"Why Buses? Innovations in bus transit and their applicability in Costa Rican's case"

Research Paper for CE 497C Public Transportation

Jonathan Aguero Valverde

Background

Urban areas all over the globe are facing the same basic problem: traffic congestion. When the demand for travel in an urban system exceeds the capacity of the system, travel times increase significantly with the consequent waste of productive time. According to the 2004 Urban Mobility Report (Schrank and Lomax, 2004), in 2002, congestion in 85 urban areas in USA produces 3.5 billions total hours of delay and increases the travel time in 37% during peak hour with respect to the free-flow travel time. Furthermore, the cost associated with congestion was estimated in $63.2 billions of dollars for 2002 according to the same publication.

Increasing motorization rates (number of private cars per capita) as well as the increasing amount of travel per capita are key contributing factors to congestion in most developing countries. Urban areas do not just get bigger in population but each person in that area also travels more and as a consequence, demand for travel increases a lot faster than supply (transportation infrastructure) and congestion gets worse.

Congestion has also environmental consequences. In congested urban areas, travel times are significantly higher than the free-flow travel time and therefore, car engines keep running longer and emitting pollutants to the atmosphere. In addition, congestion normally implies a higher number of stop-and-start maneuvers that produce more pollution than the engine running at constant speed. Congestion also has a cost associated to natural resources consumption. Just in 2002, it was estimated that 5.7 billions of gallons of fuel were wasted because of congestion in USA (Schrank and

Lomax, 2004). This situation along with the current high prices of oil are extremely problematic.

There are several ways to attack congestion; one of them is to improve public transportation to switch trips from private vehicles to public transit reducing the number of vehicles in the system. This measure, as many political debates in USA, has its critics and its supporters. In the side of the critics some like Wendell Cox (2000) argue that rather than investing in public transit, *"congestion pricing and competitive franchising of urban sectors would provide the mechanisms by which existing roadway capacity could be better used, while improving the nexus between payment and benefit by road users."* On the other side, others like the Federal Transit Administration and the Urban Mobility Report authors argue that transit reduced congestion delays for a value of $19.4 billion per year in 1999 (Lewis and Williams, 1999) and $20 billion in 2002 (Schrank and Lomax, 2004).

Despite the fact that non-transit measures like congestion pricing can be efficient in congestion reduction, in the case of developing countries, these measures are just impractical due to the capital investment needed. In this context, transit oriented measures can be a more realistic and affordable approach.

Possible Solutions

In mass public transit there are basically three alternatives:

- Heavy rail, like the New York and Washington DC. metro systems.
- Light rail, like in Portland, Salt Lake City, and Houston.
- Bus, like the CATA system in State College.

According to the North American Light Rail Information Site (2004), light rail is define as *"An electric railway system characterized by its ability to operate single or multiple car consists along exclusive rights-of-way at ground level, on aerial structures, in subways or in streets, able to board and discharge passengers at station platforms or at street, track, or car-floor level and is normally powered by overhead electrical wires".* On the other hand heavy rail is defined by the American Public Transportation Association (APTA, 2004) as *“high-speed, passenger rail cars operating singly or in trains of two or more cars on fixed rails in separate rights-of-way from which all other vehicular and foot traffic are excluded. Also known as "rapid rail," "subway," "elevated (railway)," or "metropolitan railway (metro)."*

Heavy rail is out of reach for most developing countries because of its extremely high capital costs compare with light rail and bus systems; therefore, in the following, differences between light rail and bus systems will be state. The Victoria Transport Policy Institute summarized the advantages of each one, bus and light rail in its publication “Evaluating Public Transit Benefits and Costs: Best Practices Guidebook” (Litman, 2004). This guidebook lists the following advantages of bus and light rail:

Bus

- Flexibility. Bus routes can change and expand when needed. For example, routes can change if a roadway is closed, or if destinations or demand changes.
- Requires no special facilities. Buses can use existing roadways, and general traffic lanes can be converted into a busway.
- More suitable for dispersed land use, and so can serve a greater rider catchment area.
- Several routes can converge onto one busway, reducing the need for transfers. For example, buses that start at several suburban communities can all use a busway to a city center.
- Lower capital costs.
- Is used more by people who are transit dependent, so bus service improvements provide greater equity benefits.

Light Rail

- Greater demand. Rail tends to attract more discretionary riders than buses.

- Greater comfort, including larger seats with more legroom, more space per passenger, and smother and quieter ride.
- More voter support for rail than for bus improvements.
- Greater maximum capacity. Rail requires less space and is more cost effective on high volume routes.
- Greater travel speed and reliability, where rail transit is grade separated.
- More positive land use impacts. Rail tends to be a catalyst for more accessible development patterns.
- Increased property values near transit stations.
- Less air and noise pollution, particularly when electric powered.
- Rails stations tend to be more pleasant than bus stations, so rail is more appropriate where many transit vehicles congregate.

Now, it is important to discuss the Costa Rican context so that the best alternative can be selected and discussed.

Costa Rican Context

According to the Instituto Nacional de Estadística y Censos (INEC, 2005), the total population for the country in 2005 was 4,248.508 persons. From this population more than 50% lives in the Central Region that compresses most of the economical activities and includes the capital city of San Jose as well as the three other major cities: Alajuela, Cartago, y Heredia. These four cities work as a whole in a large metropolitan area of more than 2 million persons in the central portion of the country.

This metropolitan area has somehow dispersed population, with densities higher than most US suburbs but lower than any medium size city in US. The Central Business District has small buildings that rarely exceed 10 stories. The trip to work has mainly radial patterns in the region and public transit is the main mode in the region. Costa Rica has a long tradition on public transportation and for years, most of the population has used it as the principal transportation mode. However, due to the high level of congestion in the capital city, travel times have severely increased.

It is hard to estimate the real level of congestion in Costa Rica, there is not a single attempt to measure it in a scientific way but from the point of view of a regular transit user I can testify that the level of congestion and delay are as high as (or worse than) US cities like Miami.

Other crucial fact is the level of motorization. Costa Rica has a much lower level of motorization than developed countries like US and therefore, the public transportation industry has a bigger captive market. This is certainly a consequence of the relative low incomes in the country where the mean income is roughly a quarter of the income for an equivalent worker in US and cars are around 1.5 times more expensive than here.

From the business standpoint, Costa Rica is also quite different from many countries. The public transportation business is completely private but highly regulated by federal government. Local governments have no power over public transportation or highway funds. The system is based on fixed routes granted by the Federal Department of Transportation to private companies for periods of 20 years or more. Several companies share the same basic radial routes that are different just in the final section of the route in the suburbs. In some other occasions, one single company controls all the routes to certain zones. The routes are all basically radial with the central point in the BCD. All the cost for the companies, capital or operation costs are recover through out fare collection and other services like advertising. There are not federal or local government subsidies for the companies; the only partial subsidy for operators is a lower tax for diesel than for gasoline.

Why Buses?

Based on Costa Rican reality, it is evident that bus is the best solution for the problem. Several bus advantages are more suitable for Costa Rica, among them some of the ones cited before:

- Flexibility: Routes can easily change or expand to accommodate changes in land use and urban expansion. Besides, private operators can respond faster to changes in demand with buses than with light rail. Construction of new rail lines is expensive and slow, while buses will use infrastructure already built.
- Lower capital costs: this is a key factor in the Costa Rican case. It is more likely that several providers offer the bus service than one big company take control of a big light rail system. It is clear that capital costs in light rail are high and it is very unlikely that under the current fiscal situation of the country the government decides to subsidy even a modest portion of the capital investment for a light rail system.
- Is used more by people who are transit dependent, so bus service improvements provide greater equity benefits. Most of the population in Costa Rica uses public transit in the form of buses; therefore, improvements on the service will benefit a large segment of the population. Note that the motorization level in Costa Rica is lower than 1 car for every 4 persons, as a result a high percent of the population in transit dependent.
- The voter support argument is not as important in Costa Rica. The vast majority of users in Costa Rica have never seen another type of transit system in operation. Furthermore, users are likely to be more sensible to the quality of service because they can compare between different providers than to the mode.

Under the current state of the affairs, the bus system in Costa Rica is, in my opinion, operating with a very low quality of service; therefore, there is room for lots of improvements. Currently the Federal Transit Administration is promoting a technology known as Bus Rapid Transit (BRT) as a least expensive alternative to light rail at urban areas in US (Diaz, 2004). In the following section a description of this technology and its different components will be provided as well as a discussion of their applicability to the Costa Rican Context.

Technological innovations in Bus Rapid Transit

BRT Implementation Guidelines (Levison *et al*, 2003b), defined Bus Rapid Transit as:

"A flexible, rubber-tired form of rapid transit that combines stations, vehicles, services, running ways, and ITS elements into an integrated system with a strong identity".

Basically, one can define BRT as a system with the quality of light rail transit but using buses as vehicles. A BRT system can be divided into the following components:

- Running way
- Stations
- Vehicles
- Fare Collection
- Intelligent Transportation Systems
- Service and Operating Plans

In the subsequent sections the major components of BRT will be describe followed by a discussion of their possible application in Costa Rica. Most of the following description of the BRT elements is based on the work from Diaz (2004).

Running way

Running ways refers to the portion of highways, arterials, or general roads that bus rapid transit vehicles travel on. Running ways are the most critical element in determining the speed and reliability of BRT and often are the most significant cost item in the entire BRT system. Running ways have three primary characteristics: degree of segregation, running way marking, and lateral guidance.

Degree of segregation refers to the level of separation from other traffic. Degree of segregation can vary from non-segregation in a mixed flow lane in an arterial street to a fully grade-separated, segregated BRT transitway. Clearly, the degree of segregation is the characteristic of running ways with the higher effect on BRT performance.

Running Way Marking refers to the treatments or markings to differentiate a running way where a BRT service operates. Differentiation can be accommodated through a number of techniques including pavement markings, lane delineators, alternate pavement texture, alternate pavement color, and separate rights-of-way.

BRT running ways can incorporate a feature known as lateral guidance. This feature controls the side-to-side movement of vehicles along the running way. Like most bus operations, many BRT systems operate with no lateral guidance, relying on the skills of the vehicle operator to steer the vehicle. Depending upon the type of technology used, the guidance can be mechanical, electro-magnetic, or optical.

Table 1 describes the different running way segregation types and includes an estimate of the capital cost for mile (Source: Diaz, 2004).

Table 1. Running way segregation Types.

Segregation type	**Description**	**Capital Cost per lane mile (US million dollars)**
Mixed Flow Lanes	Buses share lanes with private vehicles	$0*
Reserved Arterial Lanes	A traffic lane within an arterial roadway is set aside for exclusive BRT operation	$2.5 - $2.9
At-grade Transit ways	Exclusive facilities for BRT that only interact with other traffic at cross streets	$6.5 – $10.2
Fully Grade-Separated Exclusive Transitways	Separated from congestion in local streets at intersections and adjacent highways.	$12- $30 aerial transitway. $60 -$105 below-grade transitway.

* Use of existing lanes has minimal costs since there are no modifications to be made

Figure 1 also shows the capital cost per mile but comparing them to light rail according to the United States General Accounting Office (2001).

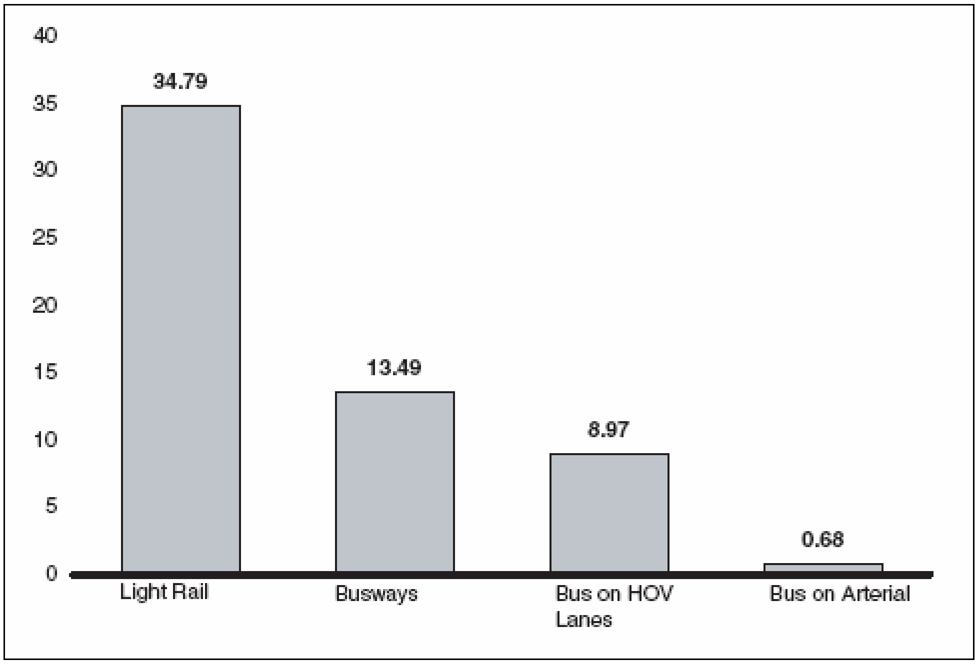

Figure 1. Capital Cost Per Mile for Light Rail and Bus Rapid Transit (million of Dollars)

Clearly from the last two exhibits, the most affordable option of BRT is the reserved arterial lanes and this is the best current option for Costa Rica. To set aside some arterial lanes for BRT will require non-new infrastructure, just a careful planning following by marking changes. Future improvements can include at grade transit ways but the availability of rights of way may be an issue. It is also important to note that contrary to the case of Curitiba where a Master plan was developed more than thirty years ago to set aside wide boulevards (FTA, 2005), in Costa Rica most of the main arterials are narrow, with no more than four lanes total. Therefore, creating exclusive BRT lanes will have its toll in the operation of the highway system. Nevertheless, this must be the first step in order to improve the operation of the transit system and to reduce congestion by moving commuters from cars to buses. Significant travel time savings can be accomplish with BRT even in mixed traffic lanes as in Los Angeles Metro Rapid Bus with travel time savings of 23% to 28% (Levison *et al*, 2003). These travel time savings are the main incentive to switch users from other modes to transit.

Stations

BRT stations serve a high volume of users due to the fact that BRT systems are located in high demand corridors with limited stops. They range from simple stops with well-lit basic shelters to complex intermodal terminals with amenities such as real time passenger information, newspaper kiosks, parking, pass/ticket sales and level boarding. Stations are also important to portray the brand Identity that must distinguish the BRT system from other public transit services.

Stations interact with several other parts of the system but two of them are especially important: fare collection and boarding level. Fare collection will be discuss in a subsequent section but here it is important to note here that an incremental development as may be the case in Costa Rica might call for a basic station that can be upgraded to a better design that must include before-boarding fare collection. In addition, a standard curb where the users must step up to board can be improved to a level platform to increase safety and performance and decrease boarding and alighting times. These and other considerations must be taken into account since the initial design phases in order to avoid future problems.

Another important consideration is the funding for stations. Most likely, in Costa Rica the funding will be federal, which again calls for incremental development. However, depending on the size of the station, amenities like newspaper kiosks coffee shops and others can be rented to help with operational costs.

Vehicles

Vehicles are the BRT element in which customers spend the most time; as a result, passengers derive much of their impression of the BRT system from their experience with vehicles.

Several characteristics of the vehicle are related with performance like floor level or size while other characteristics like aesthetic treatments or propulsion systems are more related to the identity and brand of the BRT system. Floor height is related to the boarding and alighting times. Decreases in those times clearly improve the performance of the system buy decreasing the dwelling times and therefore, decreasing travel time. On the other hand, size is important for performance in several ways. Bigger vehicles have more and bigger doors which decreases dwelling times. Larger buses or articulated buses also decrease operational costs by moving more people in a single vehicle.

In the case of propulsion, different systems can have different acceleration and maximum speed characteristics that affect performance but most times, the selection of one propulsion system over others relies on a capital cost analysis or policy issues like environmental friendliness.

Capital cost of buses has been historically paid by the private transit operator in Costa Rica. Especial BRT vehicles are more expensive than standard buses and private operators may be reticent to invest in those vehicles; however, a combination of minimal standards for buses set by the DOT with especial credit lines for bus acquisition can press on the change of units.

Better buses are indispensable for a successful BRT implementation in Costa Rica. The current fleet is old and uncomfortable and the introduction of modern buses, even articulated buses might contribute to the acceptance of the new service by the general public.

Fare Collection

There are several fare collection systems, among them:

- Pay on-board system: Typically involves a farebox or a processing unit for tickets or cards adjacent to the operator. It has the advantage of not requiring significant fare collection infrastructure outside the vehicle but has the disadvantage of requiring passengers to board through a single front door and pay the fare as they enter
- Conductor-validated system: Requires the rider to either pre-pay or buy a ticket on-board from a conductor. This fare collection method has the disadvantage of being very labor intensive.

- Barrier Enforced Fare Payment system: Involves turnstiles, fare gates, and ticket agents or some combination of all three in an enclosed station area or bus platform. It has the disadvantage of needing an enclose station to operate which increase costs but has the advantage of great decreases in dwelling times because users can use any bus door to board and have already paid the fare.
- Barrier-Free or Proof-of-Payment system: Requires the rider to carry a valid ticket or pass when on the vehicle and is subject to random inspection. The advantage of this system is that it supports multiple door boarding and thus lower dwell times. The disadvantage is the increased risk of fare evasion.

The basic current fare collection system in Costa Rica is direct payment to the driver. This has several disadvantages among them: increasing dwelling times, distraction for the driver, and the possibility of fare money subtraction by the drivers. Systems administrators have tried to reduce fare subtraction by placing infrared counters in the doors of the bus. The fare system is flat by route without possibility of transfer under the same fare. Another recent problem related to fare collection is the robbery of fare money to the drivers in the most isolated portions of the routes.

With the current state of the affairs in Costa Rica, one can speculate that it would not be very difficult to convince operators to add a farebox to their buses. Even without being the best solution to all the problems it presents important advantages over the current state. First, fare boxes imply exact change which will reduce dwelling times, improving the operation of the system. Fareboxes can take tokens, cash, or smartcards; giving the user different payment methods to choose from. The driver never touch the money, therefore, the risk to the driver of been robbed disappears. In the worse case scenario, robbers should destroy the farebox or take the whole farebox with them, making the robbery much more complex and risky which will be enough to discourage any attempt. Another advantage is that the risk of fare subtraction by the drivers also disappears.

It is important to note that rather than a technological change, a fare-collection method change will be a cultural change in Costa Rica. Past attempts to introduce cashcard readers for payment have failed due to the absence of supporting infrastructure like cashcard dispensers and low support by the users. Those were attempts by the private sector without any support from the government; any future change in fare collection must be fully support and encourage (even mandate) by the federal government in order to be successful.

Other important key for the success of changes in fare collection is an incremental development of the changes. The first step can be fareboxes follow by upgrades in the station to support off-vehicle fare collection. Busies stations can be upgraded first so that the highest time saving can be achieve and buses can keep operating on routes with mixed stations, in the low used stations on-board fare collection will be used and in the big stations users that board have already paid the fare.

Intelligent Transportation Systems

Intelligent Transportation Systems (ITS) includes a variety of advanced technologies to collect, process, and disseminate real-time data from vehicle and roadway sensors. Different combinations of technologies form different types of ITS systems. For example, automatic Vehicle Location (AVL) in combination with Automated Scheduling and Dispatch (ASD) and Transit Signal Priority (TSP) can improve schedule adherence and hence reliability as well as revenue speed.

There are several possible applications of ITS to BRT, some of them are:

- Vehicle Prioritization
- Assist and Automation Technology
- Operations Management
- Passenger Information

Vehicle prioritization includes methods to provide preference or priority to BRT services, especially in signalized intersections. The intent is not only to reduce the overall traffic signal delays of in-service transit vehicles, but also to achieve greater schedule adherence and consistency thus enhanced reliability and shorter waiting times. These methods includes simple operations like optimization of traffic signals along the BRT corridor. More complex methods like Traffic Signal Priority (TSP) also belong to this group. These technologies can be used to extend or advance green times or allow left turn swaps to allow buses that are behind schedule to get back on schedule. This is particularly useful when buses travel on exclusive lanes there will be no vehicles impeding the pass of buses; here travel time savings are more important.

Driver Assist and Automation Technology includes technologies that provide automated controls like Collision Avoidance, Lane Assist, and Precision Docking. These functions provide control of the BRT vehicle for collision avoidance, running way guidance, or station docking maneuvers respectively. These assist and automation technologies help to reduce frequency and severity of crashes and collisions and reduced running and station dwell times.

Operations Management Technologies include automation methods that enhance management of BRT fleets. Examples of these technologies are Automated Scheduling Dispatch System (ASDS), Vehicle Mechanical Monitoring and Maintenance, and Vehicle Tracking. Use of Automated Scheduling Dispatch System and a Vehicle Tracking method assists BRT management to best utilize the BRT vehicles while the use of Vehicle Mechanical Monitoring and Maintenance assists in minimizing downtime of the BRT vehicles.

In the case of Passenger Information, these technologies can improve passenger satisfaction and help to reduced wait times, which may increase ridership. These systems can also be a source of revenue through the sale of advertising time and space on information screens. These services operate in conjunction with Operation Management Technologies like vehicle tracking where the location of vehicles is send to a central processing center, there the data is processed and sent to the transit customer in the stations or to mobile devices like cell phones and PDAs.

Service and Operating Plans

Without a good service and operations plan for BRT a poor performance of the system is more than likely and a complete failure is an inevitable destiny. BRT service needs to be frequent, direct, easy-to understand, comfortable, reliable, operationally efficient, and above all, rapid. All these can be achieved just with an excellent coordination between all the parts of the system, for which a service and operations plan is indispensable.

The main characteristics of a service and operations plan are:

- Route Length and Structure: Basically, these two characteristics define the layout of the different routes and how they interact with each other. Higher route lengths decrease the need for transfers but reduce the travel time reliability. Complex route structures facilitate point-to-point service with limited transferring but can be difficult to understand for new users.
- Service Span: represent the period of time that a service is available for use. Service spans affect the segment of the market that a transit service can attract. Long service spans allow users with varied schedules and many different types of travel patterns to rely on a particular service while short service spans limit the market of potential passengers.
- Service Frequency: service frequency directly determines how long passengers must wait for BRT service. High frequencies are needed in most BRT services, especially during peak hours; therefore, service must be one of the most important elements in planning and operating a BRT system.
- Station Spacing: The higher station spacing, the higher the operational speeds and the lower the user travel time but the less convenient for users, especially those who access the stations by walking.

The service and operations plan design can be a delicate issue in Costa Rica given the fact that several private providers interact under the supervision of the Public Transit Department of the DOT. Furthermore, this office has not enough effective power to currently enforce actual service characteristics like frequency or span. Law changes might be necessary to resolve this issue but more important is to strengthen the Public Transit Department with more and better personnel and equipment.

Quality service is key for the success of BRT and private operators in a franchise environment might have little incentive to achieve it. Consequently, clear and strict rules as well as good enforcement procedures are necessary to guarantee high quality service.

Conclusions and Recommendations

Each urban area has unique characteristics that influence BRT design and operation. In the case of the Costa Rican case the most prominent characteristics are:

- Private operators of public transit under government regulation with virtually none subsidies.
- Lower capital investment capacity from both: government and private operators.
- Big captive market where more than 50% of trips were done by public transportation in 1990 (MOPT, 1990) and it is expected that the situation has not changed much since.

As a result, some alternatives for implementing BRT in Costa Rica are:

- BRT must be rapid and for that it is necessary to start with exclusive lanes on arterials and to expand the system from the busiest routes in the core of the CBD to the periphery of the metropolitan area.
- Routes must be assigned in franchises of relatively short duration on competitive bases to incentive competition and quality.
- Government founded credit lines with low interest can be open to incentive operators to change newer vehicles provided with BRT sought characteristics like low-level floor, wide doors and efficient engines. Franchise biding can also help in this respect. Articulated buses can be introduced in certain routes to also decrease operational cost to the provider.

- The fare collection system must change across the board. The easiest way to accomplish this is to change from driver collection to fareboxes that can accept cash, tokens, and smartcards. Then stations with off-vehicle fare collection can be built incrementally to improve the system.
- ITS applications in Costa Rica have a long way to go. However, there are some things that can be done early, traffic signal optimizations are one of them. In the future, signal prioritization can be implemented to increase transit operational speed.
- Support from elected leaders, private operators and users in essential for the success of BRT in Costa Rica. Once politicians have decided to give it a try, operators must give their best in order to gain user support from the first installments.
- Incremental development of BRT is the key in Costa Rica. Given the existence of several public transit providers and a government with low investment capacity, a system that does not need to be built all out-of-the-box is desirable.

References

American Public Transportation Association, 2004. *U.S. Heavy Rail Transit System Links*. [Online] Available: http://www.apta.com/links/transit_by_mode/heavyrail.cfm.

Bus Rapid Transit Analysis, 2005. [Online] Available: http://www.lightrailnow.org/facts/fa_brt.htm (03/22/05)

Bus Rapid Transit Central, 2005. *An on-line resource for information about Bus Rapid Transit (BRT) Systems*. [Online] Available: http://www.busrapidtransit.net/ (03/22/05).

Cox, W., 2000. *How "Smart Growth" Intensifies Traffic Congestion and Air Pollution*. Independence Institute. [Online] Available: http://i2i.org/SuptDocs/Enviro/AirPollutionSmartGrowth.htm

Diaz, R.B. (editor), 2004. *Characteristics of Bus Rapid Transit for Decision-Making*. Federal Transit Administration, Office of Research, Demonstration and Innovation.

Federal Transit Administration, 2005. Issues in Bus Rapid Transit. [Online] Available: http://www.fta.dot.gov/initiatives_tech_assistance/technology/brt/issues/7692_ENG_HTML.htm

Instituto Nacional de Estadística y Censos , 2005. [Online] Available: http://www.inec.go.cr/

Levinson, H.S., Zimmerman, S., Clinger, J., Gast, J., Rutherford, S., Bruhn, E., 2003b. *Bus Rapid Transit: Implementation Guidelines*. TCRP Report 90-Volume II. TRB, Washington.

Levinson, H.S., Zimmerman, S., Clinger, J., Rutherford, S., Smith, R.L.,Cracknell, J., Soberman, R., 2003. *Bus Rapid Transit: Case Studies in Bus Rapid Transit*. TCRP Report 90-Volume I. TRB, Washington.

Lewis, D., Williams, F.L., 1999. *Policy and Planning as Public Choice: Mass Transit in the United States*. Ashgate Publishing.

Litman, T.A., 2004. *Evaluating Public Transit Benefits and Costs: Best Practices Guidebook*. The Victoria Transport Policy Institute.

Metro Magazine (Bus Rapid Transit), 2005. [Online] Available: http://www.metro-magazine.com/t_brt_home.cfm (03/22/05).

MOPT, 1990. *Encuestas Origen - Destino*, ProDUS.

North American Light Rail Information Site, 2004. *North American Light Rail Terminology*. [Online] Available: http://www.lightrail.com/terminology.htm.

Schrank, D., Lomax, T., 2004. *The 2004 Urban Mobility Report*. Texas Transportation Institute. [Online] Available: http://tti.tamu.edu/documents/mobility_report_2004.pdf

United States General Accounting Office, 2001. *Mass Transit: Bus Rapid Transit Shows Promise. Report to Congressional Requesters*. [Online] Available: http://www.gao.gov/new.items/d01984.pdf (03/22/05).