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PUBLIC TRANSPORTATION AND OPTIMISATION

1. EXECUTIVE SUMMARY

Modal shares of public transport are on the decline in most developing cities. Deteriorating quality and/or lack of alternative transport modes, e.g. public transport and safe walking and cycling facilities have forced many to shift from public transport to using personal vehicles as their daily mode of commute. This shift has translated into increased traffic congestion, air and noise pollution, reduction and deterioration of public spaces and urban form, social exclusion, increased GHG emissions and many other negative externalities. Many cities (e.g. in India, Indonesia, China, Malaysia) are recognising this decline in modal shares of resource efficient modes and are attempting to address this issue at a policy level, by encouraging greater usage of public transport and non-motorised transport (NMT) modes in their cities. It is well acknowledged that in order to improve and manage a service, one has to first be able to measure it. Hence in order to make public transport services attractive, and thereby increase their modal shares, public transport services in cities not only need to be planned, operated and marketed well, they also need to be measured and monitored on a continual basis. In the last few years, Indian cities have dramatically transformed their mobility through the implementation of many bus transit solutions. Urban India experienced several major accomplishments on multiple fronts: i. Innovative policy-based initiatives in public transport ii. Various pilot reforms to enhance operational efficiency iii. The growing potential of technology applications

iv. Wide-reaching and successful strategies in branding and marketing approaches

v. A significant increase in Bus Rapid Transit Systems and the optimisation of city bus services

All these were possible as certain cities decided they need to provide better transport services to its citizens. Often, the public transport or mass transport systems are neglected or perceived as a low-class option. This is evident from the appallingly low quality of transit systems operating in many Indian cities. The National Urban Transport Policy advocates robust mass transit systems for the cities to solve the problems of poor mobility and deteriorating environment.

This volume on Public Transport covers various aspects of mass transit systems that are useful to decision makers and operators alike in achieving sustaina bility in public transport.

2. INTRODUCTION

In this document we would be understand how to evaluate performance of existing public transport system, study the demand for public transport and plan for the city's needs. We shall be going through this document in three section:

1. City Bus services

City Bus Services (CBS) are the most important Public Transport systems in cities all over the world. To date, the buses serve most of the commuting demand in Indian cities too. To develop, strengthen, and change the deteriorating image of the City Bus Services, there is a need to conceptualize, plan, develop, operate, and manage the services efficiently. This module details the factors Involved in planning, operation, and management of city bus services. The steps involved in developing a city bus system are explained for the officials and operaotrs to understand the process.

2. Mass Rapid Transit

The Mass Transit Systems available can be broadly grouped into a 'rail system' and 'bus system' classification. The distinguishing characteristic is whether the transit vehicle can use city streets without special modifications, or whether the vehicle requires special "guideways" to operate. In simplest terms, the vehicles in the rail system must operate on rails or other guideways that cannot be used by automobiles. The bus system can have its own dedicated guideway, but these vehicles are able to leave the guideway and use city streets. This distinction is important in areas where limited right-of-way (ROW) is available, such as Central Business Districts (CBD). Within these rail and bus families, different technologies have different performance characteristics and requirements to be implemented.

3. Integrated transport

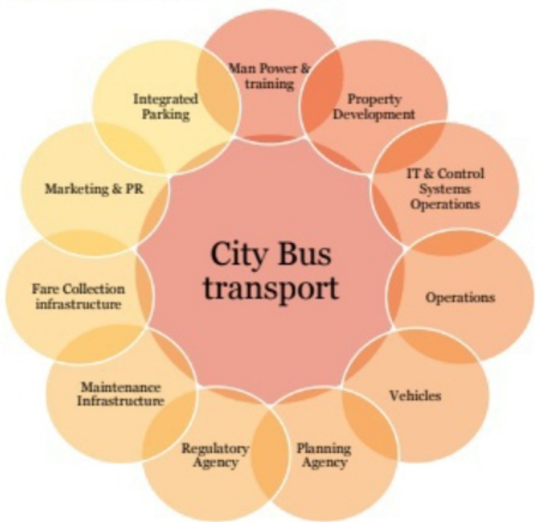
Integration of different modes helps in improving the economic and social prosperity of an area by reduced congestion on the road, convenience to commuters, efficiency, and cost effectiveness. Integration can be applied to a group of functions that are currently being administered independently. We have tried to address possible methods integrating all modesof transport present in the city. **3.**

CITY BUS SERVICES

3.1. Components of City Bus System

In India, over 90% of public transport is taken by all forms of Bus Services, including the City Bus Service. The modal share of bus transport varies from zero in some small and medium cities to about 40% in large cities such as Delhi, Bangalore, etc. Buses in Delhi enjoyed a modal share of 60% in the 1990s, which has declined to about 40% in 2008 (DIMTS 2009). In general, buses enjoy a higher modal share in larger cities and are less prevalent in smaller cities. However, there are exceptions, and buses in some small cities such as Kochi and Coimbatore serve about 50% of the total travel demand. The urban bus systems are affected by socio-economic, financial, environmental, and political factors, along with technological factors and physical problems, this makes it all the more difficult to bring above improvement in the City bus systems.

Figure 1 | **Figure showing components of City bus transport system**

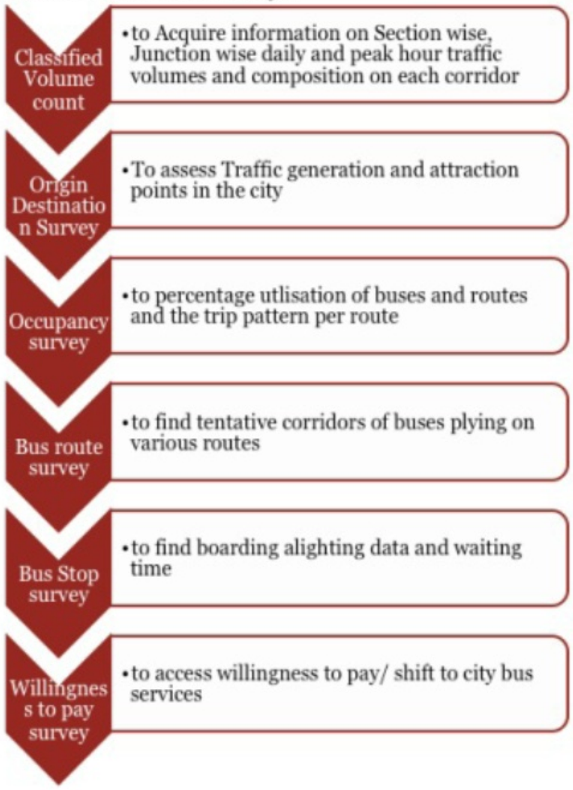


The steps involved in Planning, implementation and improvement of City bus route involves the following steps (Training Module: Public Tranport under SUTP Vol.2, p. 36):

3.2. Demand Estimation

The city bus services shall be planned based on existing demographics, socio-economic conditions and political conditions. It is to be designed in such a way that it serves for the

existing as well as future demand. To start with we need to build the demand Model; for which we require to undertake certain surveys:



After developing demand model for the city, we follow the four-step travel demand forecast model (Training Module: Public Tranport under SUTP Vol.2, pp. 38-39)

3.3. Route Identification

After demand is calculated the routes are identified and exiting ridership data on various corridors are calculated

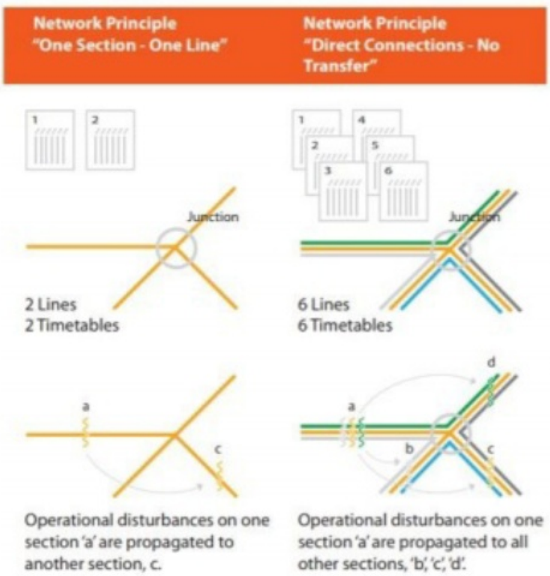
3.3.1. Data collection:

- Ridership Characteristics - Passenger load profiles on bus routes, bus passenger trip characteristics, opinions of drivers, conductors, and passengers.
- Ridership estimation - Boarding/ alighting data would be used for estimating the ridership in the future.
- Route Classification - The bus route network should follow the shape of the city and the spread of economic and residential activities.
- Stakeholder's consultation - Detailed discussion with all stakeholders, with consideration of all existing and future proposals relating to city bus services/PT facilities in the study area • System/ Route plan - City bus route plans must have connectivity between major traffic generators such high density residential colonies, employment centres, regional terminals, etc., which assures accommodating the majority of individual trips.

3.3.2. Route Location:

In a desirable system, several origin and destination points are connected by direct services, where a commuter waits for a particular bus which takes him directly to his particular destination without en-route changeovers. Instead of destination-oriented services, direction-oriented services like trunk-feeder services provide greater convenience in terms of high frequency, than connecting several origins and destinations with direct connections. While designing the network we have a number of network models to choose from based upon the from and demographic of the city this includes hub and spoke model, trunk feeder model, ring radial routes, circular routes etc. The routes should be planned such that they integrate with the rest of the network, is user friendly and understandable, easily accessible to all and connects all trip generation and attraction points in the city

Figure 2 | **Image showing issues with destinationoriented services**

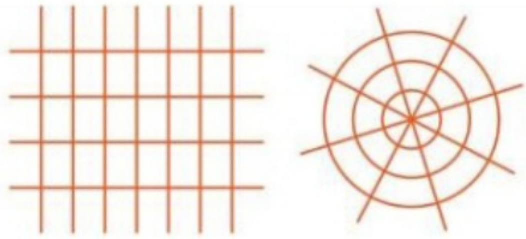


3.4. Network Planning:

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 rough route structure can then be identified 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.

Figure 3 | **Two types of Network Structures: Grid (left) Radial (Right) (Embarq (India), WRI (India), 2011)**



3.5. Planning of Feeder Route Network:

The location of feeder services may also be influenced by social considerations. Low income communities may be located in peripheral areas with poor road infrastructure. Smaller feeder vehicles are likely the only options for a system to access such areas effectively. The overall length of feeder services will depend upon demand patterns and the relative population density of residential areas. The population density of a feeder area may be two to four times lower than the population density along a trunk corridor. Since feeder services are generally expected to deliver at least half of a system's ridership, the length of the total feeder routes may need to be two to four times the length of the total trunk corridors.

3.6. Route Rationalization:

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. Route and service rationalisation in this section refers to a large-scale, periodic review of the entire network. It aims to improved accessibility, connectivity, and efficiency of the over-all public transport system of the city. Based upon the travel demand, passenger load and income efficiency of the route a rational shall be developed to create an integrated transport system.

3.7. *Service Plan:*

Once the route planning is done we require to investigate details such as type of bus, fleet size, headway and bus specification.

Calculation of fleet size

Fleetsize

$$\frac{(2\times(\text{one way travel time}+\text{Dwelling time}))}{\text{Headway}}$$

Now, we know the demand, Fleet size and Headway i.e. shall help us efficiently deduce the Passenger per hour per direction (PPHPD) in peak hours for service based on this we can decide on type of buses to be procured. Figure

4 | **PPHPD for varying Bus size and Headways (N Seshadri)**

Bus size	Bus capacity Seats	Load Factor	PPHPD for headways in secs						
Headway in secs →			30	45	60	120	180	240	300
Micro bus	12	0.70	1008	672	504	252	168	126	101
Mini	22	0.70	1848	1232	924	462	308	231	185
Midi	34	0.70	2856	1904	1428	714	476	357	286
Standard 12 M	70	0.70	5880	3920	2940	1470	980	735	588
3 axle 15 m	90	0.70	7560	5040	3780	1890	1260	945	756
Articulated 18 m	130	0.70	10920	7280	5460	2730	1820	1365	1092
Double arti 25 m	170	0.70	14280	9520	7140	3570	2380	1785	1428
Double deck	110	0.70	9240	6160	4620	2310	1540	1155	924
Double deck Arti	230	0.70	19320	12880	9660	4830	3220	2415	1932

As for Bus specification the Urban Bus Specification II published by MoHUA Can be followed.

4. Mass Transit

Mass transit includes various modes of transport services which includes trains, buses, ferries, carpool and various permutation and combinations of them. Selection of a particular mass transit system for a city will always remain a challenging task, as several players are involved in the process which include:

i. Passengers - is the most important one. They want to have a good service at a reasonable price.

ii. The transit operator - must provide the service and meet a certain service quality level to attract passengers. At the same time, he must maximize the efficiency of operations and minimize the cost for a given service quality.

iii. This local/state government and the entire population of the area served. This group is interested in promoting a socially and economically viable environment, high quality of life, and energy conservation. But, planning for transit system depends on future demand and various technical aspects that support in deciding which type of mass transit to be adopted by the city is as follows:

4.1. Carrying Capacity

The first component to be considered is the Carrying capacity the selected mode to be able to provide service for the estimated volume of passengers expected to use the system.

Capacity is measured by passengers per hour per direct which can be calculated by simply multiplying capacity of vehicle with the number of vehicles passing the station per hour. This must equate with the estimated future demand of transit per hour per direction.

4.2. Cost

The financial feasibility of any project is of utmost importance. The investments for introducing mass transit are huge this include both capital as well as Operating and maintenance cost. Hence, type of transit system chosen for a city is highly cost sensitive and depends on how much financial resources the local government can generate to implement and maintain the project.

4.3. Right of way

Physical characteristic such as Right of way and ease of implementing proposed transit system within the existing built importance while selecting the type of Mass transit system for the city.

4.4. Environment

Environmental factors such as noise pollution, air pollution, energy consumption must also be comparatively looked at before selecting the mode.

4.5. Journey time saving

This depends completely on number of passengers using the system and their value of time.

4.6. Passenger safety

The design of the of each mode must be such that there are zero fatalities. For this purpose, historical data may be quotes to understand which is the safest.

4.7. Other Factors

Other factors such as convenience, comfort, reliability is based upon the operations of the service and can be improved upon by adopting innovative ideas of last mile connectivity, user friendly stations etc.

5. Transit Integration

5.1. Introduction

It is important to increase the patronage of the transit system that we improve and increase the reach of public transit. Hence, it is important to create a seamless integration system for City bus, mass transit as well as other modes of transport within the city; this include Auto, e-rikshaws, cycle rickshaws etc. Integration needs to be done at all levels, that include:

- Operational
- Physical
- Fare
- Information
- Institutional

5.2. Operational Integration

It involves the coordination of routes, itinerary and frequencies of various modes of public transport present in the city. This will require application of management techniques to optimise the allocation of transit resources and coordinate the service: Techniques of operational integration are:

a) Coordinated Routing and Scheduling: in which high-capacity, long-haul modes, such as commuter rail and rail rapid transit, are considered as the main system and buses to act as feeder to the rail system. Accordingly, the integrated route network is planned by generating feeder bus routes for each rail station. Also, the schedules of train and buses are coordinated to minimize transfer time e between the two modes.

b) Rationalization of Redundant Services-the wasteful duplication of transit service by competing systems is eliminated and resources are redeployed to reduce headways on existing routes and extend services into new areas.

5.3. Physical Integration

This refers to the provision of jointly used facilities and equipment. There are various techniques of physical transit integration, some of them are:

a) Intermodal Terminals - Transfer between modes of transit service is facilitated by intermodal terminals, often described as transportation centre. The most highly developed of these facilities accommodate commuter rail lines, rail rapid transit lines, light rail and streetcar lines and bus services, with facilities of transfer between themselves or from dial-a-ride or circulation feeder services, taxis or private vehicles. Parking accommodation is provided to encourage park-and-ride travel, and loading areas permit passengers to be dropped off by car (kissand-ride). Appropriate provisions for bicycles and pedestrians are also provided at the terminals. Where single-fare systems for all transit modes have been established, passengers move freely among different services without being stopped by barriers or turnstiles.

b) Transit Shelters - These ranges from simple weather-protection structures on surface transit routes to "mini-terminals" at Important stops and transfer points. The more complex facilities may provide automatic ticket vending machines, free direct telephone connections to a centralized information service, locater maps, posted routes and schedules, and promotional material on reduced-fare multi-ride passes or special excursions.
(Source: Excerpts from Integrated and Infrastructure Planning Module)

5.4. Fare Integration

A single, fare structure is to be established that permits riders to purchase one ticket at the beginning of the trip and transfer freely among all modes or lines of service within the system. Fare integration, besides making it more convenient for passengers, also enables the transport companies involved to optimize their processes. This system requires the creation of administrative structures which develop and monitor the rules for distributing the revenue. There are several options for developing an integrated fare system or integrated ticketing system. In Continental Europe, transport companies have been trying to get customers to buy weekly, monthly or annual season tickets. Another approach is to move from tickets to smart cards. Smart cards can handle variable pricing systems and can be used for cashless payments outside the transport sector. Smart cards can solve the problems of buying multiple tickets if they only cover a single system. (Source: Transit Alliances by GIZ)

5.5. Information Integration

Information on routes, schedules, fares, and transfer points for all transit modes and services throughout the urban area must be provided by a centralized source. Information services include route maps, timetables, fare schedules, and promotion materials; uniform street signs and vehicle identification; display at stops, transfer points and major stations; and telephone inquiry answering service. Providing integrated information during every leg of the journey is important to make them attractive enough.

5.6. Institutional Integration

Institutional integration within transport refers to integration between central agencies; between central and local government agencies, and between modes. There is also the need for integration between local government agencies. Integration means getting a better result by doing things in a coordinated way, so that the whole is greater than the sum of the parts.

6. Conclusion

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.

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.