2005

Light Rail and BRT: Competitive or Complementary?

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Recommended Citation
Vukan R. Vuchic, "Light Rail and BRT: Competitive or Complementary?", *Public Transport International* 5, 10-13. January 2005.

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Abstract
Since the 1970s great progress has been made to develop transit systems which provide service considerably better than buses can offer in mixed traffic, but which require significantly lower investment than metro systems with exclusive ways. This “semirapid transit” category of modes, using mostly partially separated ways, has been introduced extensively in medium-sized cities, as well as supplementing metros in suburban areas of large cities.

Disciplines
Civil Engineering | Engineering | Systems Engineering | Transportation Engineering

The light rail concept grew out of the renaissance or modernisation of tramways, such as in Stuttgart (left); whereas BRT grew out of the need to separate the bus from the rest of the traffic (Mexico City, right)

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Light rail and BRT

Competitive or complementary?

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Following very successful introduction of Light Rail Transit (LRT) in cities of many countries, Bus Rapid Transit (BRT) has also been introduced and proposed for many cities to provide services much better than regular buses. Selection between these two and several other modes (Automated Guided Transit (AGT), Monorail and others) is often complicated because of inadequate technical knowledge of planners, influences by promoters of proprietary systems and political pressures. The purpose here is to present a brief review of the LRT and BRT modes, based on facts and experiences from recent decades. It should be mentioned that this writer authored reports for the US Department of Transportation which promoted development of both LRT and BRT modes [1, 2].

LRT development: innovations, successes and limitations

The concept of LRT grew out of modernization of traditional tramway networks, mostly in central European cities, such as Stuttgart, Rotterdam and Gothenburg. Major elements of upgrading tramways that led to LRT with performance more similar to metros than to street transit modes included the following:

- Upgrading of street operations to separate ways
- Construction of tunnels on short sections in city centers
- Introduction of articulated cars with capacity of up to 250 spaces
- Introduction of self-service fare collection which allowed one-person crew and very high labor productivity

Construction of new LRT systems resulted in new concepts. Many of about 40 new LRT systems built in North American as well as European cities demonstrated further innovations, such as:

- Operation of trains with up to four articulated cars and capacity of about 720 spaces with one-person crew
- Serving pedestrian areas at speeds below 40 km/h as well as long suburban lines with speeds up to 100 km/h
- Introduction of low-floor vehicles dispensing with the need for high-platform stations in pedestrian-oriented city centers
- Lines which utilize mostly partially separated ways, but also exclusive ways and mixed traffic on different line sections, not requiring transferring.
- Many European cities (e.g., in France, England and Spain) have introduced tramway-type LRT on partially separated ways and in mixed traffic as a central element in the redesign of their central cities combined with traffic taming.
- On the opposite end of the technology spectrum, fully automated LRT has been built for high-frequency, high-capacity lines on exclusive ways only. These systems in London/Docklands, Vancouver and Copenhagen actually represent small-size metro systems.

As a result of these developments, LRT has become an extremely diversified mode that can be used for short urban, as well as long regional lines with various levels of speeds and capacities, utilizing ways from streets to fully separated tunnels, viaducts and intercity railway tracks. Most importantly, LRT has been described as the central element of urban economic development, environmental upgrading and enhancement of human-oriented urban ambience[3].

Investment costs for LRT vary greatly, depending mostly on the way category and other infrastructure, types of vehicles and related improvements of areas they serve. While some LRT lines using upgraded railway tracks (San Diego first line) have been built for as little as USD 5 million/km, others, requiring tunneling (Buffalo), exceeded USD 50 million/km, with most other cities in the range of USD 15-35 million/km. LRT is therefore best suited to medium-sized cities and suburban lines in large cities, such as Paris, London and Hong Kong.

A negative development limiting applications of LRT has sometimes been overdesign. Instead of economical designs which allow construction of large networks, a number of projects have been “upgraded” step by step, resulting in very high costs. Several LRT lines in Mexican cities have been built with way category A only. Full automation, particularly in cities which need extensive networks, such as Kuala Lumpur, limited the network to a single line. Automation is particularly inappropriate in countries with low wages and social need for higher employment.

BRT development: innovations, improvements and some misdirections

Numerous attempts have been made to upgrade bus services in many cities since the 1960s[4,5], resulting in different experiences – successes as well as failures. The results of the main element of upgrading buses – separating them from mixed traffic to separate facilities have brought particularly valuable experiences, as several examples show:.

- Separate bus lanes on streets brought significant service improvements and ridership increases in many cities (Paris, Dublin), but failed and were abandoned in others (Philadelphia, Mexico). The success basically depended on the enforcement provided by police.
- Exclusive busways resulted in such major improvements that the new system began to be considered a new transit mode – BRT (Curitiba, Ottawa). In many U.S. cities, however, the pressures by automobile interests led to the degradation of busways to HOV lanes (Shirley Busway in Washington, El Monte Busway in Los Angeles), which negatively affected the quality of bus services and its distinct image.
- Preferential treatment of buses at signalized intersections have been feasible and successfully used in some cities since the 1970s[4,5], but their implementation and maintenance also depended on the technical and political support given to bus services in specific cities.

Thus, the experience has shown that effectiveness of bus lanes and signals on streets is not always permanent. It can be successful only in cities where police enforcement is strict. Busways’ permanence similarly depends on the political support which such facilities have. The main threat to their existence is pressure from pro-highway and pro-automobile organizations. These pressures in some countries are so strong, that many HOV lanes were returned to regular freeway lanes for general traffic.

The pressures of increasing traffic congestion and obvious underutilization of buses due to their slow and unreliable services resulted in the 1990s in a very strong initiative to treat bus services as a system[2,6], rather than as just individual

TABLE 1: COMPARISON OF CHARACTERISTICS OF REGULAR BUS, BRT AND LRT MODES

Characteristics	Regular Bus (RB)	Bus Rapid Transit (BRT)	Light Rail Transit (LRT)
System components			
Way category	Mixed traffic	Partially separated ways (mixed traffic)	Partially separated ways (exclusive ways, mixed traffic)
Support	Road	Road	Rail
Guidance	Steered	Steered	Guided
Propulsion	ICE*	ICE*(Dual)	Electric
Vehicle-/Train control	Visual	Visual	Visual / Signal / Fail-safe
Max. TU size & capacity	Single vehicle – 120	Single vehicle – 180	1-4 car trains 4x180 = 720
Lines / Operational elements			
Lines	many	few	few
Headways on each line	long / medium	short	short
Stop spacings [meters]	80-250	200-400	250-600
Transfers	few	some / many	many
System characteristics			
Investment costs / km	low	moderate / high	high / very high
Operating costs / space	medium	medium	low
Operation in tunnel	no	no	yes
Service in pedestrian zones	variable	difficult	attractive
System image	moderate	good	excellent
Impact on land use- and city livability	none	some	strong
Passenger attraction	variable	good	excellent

*ICE - internal combustion engine

vehicles operating on urban streets.

This systems approach in planning bus services, supported by the very successful systems in Ottawa, Curitiba[7] and Bogota, created a BRT concept that found a broad positive response in many countries. Further success of the BRT systems will, however, depend on the understanding of planning and design elements, based on experiences in real-world conditions. Another factor is the relationship of BRT to other modes, particularly LRT, its 'neighbour' in the family of transit modes. In this respect, the BRT system has seen very positive developments, but also some misguided directions.

The BRT concept is very positive in its broad approach to all system components: ways, stations, vehicles, control and image for passengers. In all these elements it is greatly superior to regular bus services. If these features are applied to upgrade present bus services from a large number of bus routes with low quality services to fewer lines with faster, more reliable services and a distinct image, many cities will realize great benefits. Many technical innovations for buses, such as cleaner engines, are very useful[8]. However, this type of broad bus service improvements is given less attention than some "flashy" technological improvements which often result in extremely expensive vehicles (dual-mode buses in Boston had a price of USD 1.5 million). Many of their features have questionable value. For example, automatic driving of buses while the driver is retained results in higher cost without payoffs; "electronic coupling" of buses has no defined applications in cities, etc.

The misleading claim that BRT can match rail systems service at much lower cost has led to some serious errors in transit planning. Under the impression that buses can match performance of rail vehicles, the Silver Line in Boston has been designed to use a curb lane on a street without adequate enforcement, and then go into a full size tunnel. Since buses are driver-steered, the tunnel profile is larger than for rail vehicles, bus speed, comfort and safety are much lower than LRT offers. Thus the most expensive way facility – tunnel and large underground stations – have been built for vehicle technology which provides much lower capacity, safety and quality of service. These system weaknesses have already come under considerable criticism in Boston press.

Comparison of regular bus, BRT and LRT

A comparison of basic characteristics of regular buses, BRT and LRT modes is summarized in Table 1 (above), based on numerous sources[9, 10, 11].

This table clearly shows significant differences between these three modes: compared to regular bus as the base, BRT and LRT represent higher steps in "investment cost/performance" relations. The quality of LRT service and its role in the city are distinctly the highest among these three modes.

The relationship between these three modes is clearly illustrated by the recently opened Insurgentes Avenue BRT line in Mexico City. It offers frequent service by articulated high-floor buses on reserved lanes with central stations and high-level platforms. This line has immediately attracted many more passengers than were carried by the unregulated buses and minibuses which it replaced. This success has created a problem, however, passenger volumes exceed the 5,000 persons per hour that the line can provide, causing serious overcrowding and unreliable service.

If an LRT line were built on this alignment, the investment cost would be significantly higher, but with two articulated car trains LRT would offer about three times greater capacity with far greater comfort, higher speed and reliability. In addition, LRT could have branches on any street which high-floor buses with left-side doors and no steps cannot have.

Consequently, this BRT represents a significant upgrading over regular buses which required moderate investment and short implementation period, while LRT would be another major step with higher investment and much better performance, passenger attraction and productivity.

In conclusion, the BRT concept is bringing great benefits in improving present bus services. Its implementation can lead to upgrading a complex network of low-image bus lines into a distinct network of frequent, reliable lines attractive to all classes of riders. In cities which are flooded by ubiquitous but low-quality unregulated minibuses, BRT is bringing a renewed concept of high-image transit network.

For applications on heavily used trunk lines, LRT represents a higher-investment/higher performance transit system than BRT. In addition to comfortable, quiet and reliable service, LRT provides better vehicle performance and possibility to use tunnels and serve pedestrian areas without the noise and pollution that diesel vehicles produce. LRT tracks symbolise permanence and represent a strong stimulus for economic development and human-oriented environment. With low-floor vehicles LRT stations fit aesthetically well in the centers of urban activities.

BRT and LRT should be considered as complementary modes. BRT tends to be more appropriate for small-to-medium size cities which do not justify introduction of a different technology. Low labor cost favors it over LRT because of larger personnel requirements. For heavy passenger volumes, use of tunnels in high-density urban centers and direct service in pedestrian zones, LRT is usually distinctly superior to BRT. The advantages it brings in such applications may easily justify the higher investment cost LRT involves. Moreover, with its stimulus for urban physical upgrading and economic development, LRT exerts unique long-term positive impacts on livability of city.

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Where high capacity is needed, light rail, although clearly more costly, will perform better (photo: Dallas)

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