to the operator. This payment is directly linked to the input costs, and hence is more reflective of the economic aspect of operations. However, in this model, the lack of financial guarantee of the government adds instability to the function of the SPV, resulting in substandard operations. There are three aspects that must be addressed in this case:

- Complete financial planning by the SPV for subsidies required
- Adequate guarantee of the SPV by the government; and
- Three-way interaction between the private operator, SPV and the government to ensure better transparency in transactions.

STAGES	ORDINARY	BIG10	VAJRA	SUVARNA	ATAL SARIGE
1	4	4	10	5	2
2	7	7	10	9	3
3	9	9	15	10	4
4	11	11	20	11	5
5	12	12	25	12	6
6	12	12	25	13	6
7	13	13	30	13	6
8	13	13	35	13	7
9	15	15	35	14	7
10	15	15	40	15	7

Table 26 Fare Structure through 10 Stages (BMTc 2014)

The trade-off between the controlled low price and affordability by the poor should actually be tackled through scientific management decisions.

for 'other differentiated services', while the price of passes must receive state government approval through the transport minister. For this purpose, BMTc adopted the Association of State Road Transport Undertakings' (ASRTU) formula for fare revision.

FARE REVISION ON ACCOUNT OF INCREASE IN DIESEL PRICES:

$$f(DPA) = (F - D) + [(RPD/BPD) \times D]$$

Where,

f(DPA) = Revised fare in terms of paisa per passenger kilometer

F = Average cost per passenger kilometer at the time of previous fare revision

D = Diesel cost per passenger kilometer at the time of previous fare revision

RPD = Revised price of diesel

BPD = Basic price of diesel when the last fare revision was permitted

FARE REVISION ON ACCOUNT OF RISE IN DEARNESS ALLOWANCE RATES:

$$fR = F + [CPKM(L)/CPKM] \times P \times F/100$$

Where,

fR = Revised fare paisa per passenger kilometer

F = Current fare per kilometer

CPKM = Total cost per kilometer at the time of

previous fare revision

CPKM(L) = Staff cost per kilometer at the time of previous fare revision

P = Percentage increase in staff cost due to DA increase over the staff cost at the time of previous revision

The advantage of periodic and timely revision is that the fare hike is nominal and STUs do not incur significant losses. However, reality indicates otherwise.

- To avoid frequent hikes in fares, the state government decided that the fares would be hiked only when the combined burden of diesel price increase and the DA increase, (refer to the formula above) exceeds 0.25 paisa per passenger kilometer (i.e. total burden exceeds INR 11 crore in a year).

- Whenever there is a decrease in diesel price, the fare will also decrease.

- The additional revenue realization on account of fare hike shall not exceed the total increased cost of diesel and DA (Parwez 2013).

Since the STU has the liberty of distributing the quantum of fare increases among the different types of services (i.e. ordinary, deluxe, and express), the impact of large fare hikes is minimized.

To fund the imposing needs of infrastructure, methods such as land-banking strategies or funds procured through paid parking can be effective.

To address the impending needs of public transport, the industry is witnessing the emergence of innovative non-farebox methods for revenue generation. This next section will delve into some effective models.

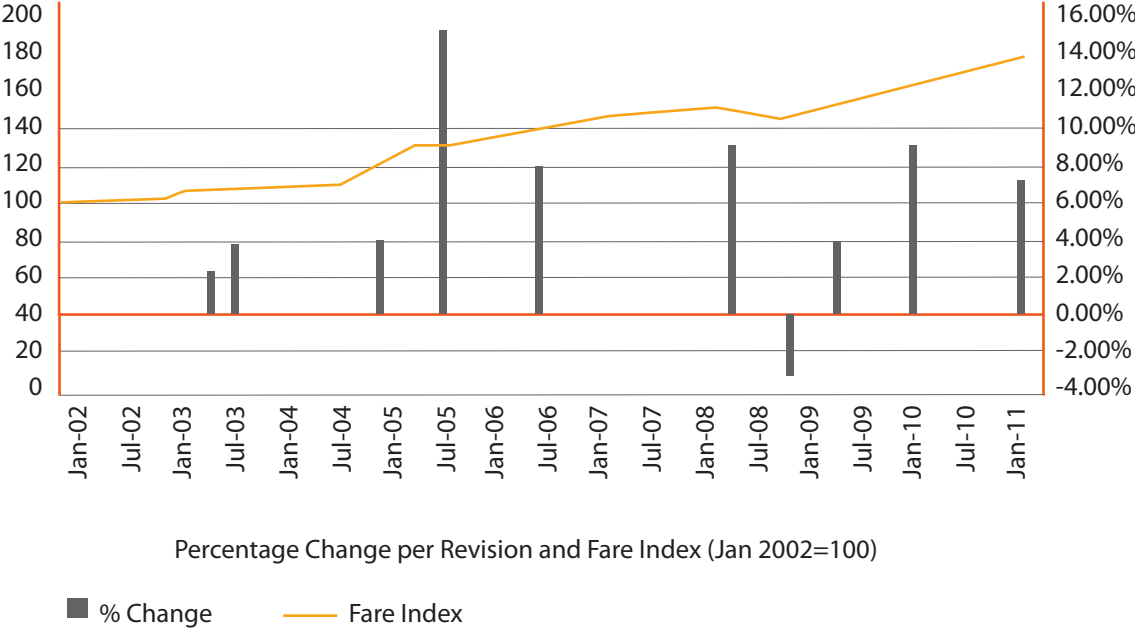


Figure 96 BMTc Fare Change (Ministry of Urban Development Authority n.d.)

SECTION SUMMARY:
Fare Setting

The aim of price policy is to find the right balance between the users’ need for an affordable public service and the commercial perspective of the operator, while pursuing the transport authority’s social objectives. There is a need for cities to adopt a scientific approach to determine the level of fares, by considering operational costs such as changes in fuel cost and inflation rates. This is can be an effective way to maintain financial sustainability of the operator and service quality.

7.3 ALTERNATE WAYS TO FINANCE PUBLIC TRANSPORT

As a key part of the discussion on financing public transport, it is important to ensure that the quality of the services provided are delivered at maximum efficiency, so as to optimise the costs and revenues. Once this is established, the agency should explore funding mechanisms to manage any shortfalls. One of the ongoing policy debates has been focused on how to find the necessary investment for the provision, as well as operations and maintenance of growing transport supply needs. Increasing fuel, fleet and staff costs are placing increasing pressures on the financial performance of transport systems.

Due to the public service aspect of public transportation, fares cannot be raised at will to increase revenues, affecting the ability to finance public transport operations. The ninth Five Year Plan (FYP) of the Planning Commission (Planning Commission 1997) identified an Urban Transport Fund (UTF), as a mechanism to satisfy the share of contribution by the state and Urban Local Bodies (ULBs) in urban transport. The 12th FYP (Planning Commission 2012) further recommended the setup of a UTF through city-level initiatives such as fuel cess, traffic receipts, etc. and identified funding streams from the state and national levels. The funds can be sourced through various types of taxes and channels such as:

- land monetization
- land value tax
- enhanced property tax
- grants of development rights
- charging cess on turnovers and sales tax
- betterment levies
- shops and establishment levies
- advertisement,
- congestion pricing; and
- parking charges.

As part of a comprehensive strategy to subsidise public transport operations, these charges collected can be directed into the UTF. With a structured financial plan based on their forecasted revenues and expenditures, operating agencies can apply for this fund as a subsidy measure.

The traditional approach to finance has largely depended on budgetary support from the government. In today's scenario, non-farebox revenue methods are getting increased attention. There is a new trend of tapping into the private sector and finding innovative mechanisms for funding requirements. In addition to this, non-

The Bangalore and Assam models facilitated revenue generation through land banks and the integration of commercial uses. In addition, ASTC also restructured existing resources to reduce ineffective costs.

farebox revenue also has an important role to play in the overall sustainability of transport systems. This section discusses the two approaches to financing public transport, with examples of Bangalore and Assam from the Indian context. Both agencies' land banks enabled the transport authorities to utilize the land to improve operations and increase revenues through commercial integration and other schemes. In the case of Assam, a reorganization of existing resources also resulted in the reduction of ineffective costs.

CASE STUDY: Financing Models of Traffic and Transit Management Centers (TTMC) in Bangalore

BMTC serves over 4.8 million passengers and 42 percent of the trips in the city. In recent years, BMTC became one of the few public transport agencies to operate at a profit. Despite its success however, in the late 2000s, BMTC faced two major challenges: alternate sources of revenue generation to maintain profitability and financial sustainability; and the provision of high quality support infrastructure to improve the level of service for bus users.



Figure 97 TTMC at Yeshwanthpur (EMBARQ India 2014)

To address both of these challenges, BMTC decided to leverage its major asset: land holdings in strategic locations throughout the city. This gave birth to the innovative concept of Traffic and Transit Management Centres (TTMCs) (see Figure 97 and Figure 98). This concept combines the development of passenger terminals, with the creation of commercial real estate space. This enables BMTC to utilize rental revenue to cross-subsidize the construction cost of the terminal and amenities, and also becomes a source of additional revenue for the corporation.

The TTMC concept consists of three main components:

- an integrated terminal with adequate facilities and amenities to cater to the requirements of all user groups;
- a mixed-use development with retail, office space and other commercial activity, to enable



Figure 98 Commercial Development at Shantinagar TTMC (EMBARQ India 2014)

SI No.	LOCATION	PROJECT COST (CRORE RS.)	COMMERCIAL REAL ESTATE DEVELOPED (IN SQ. FT)	INAUGURATED	AVERAGE MONTHLY RENT FROM COMMERCIAL SPACE (RS.)
1	Shantinagar A Block	103.78	2,82,731	13-10-2012	12,77,919
	Shantinagar B Block		94,655	17-10-2011	8,95,000
	Shanthinagar MLCP Block		53,550	17-01-2012	3,76,236
2	Koramanagala	64.34	3,10,785	01-04-2012	6,81,504
3	Banashankari	31.23	1,09,215	15-12-2011	15,15,490
4	Vijayanagar	56.6	1,65,799	16-09-2011	24,27,228
5	Jayanagar	13.9	61,184	27-12-2009	13,76,365
6	Whitefield	40.37	1,42,859	23-07-2011	15,84,349
7	Domlur	17	77,849	07-07-2011	1,57,210
8	Kengeri	37.5	1,09,779	01-08-2011	2,56,700
9	Bannerghatta	5.01	12,932	25-01-2012	19,798
10	Yeshwanthpur	89.5	2,27,634	26-01-2012	20,12,121
	Total	460.15	16,00,512		1,25,79,920

Table 27 Financial details of TTMCs in Bangalore (BMTC 2013)

people to fulfil all these needs through using bus transport; and

- the provision of park-n-ride facilities to encourage the use of public transport.

In terms of implementation, BMTC has constructed ten TTMCs since 2009. The initial funding was provided by JnNURM. Subsequently, BMTC was confident in its ability to recover costs through renting commercial space and invested significant amounts of its own funding. Table 27 details the respective costs of these commercial initiatives. The development of high-quality terminals resulted in significant improvement in the quality of bus travel. BMTC earns roughly INR 15 crore per annum from renting out commercial space. This revenue is expected to increase as commercial spaces are occupied and as rental rates increase due to the strategic location of TTMCs.

The success of the first generation of TTMCs highlighted some important learnings. The design objectives should focus on the following:

- Primarily enhance city bus operations
- Integrate other modes, such as cycling, autos and taxis
- Improve pedestrian environments around the TTMC as part of the development
- Meet the standards expected of potential tenants of commercial spaces

The JnNURM funding played a major role in the financial viability of TTMCs; future expansion however, will require further innovations in financing. To explore new alternatives, BMTC is currently analysing the public-private partnership (PPP) model for TTMC development. In this model:

- A private developer pays BMTC an upfront fee as well as an annual premium;
- The private developer builds the specified transport infrastructure as required by bmtc (terminal, depot, etc.); and
- The developer has the right to develop commercial real estate and collect the rent during the contract period.

The TTMC model from Bangalore provides a useful example of how to leverage land holdings to solve two challenges at once: the need to provide support infrastructure for bus services and the need to generate non-fare revenue to subsidise operations. As urban areas expand, public transport authorities need to recognise and actively explore the

commercial opportunities that their land holdings provide.

CASE STUDY: Restructuring Organization: Assam State Transport Corporation (ASTC), Assam

ASTC is one of the largest State Transport Undertakings (STUs) in the north eastern part of the country, which provides bus services within Assam and to adjoining states (ASTC 2014). ASTC started operations about 100 years ago as a state government department with four buses running between Guwahati and Nagaon. Gradually the transport network of the department expanded throughout the state of Assam. The state transport department was converted into a corporation on 30th March 1970. The key performance indicators for ASTC are listed in Table 28.

In early 2000, ASTC operated on a closed-door policy. Employee salaries were unpaid for about 14 months and ASTC accrued around INR 200 crore worth of liabilities. A staff of 5,400 translated

PARAMETERS	UNITS
Fleet size	750
	191
	7
	262
Total	7
Average earnings (per month)	565
	80
Total	645
Expenditure per month (Rs. In lakh)	945
Kilometers operated per month (in lakh)	23
KPL	3.39
Passengers carried (lakh per month)	11
Fleet utilisation (in %)	84
Vehicle utilisation (km/day/bus)	380
	250
	150
Accidents (per lakh km)	0.05

Table 28 Key performance indicators for ASTC (ASTC 2014)

into a bus-staff ratio of 1:27, as compared to the 1:6 ratio, recommended by the Committee on Public Undertakings (COPU) in its 30th report from December 1997. On 31st March 2000, the 3-year establishment expense was 176.46% of ASTC's average traffic earning, making it dependent on the State Government for budgetary support. ASTC had 72 vehicles that were in operational condition and the earnings were negligible, while the monthly salary requirement was around INR 2 crore. The Government of Assam tried several ways to revive the agency with limited success.

The corporation owns several fixed assets, including buildings and land banks in all small, medium and large towns throughout the state. These lands are located in highly-desirable parts of towns and cities. Despite this, the agency faced issues due to three reasons:

- A significant, complex liability of 200 crores
- Reduced productivity due to a large employee base
- Low employee morale

The situation reached a low point for the agency in 2000, following which a revival and revitalisation programme was approved by the Board and the State Government. Two strategies envisaged the way forward. First, was the reduction of the bus-staff ratio from 1:27 in 1999-2000 to 1:7 by the end of 31 March 2003, to be achieved by:

- Repairing 235 shutdown buses with government funds;
- Replacing old buses in a phased manner by purchasing 100 vehicles out of government funds and 200 vehicles by obtaining loans from financial institutions; and
- Reducing employees by 2,000 through a voluntary retirement scheme.

The second strategy was the generation of additional earnings from other schemes. This was to be facilitated by the operation of private buses under the ASTC banner, commercial exploitation of land and other sources.

PRIVATE BUS OPERATION UNDER ASTC BANNER

The PPP model did not exist in any other part of the country and was a new scheme, when ASTC decided to implement it. In this model, private vehicle

owners operate their vehicles under the ASTC brand. ASTC would undertake vehicle management including scheduling aspects, and allow vehicle owners to utilize its stations, where it also provided assistance with ticket issuance. ASTC receives 10 percent of the gross income as commission, and 90 percent belongs to the owner. The programme was initiated with 559 buses in 2001-02 and grew to 1,790 buses in 2005-06. During this period, the annual earnings increased from INR 2 crore to INR 14 crore. While this optimised operations through the PPP model, it also enabled ASTC to increase its revenues.

COMMERCIAL EXPLOITATION OF LAND

ASTC's properties, like their depots, terminals, interchanges, etc. are in prime locations and the management decided to utilize them to its commercial advantage. ASTC started to develop commercial uses at these locations by building multi-level parking lots, cinemas, shops, hotels, petrol pumps, hotels, etc. (see Figure 99, Figure 100, Figure 101, and Figure 102). These initiatives have



Figure 99 ASTC's Multi-Level Car Park, Paltan Bazaar, Guwahati (ASTC 2014)

INCOME SOURCE	AMOUNT (RS. IN LAKHS)
Hotel	132
Cinema Hall	5
Shops	4
Parking	24*
Total	165

Table 29 ASTC's annual non-farebox revenue from various sources in Guwahati (ASTC 2014)

¹ Expected revenue for recently inaugurated project

helped the agency to generate alternative forms of revenue as listed in Table 29, to cross-subsidise operations. However, there is still a gap of INR 1.35 crore in comparison to costs of operations.

OTHER SOURCES

ASTC attempted other methods to diversify from the core business of bus operations, with the intention to cross-subsidise. These included courier services, commercial operation of tyre re-treading plants and a printing press. The courier service, which was expected to earn a revenue of INR 40 lakh per annum, was introduced in December 2002 through a private firm, the Assam Courier Service. The service however did not perform as expected.

Models such as the PPP provide agencies with the opportunity to further improve the financial viability of such strategies, bringing better stability to agencies. It is important that the commercial exploitation of land holdings be viewed as a secondary aspect; the improvement of transport services should always be the primary goal. This is discussed further in Chapter 8.



Figure 100 ASTC Digital Cinema Hall, Guwahati (ASTC 2014)



Figure 101 ASTC NRL Petrol Pump at Nagaon, Guwahati (ASTC 2014)



Figure 102 ASTC Yatri Niwas, Hotel Contour, Guwahati (ASTC 2014)

SECTION SUMMARY: Financing Public Transport

As urban areas expand, an effective financing strategy for public transport agencies is to actively explore the opportunities that their land holdings provide. The TTMC model from Bangalore provides an example of how to leverage land holdings to solve two challenges: the need to provide infrastructure for bus services and the need to generate non-fare revenue to subsidise operations. Innovative contracting options such as the PPP model can increase the viability of such projects. However, it is important that agencies implement such models with a primary focus on optimising transport services.

CHAPTER SUMMARY:

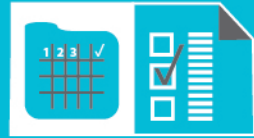
City bus agencies are under increasing financial pressure, created by the significant costs related to operations and maintenance. Agencies are faced with an inability to increase fares due to their social responsibility; as a result, the earnings do not offset the rise in operational costs related to fuel and maintenance costs. There is a need for price policy to find the right balance between the social and financial objectives of agencies. To improve their financial performance, agencies are exploring innovative mechanisms and models focused on non-farebox revenues.

Role of The State

8.1 Safety of City Bus Services

8.2 Segregated Infrastructure

Service Planning



Intelligent Transport Systems



Safe and Accesible Infrastructure Design

Bus Operating Agency



Fuel Efficiency Management



Financing



Branding, Marketing and Communication

8.3 Public Transport Subsidies

8.4 Land Planning for Transport Infrastructure

CHAPTER EIGHT

STATES' ROLE IN SUSTAINABLE BUS TRANSPORT

A concerted effort by city and state authorities can significantly magnify the impacts of operational improvements to bus systems. So far, the 2.0 Guidebook discusses the improvements for public transport agencies to enhance aspects of operations and services. While each of these modifications is significant, they fall within the purview of the transport operator. The extent of these improvements is limited within the transport operator's role. Within the larger context of the state, it is essential to recognise the role and also discuss responsibilities of state authorities. It is equally important to recognise this dynamic in order to facilitate success in urban bus transport provision. The role of the state is detailed in this chapter

through a four-point agenda in Figure 103, which will be elaborated further in the following sections.

8.1 Improving the Safety of City Bus Services

Factors related to road safety must not be compromised for the optimisation of any other service parameters. The assurance of safety is the duty of the operating agency; however, system safety entails the engagement of other government agencies including the Traffic Police and the Corporation.

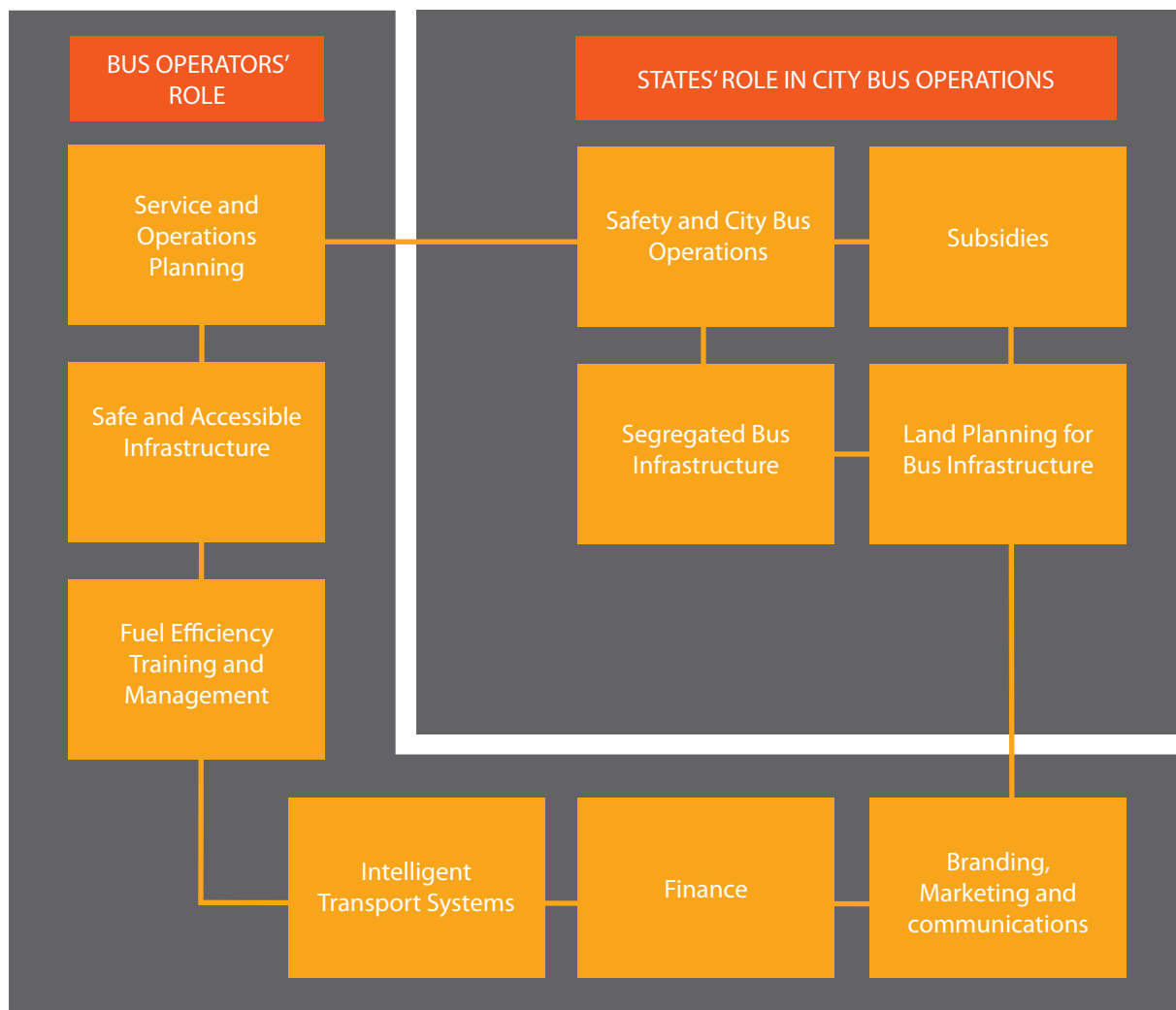


Figure 103 The States' Role in City Bus Operations (EMBARQ India 2014)

The safety considerations of bus stop locations were discussed for local conditions in Chapter 3. As an extension to this discussion, it is important to acknowledge the externalities of safety and their implications on service provision. This section discusses the present situation by exploring the vulnerability of urban bus services in Indian cities.

UNDERSTANDING Accident Data

Over the years, accident occurrence in urban India has been on the rise, with a high involvement of buses in road fatalities (see Table 30). Data indicates that the role buses play in overall urban road safety

The data from these different cities reveals that, with regard to city bus crashes, there are 3 vulnerable road user groups namely pedestrians, motorcyclists and bus passengers that fall out of a moving bus (see Figure 104). The causes of the vulnerability for each of these groups are covered across subsequent sections in this section, as well as recommendations to address them are provided.

While these statistics can be attributed to several factors, two critical factors entail a significant role in this: the inherently large size and mass of a bus and overcrowding. The size of a bus (inherent difficulty in manoeuvring and wide blind spot) significantly adds to the likelihood and severity of crashes. In the event of a crash, on account of its relatively heavier mass, a bus exerts a greater force on the pedestrian or other vehicles. This increases the severity of bus crashes, which is why a majority of them result in a major injury or death. This is particularly true on the left side and the rear of the bus (see Figure 104). A small vehicle on the left side, such as a motorcycle, can be within the driver's blind spot. Additionally, the rear of a turning bus moves into the adjacent lane of traffic, leading to sideswipe crashes.

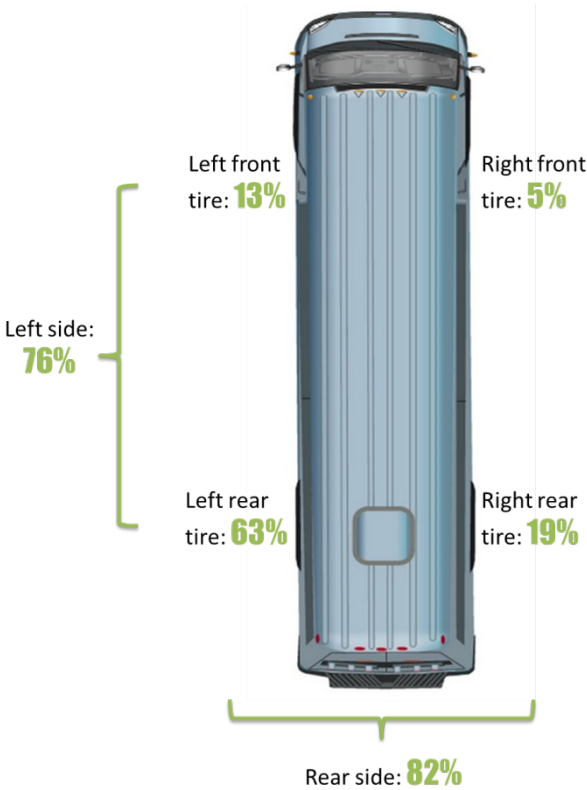


Figure 104 Share of each wheel in run-over crashes for MTC City Bus services in Chennai (Padmanaban, et al. 2010)

The second major factor responsible for poor bus safety is the low supply of buses, which results in their overcrowding. The low frequencies coupled with high demand lead to overcrowded buses, forcing passengers to hang out of the footboard of the door (see Figure 105). Such behaviour is highly dangerous and the primary reason for the high incidence of bus passenger fatalities.

CITY	INVOLVEMENT OF PUBLIC BUSES IN ROAD FATALITY	AFFECTED USER GROUPS
Mumbai	79 / 488 (16%)	-
Bangalore	113 / 943 (12%)	18% pedestrian fatality 23% 2W fatality 20% bus occupant fatality
Chennai	148 / 982 (15%)	25% pedestrian fatality 42% 2W fatality 22% bus occupant fatality

Table 30 Data on public bus involvement in accidents in three major Indian cities.



Figure 105 Overcrowded bus in Chennai puts commuters at risk of falling out and getting run over (Sreevatsan 2010)

ADDRESSING Safety of City Bus Services

Accidents are a multi-factor problem; hence, addressing them should use multiple approaches. In response to addressing these risk factors, three aspects to maximise safety were studied: driver-related factors, fleet characteristics and road design. Correcting one or two of these factors can significantly lower accident severity.

DRIVER BEHAVIOUR

Training is an effective way to influence driver behaviour. Small investments in initiatives that encourage safe driving techniques, for instance, can have a large impact on minimising accidents. Driver training and skills refreshment programmes are discussed in detail in Chapter 4. The chapter also elaborates the need to ensure that drivers get adequate rest in order to drive safely.

In addition, there are several intensive methods of monitoring, which can be facilitated through both live and recorded monitoring. Incidents of high speed, quick acceleration, abrupt braking, lane swerving, etc. can be monitored. Chapter 5 discusses the options to monitor driver behaviour through the use of Intelligent Transport Systems (ITS). In the absence of capital to adopt technology-intensive methods however, more manual measures can be considered. For example, a system can be implemented to receive feedback from bus passengers, bus conductors, traffic police, other bus drivers, and bus maintenance personnel. Unscheduled checks can also prove effective (BEST Undertaking 2014)(Navi Mumbai Metropolitan Transport 2014).

The use of these observations as constructive

The severity of an accident can be minimised by addressing one or two of three key factors: driver-related, fleet and road environment design.

feedback to the driver is an important aspect of driver monitoring. A system of levels of warning could be set in place, wherein action can be taken against drivers who cross a certain level of warnings in a given duration. It is also important to use monitoring to reward drivers that are doing well, and a system of incentives for safe driving should be set in place.

FLEET CHARACTERISTICS

A second factor that strongly impacts safety levels is the characteristics of a fleet: size, vehicle condition, and vehicle design. Firstly, overcrowded buses or low fleet size (resulting in low frequencies) forces passengers to hang out of the footboard of the door, creating a highly dangerous situation. Automatic doors help to reduce this. Also required is an increase in fleet size and frequency during peak hours.

A significant number of accidents involving buses occur due to the overcrowding in buses (Padmanaban, et al. 2010). The use of mechanical doors that ensure closure during the bus journey can be effective in reducing the number of fatalities (Kharola, Tiwari and Mohan 2010). Hence it is important to note that with the use of automatic doors, agencies are urged to adhere to a standard of maintenance to maximise functioning and hence, level of safety too.

The second factor of fleet characteristic is the condition of the vehicle. Routine maintenance also improves safety. In most Indian cities, the bus fleet is old and inadequately maintained, resulting in low quality brakes, suspension, and steering. In some cases, buses are so old that they use outdated technologies. Replacing the old fleet is helpful in meeting basic safety standards through enhanced design.

Simple features of vehicle design can effectively optimise safety. Table 31 highlights design features and their impacts on safety.

In light of the safety issues highlighted in this section and Section 3.1, it can be inferred that the use of

FEATURE	IMPACTS ON SAFETY
Wide-angle rear-view mirrors that protrude further out of the front side of the bus; side- and rear-view cameras	Minimises blind spots
Long and wide, single-frame windshields Low seating position for the driver	Increases driver visibility of crossing pedestrians, potholes, speed bumps, etc. Situates eyes closer to the road and minimises blind spots
Side, rear, and front underrun protection that is energy-absorbing	Reduces likelihood of vehicle / pedestrian being run over by a bus wheel; absorbs some of the crash force with another vehicle (and reduces severity of the crash)
Retro reflective markings on all sides of the bus Speed governors	Increases visibility of the bus where lighting is poor Limits maximum speed capable by the bus
High-quality breaks, suspension and steering	Significantly lowers risk of being involved in a crash
Automatic doors	Reduces likelihood of passenger falling out of the bus

Table 31 Bus design features and their impacts on safety (EMBARQ India 2014)

International experience demonstrates that a well-designed, segregated, central-lane BRTS is the safest type of bus corridor.

bus lanes can have positive safety implications. International experience demonstrates that a well-designed, segregated, central-lane BRTS is the safest type of bus corridor (Duduta, et al. 2010). Segregation virtually eliminates the possibility of collision with other vehicles. At intersections, signal priority can inhibit crossing movements of other traffic with BRTS buses. Median lanes also omit the risk of conflict with kerbside pedestrian movement

and vendor activity. A kerbside lane puts the bus into conflict with parked vehicles, as well as people and vehicles accessing properties and making left turns.

Central lanes for BRTS can, however, pose issues for local pedestrian accessibility and traffic movements: pedestrians may try to jump over segregating guardrails to cross the road, or motorists may drive illegally against traffic to avoid a long detour. To prevent these mishaps, adequate and safe facilities for pedestrian crossovers and vehicle U-turns must be provided.

SECTION SUMMARY: Improving the Safety of City Bus Services

Data indicates that buses are involved in a high number of road crashes and in severe road crashes. To manage this effectively, it is important to recognise that accidents are a multi-factor problem. Safety can be maximised by addressing three factors: driver monitoring through methods such as technology systems; improving vehicle safety; and designing the road environment and design to manage vehicle speeds and driver behaviour. Incorporating these factors into the planning framework can facilitate enhanced safety of city bus services.

8.2 Segregated Bus Infrastructure

Increasing the service and operational efficiencies of a public transport system has a finite scope in improving the system; beyond a point, it is important to understand that there is a need for segregated bus infrastructure. Segregated bus infrastructure helps cities obtain optimal results for bus transport services. Segregated infrastructure through a Bus Rapid Transit System (BRTS) ensures fast, reliable, secure, and high-capacity services to drastically increase the capability of urban public transport.

The implementation of BRTS in Indore is a prime example of how the city was able to improve the performance of its bus services through the implementation of segregated infrastructure. The flowchart in Figure 107 indicates the impacts of segregation against non-segregation of bus infrastructure. Segregation primarily reduces the effects of traffic congestion, increasing the travel

speed and the frequency of the system. From an operator's perspective, higher speeds effectively optimise fuel use and fleet use, bringing down related costs such as manpower and maintenance. The Indore system incorporates the elements of a full-BRTS: stations with prepayment, level boarding, segregated busways, a distinctive branding and image, multiple doors, and the use of technology. Data indicates that the Indore BRTS, or iBus, was able to provide significantly improved services, as seen in the following case study.

The performance of the Indore system was assessed based on six parameters:

- Ridership;
- Time saved;
- Mode share;
- Lives saved;
- Ridership / bus / day; and
- Average earnings

Segregated bus infrastructure helps cities to obtain optimal results for bus transport services.

CASE STUDY: Performance of Bus Transport in Indore through Segregated Infrastructure

Atal Indore City Transport Service Limited, or AICTSL, began city bus operations in 2006 in Indore (Atal

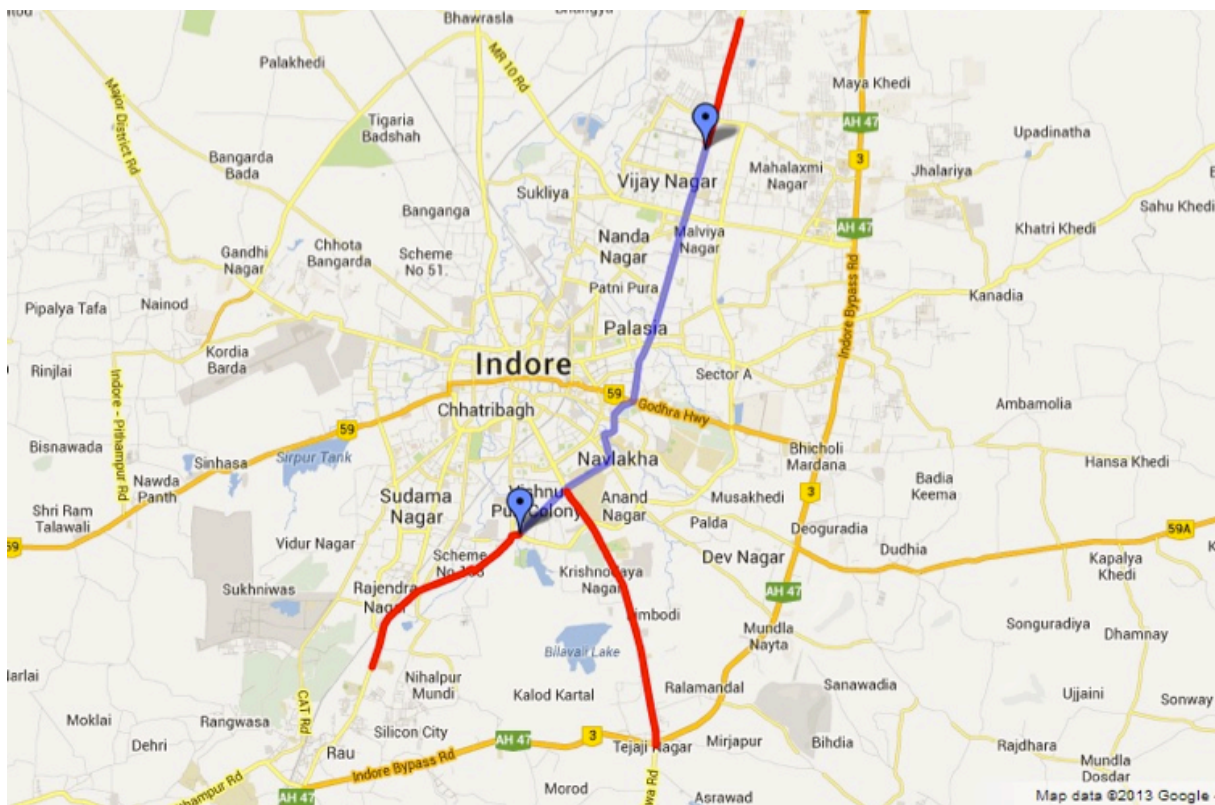


Figure 106 the Indore BRT alignment (EMBARQ India 2014)

MONTH	ROUTE 1 AVERAGE PASSENGERS PER BUS PER DAY	EARNINGS PER Kilometer (Rs.)	ROUTE 2 AVERAGE PASSENGERS PER BUS PER DAY	EARNINGS PER Kilometer (Rs.)
Jan-13	605	30.27	568	29.04
Feb-13	626	31.64	598	29.25
Mar-13	566	28.44	537	25.73

Table 32 Performance of Routes 1 and 2 of Indore City Bus Services (Patwardhan 2014)

Indore City Transport Service Limited 2014). Owing to the growing congestion throughout the city, the system was increasingly facing challenges related to inefficiencies, increased travel times, falling ridership, etc. Over the last decade, the average travel speeds decreased by 23 percent, from 24.6 kmph in 2000 (CES 2004), to 18.9 kmph in 2011 (Indore Municipal Corporation 2011). The Comprehensive Mobility Plan (CMP)(Indore Municipal Corporation 2011) for the Indore Planning area projects a further decrease in travel speed during peak hours – as low as 10.8 kmph by 2021 – under the current traffic scenario. As a result of lower travel speeds, travel times for all traffic increased drastically. More importantly, the increased travel times on city buses reduce the attractiveness of public transport, causing people to shift to private vehicles as their preferred mode. To maintain a desirable service frequency with ever-increasing congestion and travel times, AICTSL required a constantly growing fleet size, which would eventually result in it being financially unviable.

Route 1 and Route 2 of the city bus services served large parts of the AB Road corridor. Table 32 lists the average occupancy per bus per day as well as the earnings per kilometer (EPKM) for the time period prior to the BRT launch.

In 2012, these two routes served up to 900 passengers per bus per day on average, making them two of the most profitable routes in the city. The decrease in travel speeds, however, was a major factor in reducing the ridership of city buses, which in turn even reduced the viability of newly planned routes. This trend is common in other cities, resulting in poor service quality, and in some cases, private operators pulling out of service.

In light of the existing traffic scenario, AICTSL needed to lower journey times and increase throughput in order to improve overall system efficiency. To address these concerns, the city authorities decided to implement a BRTS for Indore.

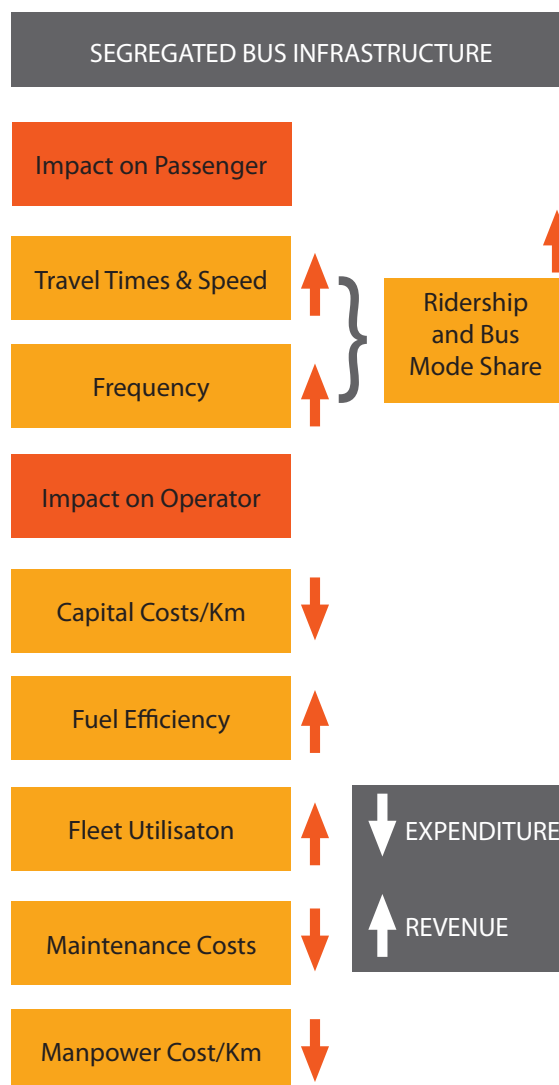


Figure 107 The impacts of segregated bus infrastructure on bus operations and traffic (EMBARQ India 2014)

THE BRTS PILOT CORRIDOR

In 2007, a comprehensive BRTS Master Plan was developed, with a proposal for a 120-km network to be constructed over three phases. An 11.45 km corridor along AB Road from Rajiv Gandhi to Niranjapur was selected for pilot implementation

PARAMETERS	VALUE
Ridership	30,000 passengers
Time saved	26% time saved
Mode Share	25% shift from private vehicle use
Ridership / bus / day	1,600 passengers
Earnings	Rs. 66.43 / km

Table 33 Key Performance Indicators of the Indore BRTS (Atal Indore City Transport Service Limited 2014)

(see Figure 106). The construction of the corridor commenced in 2007 and was completed in March 2013. The system incorporates the following features:

- 20 median bus stations and 1 set of conventional kerbside bus stops, where a median station is yet to be constructed
- Segregated corridor for 11.45 km, barring 200 m between Palasia and Guitar junctions
Closed median stations that allow off-board payments
- Dual-door access and level-boarding to reduce boarding and alighting times
Distinctive buses and stations that adhere to a particular branding style
- The use of Automatic Vehicle Location Systems (AVLS) to track buses

After operating for eight months, the system set a new standard for public transport, as it surpassed many benchmarks in bus-based urban public transport in the country. In September 2013, with 19 buses operating from 7:00 AM to 10:30 PM, the system served 30,000 passengers per day (Atal Indore City Transport Service Limited 2014). Figure 8.6 shows the public transport (AICTSL buses only) ridership on the AB Road corridor before (only Routes 1 and 2) and after the launch of the BRTS. Within a period of 4 months, the BRTS was initially able to achieve an approximate 290-percent increase in the public transport ridership on AICTSL buses. This ridership was a first critical indicator of the public acceptance of the project and is a key element of any public transport system.

One reason for the phenomenal increase in ridership was the significant savings in travel time that the

segregated and prioritized mode offered users. Average estimates indicated that the BRTS allowed users to save around 26 percent of their travel time as compared to their journey by city bus along the same route. This translates into a 5-minute savings on an average trip length of 4.5 km, which is significant, as a 4.5 km trip takes only 14 minutes. Initial expectations for modal shifts to the BRTS were based on the numerous informal transport modes prevalent along the pilot corridor. However, surveys revealed that nearly 25 percent of the total BRTS passengers actually shifted from private vehicles (cars and two-wheelers). This is a substantial achievement for the project and is a result of the considerably higher level of service offered through segregation.

In addition to the positive impacts on ridership, throughput, and travel time savings, the project was able to improve the financial viability of the system. Data indicated that the initiation of the BRTS pilot resulted in an additional 1,600 passengers per bus per day (Atal Indore City Transport Service Limited 2014). This increase allowed better distribution of capital investment costs across a larger passenger load. In other words, the per capita costs of the project were reduced, thereby also reducing the overheads as well as operations and maintenance costs. From an operational perspective, this helps to maintain a low fleet size to reduce the burden of capital expenditure on vehicle procurement.

As a result of these impacts, the iBus also reaped considerable financial benefits, with an average EPKM of Rs. 66.43 (Atal Indore City Transport Service Limited 2014). As compared with EPKM figures for city buses, this is more than a 100 percent increase.

Post-implementation data analysis indicates that the system improved in 6 parameters (see Table 33): ridership, time saved, new ridership from private vehicles, lives saved, ridership / bus / day, and average earnings.

In October 2013, the ability of the iBus to operate in segregated lanes was revoked due to numerous objections questioning the safety and viability of the system (Atal Indore City Transport Service Limited 2014). AICTSL is presently discussing valid counter-arguments to these perceptions, addressing issues and concerns, and determining a clear way forward. Despite this setback, in September 2014, the system served up to 46,000 passengers per day (Atal Indore City Transport Service Limited 2014), indicating a growing number of riders.

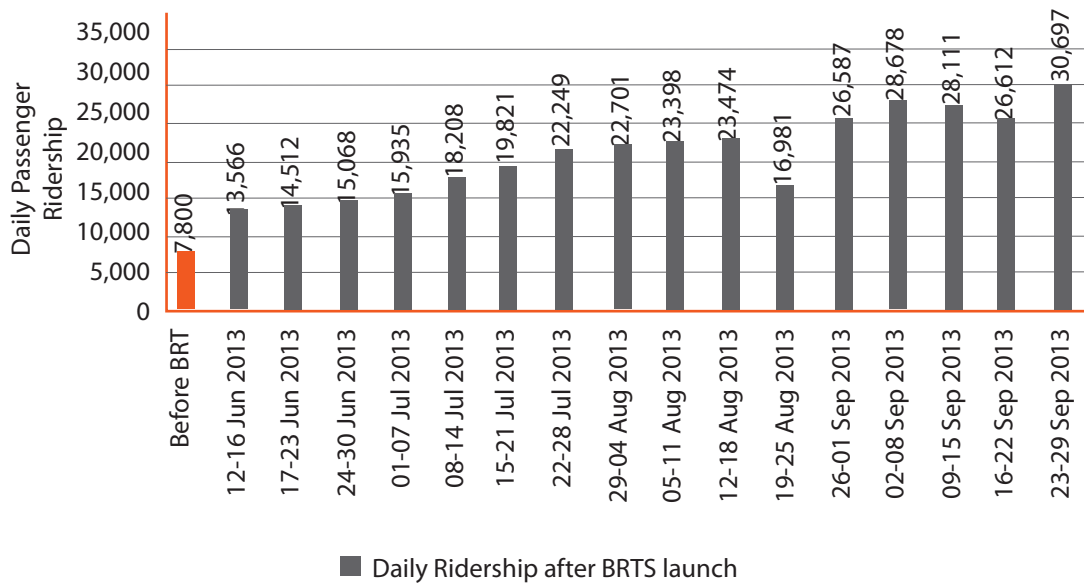


Figure 108 Ridership on AB Road before and after BRTS launch (Atal Indore City Transport Service Ltd. 2014)

SECTION SUMMARY: Segregating Bus Infrastructure

Data indicates that buses are involved in a high number of road crashes and in severe road crashes. To Improvements made to standard city bus services can only improve bus transport to an extent; beyond a point, there is a need for segregated bus infrastructure. Segregated bus infrastructure presents the opportunity to increase vehicle speed, which has an impact on capital costs, fuel efficiency, fleet utilisation, maintenance and manpower requirements.

With an increase in congestion, Indore was faced with low travel speeds and drastic increases in travel times. These negate the attractiveness of bus transport, and the system ridership declined over time. As a way to overcome the effects of traffic congestion on bus service provision, the city introduced the Indore BRT corridor. Post-implementation analysis indicates the system improved in six parameters: ridership, time saved, new ridership from private vehicles, lives saved, ridership / bus / day and average earnings.

8.3 Public Transport Subsidies

Public transport subsidy is an instrument used to maintain and provide quality transport services. It is important to note that subsidies work as a financial input, after ensuring that all other self-sustaining methods are exhausted. This is to ensure that the operating agency consistently works to improve system inefficiencies, rather than depending on the subsidy to manage operations. Subsidies in public transport have been implemented in India; however, there are no assessments to indicate if the system is working effectively. There is a strong case for subsidising public transport services to ensure that it is socially inclusive, promotes public transport use, and potentially results in a modal shift from private vehicles. In India, there is no transparent policy on subsidies as they are by and large provided based on political will. This section discusses the need to provide subsidies, the role of city and states authorities and the ways to approach subsidy provision.

PUBLIC TRANSPORT Subsidies and Quality of Service

Chapter 7 elaborately discussed the imbalance that exists between the expenditure and revenue in public transport service provision, as experienced by many cities. To manage the financial sustainability of an agency in this case, there are generally two ways forward: either service quality is reduced, or subsidies are introduced.

For example, AICTSL, the city bus service provider in Indore, initially employed 95 buses on 26 routes. Over a period of time, the decline in speed due to traffic congestion in the city, led to increased travel times and a loss in ridership. To maintain an adequate level of service and to continue operations within the budget, AICTSL decided to reduce the area served. This allowed the agency to manage the existing fleet of 95 buses on 15 routes, within a smaller service area.

Instead, AICTSL adopted another way forward. A key performance indicator of any city bus system is the speed at which buses operate and the effect on passenger travel times. A minimal increase in speed, through segregated bus infrastructure for example, can reduce the fleet, frequency and trips required (as shown previously in Figure 8.4). As a result, an increase in ridership and revenue would improve the financial position of an agency, in turn reducing or omitting the need for any subsidy.

In the comparison between the operational costs of minibuses against that of standard city bus services, Chapter 7 also indicates the reduced operational costs of minibuses (see operating cost of Naya Raipur bus services in Table 7.1 and minibus operating costs in Bhopal in Table 7.3 and Table 7.4). The data indicates that operating costs for minibuses are lower, in comparison to city bus services, in this case. While this option is available to service providers as a way to reduce operational costs, it is important to note that the quality of service provision by minibuses faces multiple challenges. Surveys conducted indicate five issues with the minibus service: low service reliability, lack of standard fares and information pertaining to fares, overcrowding, poor condition (due to inadequate maintenance work) of buses and bus stops, and a lack of adherence to rules and regulations. It is important to recognise that poor service quality can have a negative effect in the long-term.

GUIDELINES for Public Transport Subsidies

At a basic level, public transport brings with it several positive externalities, adding to the quality of living for cities in many ways. These externalities can be grouped into three overall effects that make subsidies necessary for any city:

- **Addressing social inclusiveness:** This is to ensure that public transport is accessible for all. Subsidising helps low-income earners to use public transport and prevent the problem of social inclusion.
- **Addressing Urban transport issues:** Public transport use brings with it positive externalities through reduced congestion, minimising air and noise pollution, addressing parking needs and accidents. In the current set up, it is not feasible to charge private vehicles for the externalities they cause. One way is to provide subsidies to public transport.
- **Promoting the use of Public Transport:** One of the major expectations is that modal shift to public transport will take place if subsidies are provided to reduce costs. However, with poor level of service and reliability, the modal share of public transport across cities has either remained stagnant or has started declining.

Public transport subsidies are financially burdensome for the provider of funds (Cervero 2011). However, the positive externalities are significant in offsetting the impacts indicating the

need to ensure a balance between the social and financial responsibility of the agency. In this context, the following guidelines should be considered when establishing the level of subsidies for public transport:

- The extent of subsidy should take into consideration the source of funds for the subsidy, income from the public transport, and the welfare weightage that policymakers attribute to different income classes.
- In order to receive subsidy, it is important to maintain a certain percentage of farebox recovery for the remaining cost.
- Scientific approach to fare setting: While subsidy is a political decision, it is important to calculate the technical and public fare before deciding the subsidy. Based on this, agencies can determine the gap between the technical and public fares and apply for subsidies as required.
- Subsidies only to targeted groups: There is a

need to target specific user groups that need subsidies for public transport use (Cropper and Bhattacharya 2012). User groups such as the elderly, students and the differently-abled are largely dependent on public transport (Ubbels, et al. 2001).

- While subsidies are in place, it is important to improve the level of service. This is to ensure that the public transport system is efficient and retains the section of passengers who do not claim any subsidy.

Providing subsidies can be a burden on the subsidising authority (World Bank 2011), typically the city or state government in the Indian administrative system. It is hence good practice for operating agencies to financially plan for their subsidy requirements, based on operational data available from the previous year. This exercise, along with strategies including the implementation of an urban transport fund or land-banking strategy (discussed in Chapter 7) can be effective in ensuring quality public transport services.

SECTION SUMMARY: Public Transport Subsidies

Further to the discussion in Chapter 7 on the imbalance of public transport expenditure versus revenue, subsidies can assume a significant role in bridging this gap. It is vital to understand that the primary goal is to improve transport services. As a secondary aspect, alternate ways such as land-banking can strengthen the financial position of agencies. Further to this, subsidies can be effective in maintaining quality public transport services.

Subsidies have four distinct objectives. They address social equity, urban transport problems, public transport promotion and scale of operation. There is a scientific process for calculating subsidies which involves timely financial planning by operating

8.4 Land Planning for Transport Infrastructure

Establishing a structured and detailed process for planning land provisions for bus transport infrastructure can expedite operations and maintenance activities. The current development plan process in cities incorporates the basic needs of bus transport. For example, the Bangalore Development Control Regulations (Revised Master Plan 2015 - Bangalore Volume III 2007) specify transportation zones, which consider bus stands, bus shelters, and transport depots. The process followed by some younger or greenfield-development cities, such as Naya Raipur in Chhattisgarh, earmarks space for the right of way of buses. Rather than mandatory requirements, these are guidelines put in place by the Naya Raipur Development Authority. In this case, the agency closely monitors the process to ensure that the guidelines are followed.

Every city adopts a different approach to provide land for bus transport services and infrastructure. There is however, a need to mainstream this process and ensure that it considers some critical factors. Taking the example of bus infrastructure needs, this section discusses how the preparation of the Development Plan (DP), typically undertaken every decade, can facilitate service provision by including detailed planning forecasts of the local transport operator.

With the expansion of transport services, there is an increasingly stronger need to allocate space for infrastructure. Infrastructure such as depots, terminals, interchanges and intermodal hubs are an essential component for the efficient operations of public transport system including city bus services.

- **Terminals:** The primary aspect of off-street terminals is the space required for convenient and safe bus turnarounds.
- **Depots:** Depots are used for maintenance purposes, parking and in some cases to also start and terminate routes. The placement of depots at prime locations enhances operations by reducing the rate of dead kilometers and ensuring the quality of maintenance.
- **Intermodal hubs:** Hubs are generally located for the convenient transfer between various transport modes. Two important factors to consider are the convenient location and size of intermodal hubs, to ensure passenger convenience and operability.

Subsidies have three distinct objectives: social equity, to address urban transport issues, and the promotion of public transport.

It is common practice to overlook transport needs in the DP, which results in hampering efficient operations. While planners acknowledge land requirements, there is a need to consider the characteristics of the land. By using the example of transport depot infrastructure, this section discusses the extent to which these elements are considered in the DP and how this can be strengthened.

PLANNING for Depot Spaces

Cities typically undergo a general process to reserve land for transport infrastructure in their DPs. During the drafting process, the development authority studies the Comprehensive Transport Study, or CTS, to gain an understanding of the long-term mobility strategy for the city. It then earmarks the city's transport infrastructural needs in response to the urban and regional vision.

As and when the need for additional space arises, the transport agency submits a request to the development authority. Dialogue between the two authorities helps understand the availability of land in response to transport needs. For example, when land prices in urban centres increase drastically, in reality, this remains a constraint on the availability of land. The authority responds either by reserving land while drafting the DP, earmarking space for the infrastructure, or providing the transport operator with existing land, where feasible. This response largely depends on factors such as the availability / ownership of land and the existing land use. In Navi Mumbai, for example, the transport agency has a minimal role to play in the allocation of land for its depot. The agency receives land based on availability. Recently, the City and Industrial Development Corporation, or CIDCO, offered the agency a seven-acre plot of land at Ghansoli, where it plans to set up a depot facility catering to around 200 buses (Navi Mumbai Metropolitan Transport 2014).

Once land is reserved in the DP, however, the transport agency has no guarantee that the land will be available and ready for use. In some cases where the land is earmarked for transport use in the DP, the vagueness of the term 'transport' is manipulated

Three factors must be considered to ensure adequate land reservation in the DP: a specific and coherent institutional approach, the location and the size of the land.

and utilized for non-bus transport infrastructure, e.g. to provide housing for transport staff and officials. Further conversation on land acquisition and use for bus transport becomes an issue for the development authority.

In the case of depots, three factors must be considered to ensure adequate land reservation in the DP: a specific and coherent institutional approach, the location, and the size of the land provided.

A SPECIFIC and Coherent Institutional Approach

Though the DP process allocates land for support infrastructure, there is a critical gap between what the transport agency requires and what is actually provided. Incorporating the precise needs of the transport agency greatly facilitates transport operations. It is essential to maintain constant dialogue between the transport agency and development authority in order to consider the changing needs of dynamic urban areas. This requires the transport authority to establish sufficient planning of spatial objectives and market trends with a long-term strategy in place.

Once land is earmarked, it is important that the DP recognises it as infrastructure pertaining specifically to bus transport. This is important in preventing any manipulation of the space for transport-related uses, such as residential areas for transport staff. Furthermore, the reservation policy should include a level of flexibility to allow alterations based on future growth patterns of the city.

Another aspect relates to the current restrictions on where support infrastructure can be located. Some DPs prohibit the placement of support infrastructure in residential areas, which would operationally benefit the transport agency. The misconception that bus maintenance activities are industrial in nature is no longer valid with the use of advanced technology. Land use policy should be modified to allow for the construction of support infrastructure in residential areas to facilitate better user access to

transport and to reduce wasted kilometers for the operator.

LOCATION AND ACCESS TO INFRASTRUCTURE

The second critical factor is the location of the land. Strategic distribution of infrastructure spaces across the city can significantly improve system efficiency. A desirable location facilitates transport operations. The proximity to existing demand / proposed route structure (i.e. locating a support infrastructure closer to the area of operation) facilitates two benefits: quick response to breakdowns / schedule alterations, and reduction in dead kilometrage. The distribution of support infrastructure is helpful in reducing ineffective kilometers due to mid-day stabling. Intermodal integration, reduction in cycle times for turn round, easy access and night-time parking are other benefits. Additionally, the reduced ineffective kilometers also optimise costs.

Table 34 shows data on five factors that indicate how transport agencies fare in locating their bus depots. In the case of Mumbai and Navi Mumbai, the dead kilometer count is non-indicative since most of their routes are intended to start from depots.

In the case of Delhi, afternoon stabling of buses requires drivers to return to the depot, further adding to the dead kilometrage count. To address the inefficient use of fuel, time, and costs to return to the depot, DTC decided to allow buses to refuel at the depot nearest to the operated route (Bhasin 2011). With a large network of depots spread across the city, Delhi is able to benefit from this operational adjustment.

ADEQUATE SPACE FOR DEPOTS

As indicated in Table 35, depot plans typically consider space for:

- Number of buses to be parked
- Maintenance requirements (stores, pits, fuel pumps, etc.)
- Administrative buildings
- Staff amenities

To accommodate 100 buses, a depot is roughly 5.5 acres in size (Singh 2014). The Report on Indian Urban Infrastructure and Services (The high Powered Expert Committee (HPEC) for Estimating the Investment Requirements for Urban Infrastructure Services 2011) specifies that a depot is required for every 70 buses. When submitting a request for land requirements, the transport agency must determine

the needs for future operations. The size of the depot is directly proportional to the size of operations; hence, it determines the ability of the agency to expand operations in the future. For example, depot sizes in Mumbai are between 5.5 and 6 acres for 175 to 200 buses. As the city's demand for transport constantly increases, the space inadequacy is a critical factor that restricts the introduction of new services. As a result, even high-frequency routes become overcrowded. In London for example, the most important factor to contesting for service contracts is the access to depots.

Under the cluster model, initiated by the Delhi Integrated Multi Modal Transit System (DIMTS), the Delhi Transport Corporation (DTC) expected private operators for each of the 17 clusters. However, operations for only one cluster were initiated. While the DTC has requested the allocation of space for depots in each cluster, the Delhi Development Authority (DDA) is yet to adhere. The unavailability of land has led authorities to deliberate over one large depot or two smaller depots (Banerjee 2014). As a result, operations remain largely inactive. An increasing difficulty to provide for land within city limits and close to demand and operations is a problem that many cities face today.

FUNCTION	FACILITIES	TMT, THANE (PERCENTAGE OF TOTAL SPACE)	STAR BUS, DELHI
Maintenance	Workshops, washing area, service pits, tire / lubricant / oil stores, etc.	5%	10 – 15%
Parking	Reserve fleet area, off-duty vehicles, night-time parking, vehicle circulation	93%	90%
Staff Amenities	Toilets, Kitchen, Driver Rest Area, Lockers, Staff Parking	Included in administrative block	2.5%
Administrative Block	Office space, Clerical work, accounting, etc.	2%	<1%
Total Space		9.32 acres 200 buses	5.6 acres 100 buses

Table 34 Space Allocation in depots in Thane (Mumbai suburbs) and Delhi

	DELHI	MUMBAI	BHUBANESWAR	NAVI MUMBAI	INDORE
Number of Buses	5,500	3,769	185	356	25 BRTS buses
Number of Depots	46	26	10	2	3
Average Size of Depots (acres)	5	6	-	7.5	2.2
Average number of buses / depot	119	144	18	178	40
Average Dead Kilometers (per day)	5,390 (per depot)	0	597	0	290

Table 35 Comparison of number of depots to dead kilometerage for agencies

¹ BEST begins / ends every route from a depot; their dead kilometerage is 535 kms, which is accumulated during practical sessions held at the training centre.

NMMT begins / ends every route from a depot, to minimise dead kilometerage.

A key decision to be undertaken at this point is who will provide the space for infrastructure – the agency or the contractor. If the private operator were to invest in long-term assets such as land for infrastructure, challenges considering the ownership of the asset post the contract period must also be addressed.

An approach to facilitating the land provision, presently being considered in Delhi, is the use of smaller land parcels at various locations. The main purpose of a depot is bus maintenance, parking and other daily functions such as fuelling, washing, etc.; these functions are not co-dependent and hence can be undertaken independently. With an increase in space deficiency in many cities, a more creative approach may be required to accommodate the need for depots. In this case, smaller depot sizes or the use of terminal space for overnight bus parking can be helpful for agencies.

Some transport agencies lack operational depots for parking and maintenance works to be undertaken. The unavailability of land and the lack of funding to acquire land are key impediments to adequate maintenance measures. Mira-Bhayander Municipal Corporation's Transport wing (MBMT) manages local bus transport with a fleet of 55 buses. While operations and maintenance are outsourced through contracts, the absence of depot facilities results in parking and maintenance occurring on roads or below flyovers (see Figure 109). As a consequence, 10 percent of bus schedules are cancelled every month, hampering operations (Mira-Bhayander Municipal Transport 2014).

At present, Mira-Bhayander is putting efforts towards designing a new depot space near Bhayander Station to provide for the existing fleet and new fleet being procured under JnNURM funding.

CASE STUDY: Land Planning for Transport Infrastructure in Bangalore

Ever since the Information Technology (IT) boom in the 1990s, Bangalore city has continuously expanded to absorb the surrounding villages at its periphery. In prospect of the city's growth, the transport authority - Bangalore Metropolitan Transport Corporation (BMT) - bought parcels of land in these peripheral areas, with the expectation of significant transport demand in the future. As the city grew and the perimeter became populated, the corresponding demand for mobility services also grew.

With 4,500 buses and 6,500 buses, in Mumbai and



Figure 109 Bus maintenance in Mira-Bhayander occurs under flyovers and on streets (Mira-Bhayander Municipal Transport 2014)

Delhi, transport agencies have been restricted from expanding fleet use due to the lack of support infrastructure. Meanwhile, BMT has doubled its ridership from 2.5 million to 5 million passengers, with a fleet expansion from 3,500 to 6,500 in the last decade. BMT presently has 38 depots and 50 bus terminals that were developed through a long-term land banking strategy (BMT2014).

As BMT began operations in these parts of the city, the land was utilized for depot facilities. A long-term strategy and vision with a planning horizon of around 10 years helped the agency to predict the transport requirements in conjunction with the expansion of the city. The planning allowed BMT to ensure ownership of land in prime areas.

SECTION SUMMARY: Land Planning for Transport Infrastructure

The Development Plan preparation process typically includes a visioning exercise for basic bus transport requirements, such as the right of way and the need for infrastructure. This level of detail however becomes ineffective for transport operators, often impeding operations. Development plans need to consider three additional factors to ensure adequate land reservation in the planning document: a specific and coherent institutional approach, the location, and the size of the land provided.

CHAPTER SUMMARY:

Public transport provision falls within the purview of the transport operator and city and state authorities. The discussion so far focusses on the responsibility of the operating agency in managing operations. As a way forward, there are four areas where the state's decision and policy-makers' active engagement can be effective in expediting bus operations: system safety, segregated bus infrastructure, public transport subsidies, and land planning for bus infrastructure. In conclusion, each of the four-point agenda links back to the initial discussion on strengthening bus systems as a way to promote public transport use.

APPENDIX A

DELHI TRANSPORT CORPORATION

Type of Operator	Public
Fleet	5,602 buses
Daily Ridership	30 lakh passengers
Manpower	38,103
Area of Operation	Delhi
Bus System	City Bus
Fleet Utilisation	85.8%
Schedule kms	205,509

NAVI MUMBAI MUNICIPAL TRANSPORT

Type of Operator	Public
Fleet	411 buses
Daily Ridership	1.5 lakhs
Manpower	2,200
Area of Operation	Navi Mumbai, Mumbai, Mira-Bhayander, Kalyan, Thane
Depots	2
Bus System	City Bus
Case Study and Highlights	Driver Training Programme

BRIHANMUMBAI ELECTRICITY SUPPLY AND TRANSPORT

Type of Operator	Public
Fleet	4,533 buses
Passengers / bus / day	906
Manpower	35,000
Area of operation	Mumbai Metropolitan Region
Scheduled kms	6.66 lakhs
Depots	26
Bus Stops	6,363
Routes	506
Bus System	City Bus
Case Study and Highlights	Feeder Bus Design, Scheduling Driver and Conductor Duties

MIRA-BHAYANDER MUNICIPAL TRANSPORT

Type of Operator	Public
Fleet	50 buses
Daily Ridership	78,000
Manpower	550
Area of Operations	Mira-Bhayander, Mumbai, Navi Mumbai, Thane
Bus System	City Bus

JAIPUR CITY TRANSPORT SERVICE LTD.:

Special Purpose Vehicle	Jaipur Development Authority, Jaipur Municipal Corporation, Rajasthan State Road Transport Corporation
Fleet	408 buses
Daily Ridership	2 lakhs passengers
Manpower	1,300
Area of Operation	Jaipur and surrounding towns
Bus System	City Bus, BRT
Case Study and Highlights	ITS Implementation and Challenges

THANE MUNICIPAL TRANSPORT

Type of Operator	Public
Fleet	338 buses
Daily Ridership	2.4 lakhs
Manpower	2,306
Area of Operation	Thane City, towards Kalwa, Mumbra, Mira Road, Narpoli and Borivali
Fleet Utilisation	68.05%
Scheduled kms	149.12 lakhs
Depots	2



ANDHRA PRADESH STATE ROAD TRANSPORT CORPORATION

Type of Operator	Public; State
Depots	213
Fleet	22,507
Effective kms per day	83 lakhs
Daily Average Ridership	1.55 crores
Manpower	1,22,692
Staff to bus ratio	5.94
Fuel Efficiency	5.15
EPKM	24.10
Bus System	City Bus, State
Case Study and Highlights	Fuel Efficiency Training and Management

ATAL INDORE CITY TRANSPORT SERVICES LTD.:

Type of Operator	Special Purpose Vehicle
Fleet	110 buses
Daily Ridership	1 lakh passengers
Manpower	625
Areas of Operation	Indore
Bus System	City Bus, BRT

BHOPAL CITY LINKS LTD.:

Type of Operator	Special Purpose Vehicle: Bhopal Municipal Corporation and Bhopal Development Authority
Fleet	205 buses
Daily Ridership	1 lakh
Scheduled Kms / bus / day	223 km
Area of Operation	Bhopal
Bus System	City Bus, BRT

NORTH EAST KARNATAKA ROAD TRANSPORT CORPORATION

Type of Operator	Public; State
Fleet	4,295 buses
Daily Ridership	10 lakhs
Manpower	17,500
Area of Operation	North East Karnataka
Bus System	Inter-city
Case Study and Highlights	Initiating city bus services, Data and Monitoring Performance, Terminal in Gulbarga

KARNATAKA STATE ROAD TRANSPORT CORPORATION

Type of operator	Public; State
Depots	77
Fleet	8243
Effective kms per day	26.59 lakhs
Daily average ridership	25.73 lakhs
Staff	37,810
Bus system	Inter-city

BANGALORE METROPOLITAN TRANSPORT CORPORATION

Type of Operator	Public
Fleet	6,691 buses
Daily Ridership	49.5 lakh
Manpower	36,164
Depots	40
Scheduled kms	13.14 lakhs
Fleet Utilisation	89%
Fuel Efficiency	3.79 kmpl
Bus System	City Bus
Case Study and Highlights	Hosur Road Interchange, Branding the BIG Bus Network, Fare Fixation, Land Planning for Infrastructure

CHENNAI METROPOLITAN TRANSPORT CORPORATION

Type of Operator	Public
Fleet	3,798 buses
Daily Ridership	48.07 lakhs
Manpower	24,169
Scheduled kms	3442 lakh
Fuel Efficiency	4.34 kmpl
Area of Operation	Chennai
Bus System	City Bus

APPENDIX B: GLOSSARY OF ABBREVIATIONS AND ACRONYMS

ACRONYM	DESCRIPTION
AC	Air-Conditioned
ACA	Additional Central Assistance
AFCS	Automated Fare Collection System
AICTSL	Atal Indore City Transport Services Limited
AMC	Annual Maintenance Contract
APSRTC	Andhra Pradesh State Road Transport Corporation
ASRTU	Association of State Road Transport Undertaking
ASTC	Assam State Transport Corporation
AVLS	Automatic Vehicle Location Systems
BAS	Boarding Alighting Surveys
BOS	Bus Occupancy Surveys
BCLL	Bhopal City Links Limited
BEST	BrihanMumbai Electricity Supply and Transport
BIG	Bangalore Integrated Grid
BMTC	Bangalore Metropolitan Transport Corporation
BOT	build-operate-transfer
BRTS	Bus Rapid Transit System
CBD	Central Business District
CDAC	Centre for Development of Advanced Computing
CIDCO	City and Industrial Development Corporation (Navi Mumbai)
CMP	Comprehensive Mobility Plan
CNG	Compressed Natural Gas
COPU	Committee on Public Undertakings
CST	Chhatrapati Shivaji Terminus (Mumbai)
CTS	Comprehensive Transit Study
DA	Dearness Allowance
DDA	Delhi Development Authority
DIMTS	Delhi Integrated Multi Modal Transit System
DP	Development Plan
DPR	Detailed Project Report
DTC	Delhi Transport Corporation
DTS	Dream Team Sahara (Bhubaneswar)
DULT	Directorate of Urban Land Transport (Bangalore)
EDC	External Development Charges
EMI	Equated Monthly Instalment
EPKM	Earnings per Kilometer
ETM	Electronic Ticket Machine
EWS	Economically Weaker Section
FSI	Floor Space Index
GEF	Global Environment Facility
GHG	Green House Gas
GMDC	Gujarat Mineral Development Corporation
GNCTD	Government of the National Capital Territory of Delhi
GPRS	General Packet Radio Service
GPS	Global Positioning System
HPEC	High-Powered Expert Committee
IABM	Indian Association of Bus Manufacturers
iBus	Indore BRT System
INR	Indian Rupees
IPT	Intermediate Public Transport
IR	Indian Railways

IRC	Indian Roads Congress
IT	Information Technology
ITI	Industrial Training Institute
ITS	Intelligent Transport Systems
JCTSL	Jaipur City Transport Services Limited
JDA	Jaipur Development Authority
JnNURM	Jawaharlal Nehru National Urban Renewal Mission
KMPKG	Kilometers per kilograms (of CNG)
KMPL	Kilometers per litre (of diesel)
KSRTC	Karnataka State Road Transport Corporation
LED	Light-Emitting Diode
LoS	Level of Service
MBMT	Mira-Bhayander Municipal Transport
MCGM	Municipal Corporation of Greater Mumbai
MITRA	Mysore Intelligent Transport System
MMR	Mumbai Metropolitan Region
MPIC	Monthly Programme Implementation Calendar
MoUD	Ministry of Urban Development
MTC	Metropolitan Transport Corporation (Chennai)
MyBus	Bhopal BRT System
NCPA	National Centre for the Performing Arts (Mumbai)
NEKRTC	Northeast Karnataka Regional Transport Corporation
NGO	Non-Government Organisation
NHAI	National Highway Authority of India
NMMT	Navi Mumbai Municipal Transport
NUTP	National Urban Transport Policy
O&M	Operation and Maintenance
ORR	Outer Ring Road (Bangalore)
PIS	Passenger Information Systems
PPP	Public-Private Partnership
PT	Public Transport
PWD	Public Works Department
RAJPATH	Rajkot BRT System
RFID	Radio Frequency Identification
RPM	Rotations per Minute
RSRTC	Rajasthan State Road Transport Corporation
SMS	Short Message Service
SPV	Special Purpose Vehicle
SRTU	State Road Transport Undertaking
STU	State Transport Undertaking
SUTP	Sustainable Urban Transport Project
TA	Technical Assistance
TDR	Transfer Development of Rights
TfL	Transport for London
TMT	Thane Municipal Transport
TSP	Transit Signal Priority
TTMC	Traffic and Transit Management Centre (Bangalore)
UBS	Urban Bus Specifications
ULB	Urban Local Body
USD	United States Dollar
UTF	Urban Transport Fund
VGf	Viability Gap Fund
VMU	Vehicle Monitoring Unit
WEH	Western Express Highway (Mumbai)

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