Bus Rapid Transit: An Integrated And Flexible Package Of Service

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ABSTRACT

While light rail is an increasingly popular form of fixed guideway transit, the high costs of building and operating a light rail system makes it difficult for smaller and medium sized cities to invest in this type of transit infrastructure. A staged or incremental approach to fixed guideway transit investment, commensurate with the existing and near term travel market characteristics, is gaining increasing interest with the Federal government and certain US transit agencies. Bus rapid transit can serve as both a relatively inexpensive alternative to light rail systems for all types of cities and a stepping stone for growing cities to invest in future fixed guideway infrastructure. Our research of individual bus rapid transit systems in Brazil, Canada, England and the United States has given us comprehensive insight into bus rapid transit systems and the opportunity to document and analyze the role bus rapid transit can play in urban areas.

The definition of bus rapid transit goes beyond any particular application of technology, facility improvement, or service configuration. In fact, many of the bus rapid transit systems around the world incorporate widely varying applications of bus technology, facilities and operations. What differentiates bus rapid transit systems is the way in which they combine improvements in the technology with a comprehensive revision in the operating plan and thoughtful improvements to the interface of the system with the customer. The approaches presented in this report suggest that bus rapid transit can be used as an effective tool to supplement and build toward a high capacity rail transit system.

INTRODUCTION

Increasing congestion in urban and suburban areas have led a number of transit agencies to invest in light rail transit systems. Light rail is a lower cost alternative to more expensive rapid transit subway systems and is usually of higher quality than traditional bus systems. While an increasing number of transportation investment studies result in a locally preferred alternative that incorporates light rail, light rail project plans have become increasingly more expensive and the backlog of cities requesting Federal funds is growing faster than the capacity of the funding sources available. Consequently, a staged or incremental approach to fixed guideway transit investment, commensurate with the existing and near term travel market characteristics, is gaining increasing interest with the Federal government and certain US transit agencies. Based on experience in other parts of the world where rail system construction is prohibitively expensive, but where mass transit investment is critical to the economy, the concept of bus rapid transit (BRT) is coming to the United States.

The definition of BRT goes beyond any particular application of technology, facility improvement, or service configuration. In fact, many of the BRT systems around the world incorporate widely varying applications of bus technology, facilities and operations. What differentiates BRT systems is the way in which they combine improvements in the technology with a comprehensive revision in the operating plan and thoughtful improvements to the interface of the system with the customer. This integration of technology, operating plan, and customer interface can create a package of service with greater speed, reliability, safety and security, user-friendliness, and comfort than is typically provided by conventional bus operations. Bus rapid transit systems such as those in Ottawa in Canada, São Paulo in Brazil, and London in the United Kingdom have taken this integrated approach to create a focused, cohesive package of high-quality service.

This paper will define BRT and its three major elements and will offer some important characteristics of BRT that make it an effective solution towards solving current congestion problems while preparing to introduce light rail.

DEFINING BUS RAPID TRANSIT

In this section, we will detail the essential elements of bus rapid transit systems – technology, operating plan and customer interface – and demonstrate the flexibility of BRT.

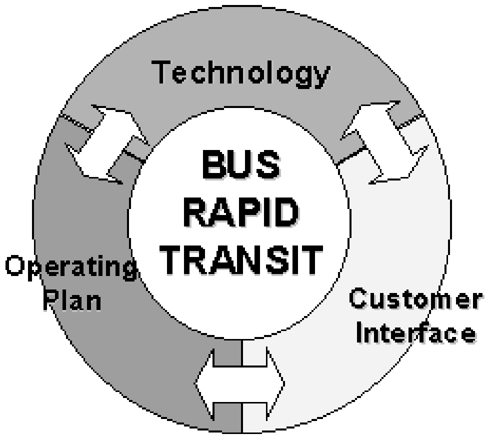

Figure 1. Defining Componets of Bus Rapid Transit

Technology

There are five main elements of BRT systems technology to consider – vehicles, guideway, control systems, fare systems and passenger information systems. Each element has a variety of options, each with different effects on the overall operations of the BRT system. What follows is a brief explanation of each technology and some examples of the varying ways in which each element can be used.

- Vehicles – The vehicle is the central element of BRT technology. Vehicle technology can affect the speed and reliability of transit service as well as user-friendliness and comfort. Vehicle technology options span the range from the existing diesel-powered buses to alternative fueled applications, electric-powered alternatives and the more recent fuel cell developments. Vehicle size applications can include the existing 30 and 40 foot buses used as the mainstay of fixed route bus operations to full size articulated and double articulated buses.
- Guideway – Guideway and station facilities define where and how bus vehicles can travel and where and how passengers can access those vehicles. Improvements to guideway depend on the application (in-street to dedicated) and the extent of right-of-way availability within each application. In-street improvements range from peak period diamond lanes, restricted access lanes with some traffic separation, to dedicated in-street bus lanes or fully-separated roadways at all time periods. Separated rights-of-way can include separate, at-grade applications with some major intersection crossings, to subway and elevated guideway applications along separate rights-of-way.
- Control Systems – Control systems technologies define where and when vehicles are and should be during the operation of the BRT system. For BRT, control systems technologies can be divided into two functions – dispatching and signaling. Dispatching systems control the relaying of service instruction to operators both at the start of their runs and along the route in order to ensure greater service reliability, headway consistency and passenger safety. Signaling systems define when and how a vehicle can travel. Signaling systems can provide preferential treatment to transit vehicles within the mixed roadway rights-of-way.
- Fare Collection Systems – Fare systems investments can facilitate passenger boarding and reduce the need for transfers which reduce dwell times and increase operating speeds. These systems can also reduce the need for cash, increasing passenger safety.
- Passenger Information Systems – Limited passenger information, especially real-time service information, is often a critical barrier to the use of transit. Discretionary travel is often very difficult without a simple user interface or without readily-available access to real-time service information. Also, multiple media communication links available to potential passengers can provide more effective marketing efforts and help overcome the information barriers.

Operating Plan

The operating plan determines how service needs are met. By carefully defining the six elements of the operating plan – route structure, service frequency, stop/station spacing, service span, network structure and degree of integration with other transit services - significant efficiency in the BRT system can be achieved. Similarly, the transition from a BRT system to a light rail system can be more smoothly brought about if the long-term vision is translated into shorter term goals to be achieved by different elements of the BRT system operating plan.

	Speed	Reliability	Safety and Security	User-Friendliness	Comfort
Vehicles	Level Boarding, Improved Engine Efficiency	Level Boarding	--	Level Boarding	Smoother engines, Alternative fuels
Guideway	Separation from mixed-flow traffic	Separation from mixed-flow traffic	Reduction in the number of crossings	--	Electronic or Mechanical Guidance
Control	Signal Preference and Pre-emption	Signal Preference and Pre-emption	Traffic control devices	Regular ordering of bus convoys	--
Fare Systems	Fare Pre-payment	Fare Pre-payment	--	Electronic, pre-paid ticketing	--
Passenger Information Systems	--	--	Security announcements and advisories	Multimedia information on routes and schedules	--

Figure 2. Aspects of Service Quality that are Improved by the Different Elements of Bus Rapid Transit Technology

- Route Structure – The structure of a route is the core element of the BRT service design. It defines where a route operates, what locations are served on that route, and what patterns of service operate on that particular route.
- Service Frequency – The service frequency defines how often patrons along a particular BRT route are served. Although greater service frequency often means lower waiting times, networks with multiple lines and multiple destinations converging on a single trunk line can offset gains in frequency by losses on service reliability and user-friendliness.
- Stop / Station Spacing – The spacing of the stops or stations along a particular route defines where patrons can access a particular route. Typically, stop spacing on a BRT route is much longer than for conventional transit routes allowing for faster running speeds between stops/stations and shorter times spent dwelling at stops due to consolidation of patrons at stops/stations.
- Service Span – The service span defines what period of the day a particular service operates. While most of the BRT systems surveyed operated their respective BRT services during the entire service day, an operating plan can often take advantage of travel market characteristics to meet service needs with BRT where physical conditions may constrain the operation.
- Network Structure – The structure of the BRT network defines the coverage of the BRT system over a metropolitan area and the spatial relationship of BRT routes to each other and to the other routes within the system.
- Degree of Integration with Other Transit Services – The degree of integration of the BRT services with other transit services defines the ability of patrons to transfer between different routes in the service network and reach their final destination.

Customer Interface

For transit systems in the United States, the needs of the technology and operating plan have historically dictated or dominated the needs of the customer interface. However, as overall transit ridership levels have been decreasing over the last years, more attention has been given to the importance of not only knowing who the customer is but implementing long term management strategies that directly affect customer satisfaction. In most cases, significant increases in customer satisfaction can be achieved just by placing importance on the customer’s comfort in using the system. There are five primary components of the customer interface important to BRT – marketing strategy, fare structure, security, passenger information strategy, architecture and design.

- Marketing Strategy – The marketing strategy can define operational parameters, technology needs and the customer interface. Although operations and technology have other constraints, the customer interface can often be designed to best satisfy the marketing strategy developed. This includes the fare structure, safety measures, passenger information systems, architecture and design. The design of the system is extremely flexible and as a result, can be manipulated in many creative ways to satisfy those needs that are deemed to be priorities.
- Fare & Fare Strategy – The fare structure an agency will adopt is largely based on the size of the network, the different transit services offered, the resources of the agency and the customer base. The fare strategy (medium, variety of payment types and collection technology) can better reflect the constraints of the agency and the needs of the customers. The flexibility of BRT allows for a design that incorporates different methods of fare strategy that some, more rigid transit systems, may not be able to.
- Security and Safety – BRT affords more security than traditional bus systems by providing more consistent and reliable service than traditional bus networks. Additionally, the reduced dwell times, priority signaling and exclusive right of ways can also help in reducing traffic accidents. The more modern buses typical of BRT are also better equipped for passenger safety.
- Passenger Information Strategy – In addition to performing on time and efficiently, one resource that many agencies fail to use but will likely have some of the infrastructure for is real time passenger information systems. The anxiety taken away from bus riders when they know the exact arrival time of the bus considerably facilitates the customer's ease of use and encourage ridership.
- Architecture and Design – The new light rail systems have innovative designs that attract customers. People enjoy the light rail systems aesthetically and this has a significant impact on initial usage and customer retention. BRT also uses innovative design strategies to capture customers and ease customer use (like color coding different bus routes).

BUS RAPID TRANSIT AS A STEP TOWARD RAIL

The integrated service that BRT can offer enables cities and regions to prepare certain corridors for higher capacity rail systems. There are two ways in which the development of a rail line can benefit from an interim BRT solution. First, a BRT service with lower capacities can provide sufficiently high levels of service to focus development and to build demand for even higher capacity transit service in a given corridor. Second, BRT rights-of-way, technologies and facilities can be adapted directly to rail, allowing the benefits of improved fixed guideway transit to be experienced over a longer period of time with some extended benefit from the initial bus investments.

Building Demand and Shaping Urban Development

Planners in emerging and growing corridors often face a strange paradox. Regions need high quality transit service in order to guide development into the compact spatial patterns best designed to minimize traffic congestion and promote accessibility. High quality, high capacity transit services like rail, however, need ready markets represented by high concentrations of population and employment in order for the operation to be cost effective. Allowing development to occur without a high quality transit service to guide it often results in development patterns not conducive to rail. Similarly, building a rail service through an already developed area also can be an expensive and disruptive process.

Deploying Technology Incrementally

Rail systems involve a high level of technological complexity. BRT technologies can serve as an effective bridge between the simple technologies of a conventional bus system and the more complex technologies of a rail system. By starting with a BRT system, a transit agency can add and modify technologies in several stages in order to allow for a gradual improvements to service quality (greater speeds, reliability, safety, user-friendliness, and comfort) and a smooth transition to a rail system. This incremental approach ensures that a transit system can meet its patron's needs as they arise, and generally, within agency financial capacity (Figure 3).

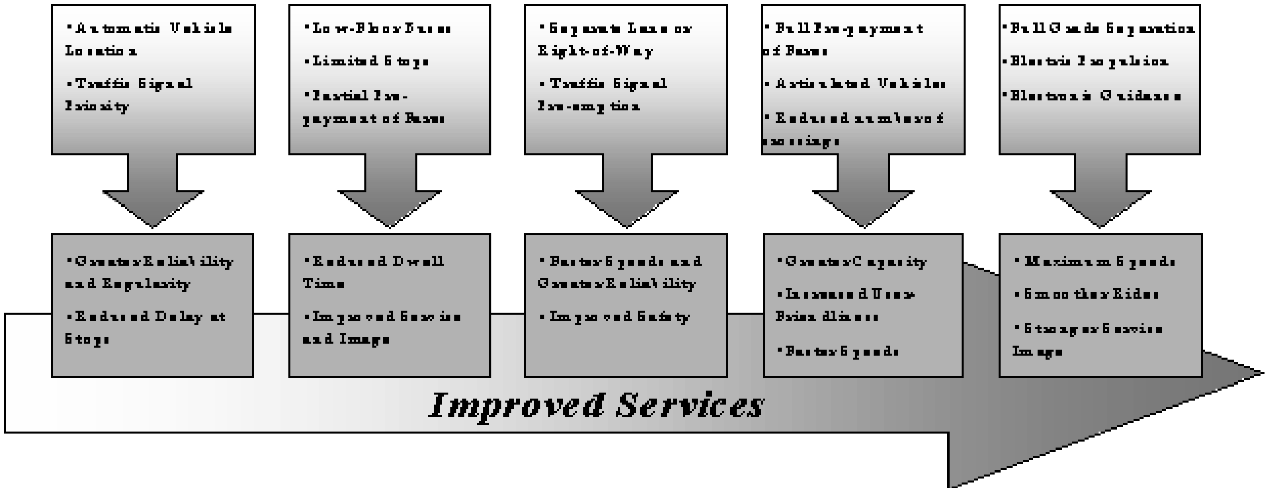

Figure 3. Implementation of Technology and the Subsequent Improvement in Service

A good example of how a transit property can improve its BRT services is in Porto Alegre, Brazil. The transit agency, Public Enterprise of Transportation and Circulation (EPTC), plans to maintain and improve their services by investing in new BRT technologies and defining new types of service offerings. These services have been added based on the increase in market demand and are designed to address specific needs. Such flexibility in providing new services expediently are not possible with light rail and are less effective with conventional bus systems. In addition, improvements in the technology add customer satisfaction and greater operational efficiency. Some incremental service improvements EPTC are planning include:

1. Running articulated vehicles
2. Installing high level platforms to allow level boarding and alighting in terminals and stations.
3. Implementing electronic fare collection technologies to reduce dwell times and increase passenger safety. In addition, electronic payment will allow for free transfers in a limited period consolidating the integration of the bus service.
4. Installing priority-signaling systems operated by floor sensors which will increase average speeds thus reducing travel times by six minutes

Porto Alegre's approach to meet increasing service demand is tailored to its market and can therefore, be more effective in satisfying the customer needs. In addition to adding services, it can easily remove services in areas where demand is not being met. Such flexibility within a system allows enhanced efficiency in the use of resources without sacrificing the quality of services provided.

THE NETWORK

The flexibility BRT gives at the corridor level is also available at the macro-level. BRT networks can be built incrementally as funds become available, demand rises or when service standards are desired to be increased. By building the network component by component – by adding spokes to a hub and spoke system or adding feeder routes to a main trunkline – transit agencies can be more efficient about their transit operations and address those needs that are more acute and in a shorter time frame. Similarly, the network can be expanded when resources become available with the advantage of faster implementation times.

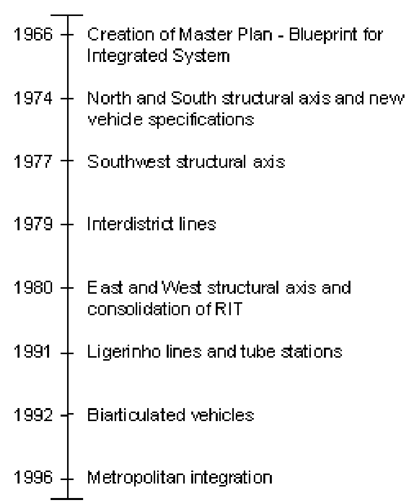

Figure 4. Timeline of Curitiba's Intergrated Transportation System

Curitiba, Brazil has long been expanding its network incrementally to meet growing demand and to take advantage of resources. Along with meeting a demand from the market, Curitiba has also directed growth along the corridors to be able to shape a network that targets certain areas and incorporates land use and economic growth in the region. The timeline in Figure 4 shows how Curitiba was able to expand its network to incrementally meet the needs of the metropolitan area.

A Tool For Adapting Land Development To Rail

The flexibility of BRT enables it to be used as an effective tool to prepare development patterns to adequately support rail transit and other high-capacity transit investments. The availability of BRT as such a tool is important for two reasons. First, building the market for transit in a corridor ensures that an ultimate rail investment can serve as many passengers as possible, thereby justifying the investment's high capacities. Second, federal and state authorities increasingly examine the existence of transit-supportive land development patterns or plans to support such patterns as a criteria for funding high-capacity, capital-intensive bus and rail projects.

The link between transit and land development is well demonstrated. High concentrations of population and employment throughout a corridor support high levels of transit service. Likewise, high levels of transit service promote development growth in a corridor and enable this growth to occur without all of the attendant impacts on congestion and land consumption. This synergy between transit and land development leaves transit and development planners with a dilemma. In many of today's American cities, developments are being built at low densities with large supplies of parking. These densities are generally too low to take advantage of the high capacities that a rail transit system can provide. Alternately, corridors and future station areas require high-quality transit service to develop in transit-supportive patterns with relatively higher concentrations of housing and employment and pedestrian-oriented urban form. Therefore, it is difficult to support a high-capacity transit system (without significant subsidies) without the associated transit-supportive development patterns, but it is likewise difficult to support transit-oriented development patterns without a high-quality transit investment.

The range of solutions that BRT provides can provide a robust tool for a long term transit and land use strategy for a corridor. As presented in an earlier section, BRT can function with high levels of service at a range of capacities. Using this flexibility, local transit and land use planners can use BRT to support an integrated transit and land use strategy in a corridor. Such a strategy enables the land development in corridor station areas to evolve gradually as capacity grows, while maintaining high frequencies of transit service.

SUMMARY

BRT provides a way to rethink the role of the bus in bringing accessibility, congestion relief, and livability to all types of cities. With a solid operating plan and a user-friendly customer interface, a fully integrated network of services can be built with many different types of BRT lines, each suited to a particular context. BRT is also effective way of building demand and developing the infrastructure for future light rail investments. As a comprehensive stand-alone transit service, as part of an integrated transit system, or as a stepping stone towards light rail, BRT is an integrated package of service that is dynamic, of high quality, and responsive to the needs of the user and the transit agency.