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Sustainable public transport systems: Moving towards a value for money and network-based approach and away from blind commitment ☆

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Abstract

Growing public transport patronage in the presence of a strong demand for car ownership and use remains a high agenda challenge for many developed and developing economies. While some countries are losing public transport modal share, other nations are gearing up for a loss, as the wealth profile makes the car a more affordable means of transport as well as conferring elements of status and imagery of "success". Some countries however have begun successfully to reverse the decline in market share, primarily through infrastructure-based investment in bus systems, commonly referred to as bus rapid transit (BRT). BRT gives affordable public transport greater visibility and independence from other modes of transport, enabling it to deliver levels of service that compete sufficiently well with the car to attract and retain a market segmented clientele. BRT is growing in popularity throughout the world, notably in Asia, Europe and South America, in contrast to other forms of mass transit (such as light and heavy rail). This is in large measure due to its value for money, service capacity, affordability, relative flexibility, and network coverage. This paper takes stock of its performance and success as an attractive system supporting the ideals of sustainable transport.

Keywords: Bus rapid transit (BRT); Value for money; Network coverage; System

1. Introduction

There is growing support for an attractive alternative means of transportation to the car in cities. If increased public transport capacity is the way to proceed, it is very important that the investment in such systems is made in a rational way. There is a need for sensible selection and funding of technology and consideration of appropriate ways of addressing the problems attributed to the automobile. Following on from the earlier shift from heavy rail to light rail (Mackett and Edwards, 1996a, b; Edwards and Mackett, 1996), there are now signs of a shift from light rail to bus-based systems. This trend is perhaps associated with recent evidence that investment in bus rapid transit (BRT) is less risky than rail in terms of cost overruns and patronage forecasts (Flyvbjerg et al., 2004). However, there are still many examples of the use of over-sophisticated technology being used despite tight budgets and the risk of spreading thin resources even thinner.

After many years of trying to instill some sense of relevance in the debate on public transport (e.g., Kain, 1988; Hensher and Waters, 1994; Hensher, 1999), it is easy to conclude that investment in heavy and light rail is widely assumed to be the "best" solution. Unfortunately, there are at least two major deficiencies of this popular perception[1]—namely the huge cost involved (in the billions, not millions) and the inability of such a solution to deliver more than a service to specific corridors, to the neglect of the needs of the systemwide network (Kain, 1988).

It is generally agreed that improved public transport can help to solve metropolitan congestion but there are many

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[1]The Sydney debate on the role of LRT and BRT focuses on a view that buses cause congestion and light rail in the CBD will eliminate traffic gridlock. In fact, LRT would take up more space and, according to department of planning data (personal communication), buses account for less than one per cent of traffic in the central business district.

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possible ways of investing in improved public transport. These include heavy rail, light rail, and BRT, where buses have their own dedicated roads just as trains have their own dedicated track.

Globally there is growing support for delivering service capacity through BRT as a legitimate alternative to heavy and light rail within the traffic density range that many cities experience. Wright (2005) provides evidence to show that typically $ 1 billion buys 400 km of dedicated BRT in contrast to 15 km of elevated rail or 7 km of underground rail.[2] Most importantly, not only does this deliver greater network coverage but it also falsifies the traditional view of the capacity of specific public modes (buses up to 6000 passengers per hour in one direction compared to up to 15,000 for light rail/tram and over 15,000 for heavy rail/metro—see Wright 2005). Advanced BRT systems such as TransMilenio in Bogota (Columbia) can move 38,000 passengers per hour in each direction.[3] The important point should not be the capacity of vehicles but the capacity of the service. In the Sydney context, for example, buses currently deliver 5100 people an hour inbound on George Street at Railway Square in Sydney in the morning peak. The buses have the capacity to carry about 7500 an hour at 60 people a bus. Light rail's capacity is 3600 an hour at working capacity, with people sitting and standing comfortably, and 4800 an hour at crush capacity. It thus seems that the arguments about capacity do not wash! In addition, buses can seat 75% of passengers compared with 25% on light rail and, with fewer trams carrying more people, there would be longer waiting times.

There are a growing number of BRT examples around the world, and the International Union of Public Transport Operators (UITP) in Europe has recently stated that BRT is increasingly preferred over fixed rail systems for value for money. But, despite the growing evidence, there is still a powerful body of support for very expensive fixed corridor rail systems, which will fail to serve the fuller demands of many metropolitan areas.

One problem is summarised in the adage 'trains are sexy and buses are boring' (Richmond, 1998; Hensher, 1999). The challenge is to get away from thinking of BRT as those awful polluting buses that get delayed because they compete with cars (even if they are occasionally offered disconnected bus lanes). This is not BRT! BRT has its own dedicated right of way (all be it narrower and less intrusive than that required for light rail transit (LRT) and, as to pollution, one should think of starting the investment in BRT (as cities such as Curitiba, Brisbane, Taipei, Bogota, and Pittsburgh have done) with clean-fuelled buses.[4] Electrically powered rail may have limited impact on the local air quality but it requires unsightly power lines and, particularly if sourced from coal-fired power stations, may be responsible for significant greenhouse pollution.

There is a need to set aside dedicated 'roads' for BRT to achieve its potential, not only in the inner city-CBD area but also across a metropolitan network. Crucially, the technology must not be the determining influence; rather the way forward is to identify systems (i.e., integrated vehicles and infrastructure) that will provide a high level of service capacity throughout a connected network, delivering frequency, connectivity, and visibility.[5] Public transport improvements must be part of a larger package in which we consider ways of financing these improvements, and a good start is to learn from the experiences of London and Stockholm where a congestion-charging scheme is in place. The money raised in London and Stockholm is earmarked for investment into public transport—surely a sensible strategy. Most importantly the politicians have earned respect for taking such an initiative. All of this seems so obvious in many ways; yet will other world cities rise to the occasion?

What about the future for bus systems? Despite the growing appeal of bus-based transitways, there is still a lot that can be achieved by simple solutions such as adding more buses, adjusting fare schedules, improving information systems, and integrating ticketing. Unfortunately, these incremental improvements may be ignored if the debate concentrates on the relative merits of special rights-of-way for buses as against light rail. Buses, especially bus-based transitway systems, are arguably better value for money, and if designed properly, can have the essential characteristics of permanence and visibility claimed to be important to attract the property development, which is compatible with medium to high-density corridor mobility. Newman and Kenworthy (1989) suggest that good rail transit systems provide the opportunity for highlighting public values in ways, which give a city new pride and hope for the future. While this may have some truth, it should not deny the capability of achieving the same impact with a high-quality dedicated bus-based transitway; indeed, it may be argued that the images created in promotion of the Liverpool–Parramatta transitway in Sydney and the Brisbane busway system are actually more appealing to civic pride than the existing heavy and light rail systems.

An assessment of BRT systems throughout the world suggests that their cost structures impose less burden on taxpayers in subsidies per passenger than does LRT. Thus, for any given amount of investment, the environmental, energy, and traffic reduction benefits of BRT are likely to be much higher than LRT. Because it can offer more direct origin to destination service, BRT can provide higher quality service by avoiding time-consuming transfers, and by using modern technology, the vehicles, stations, and rights of way of BRT systems can be very attractive.

[2]Even if these numbers are debatable and subject to error, the differences are sufficiently stark to be worthy of note.

[3]Personal communication with TransMilenio.

[4]Diesel technology has come a long way in reducing emissions, with the new Euro 3 buses emitting less than natural gas buses.

[5]By which we mean a physical presence, which indicates where the services run to and from.

Importantly, BRT can be built much faster than competing systems and is more adaptable to changing travel patterns.

2. The appeal of BRT

BRT has shown to be an effective catalyst to help transform cities into more liveable and human-friendly environments. The appeal of BRT is the ability to deliver a high-quality mass transit system within the budgets of most municipalities, even in low-income cities. BRT has thus proven that the barriers to effective transit are not costly or high technology. The principal ingredient is simply the political will to make it happen (Wright and Hook 2006, preface).

There is growing evidence around the world, in origin–destination density contexts similar to the locations proposed for light rail, that a dedicated BRT system (i.e. road infrastructure dedicated exclusively to buses as in Brisbane, Curitiba, Bogota, Pittsburgh, Ottawa etc.) can carry the same number of people as light rail for a typical cost 4–20 times less than a LRT system and 10–100 times less than a heavy rail system (USA General Accounting Office, 2001). It is flexible, it is as permanent as light rail and it can have the image of light rail (rather than the image of boring buses) if planned properly. The USA General Accounting Office (2001) audit of BRT and light rail in six US cities found that the capital cost per mile for LRT compared to BRT in its own lane was 260% more costly. Comparisons with BRT on street or on an HOV lane are not useful and have been excluded. When one also notes BRT's lower operating costs for both institutional[6] and maintenance reasons, the case is clear.

The 16 km state-of-the-art south east busway in Brisbane, opened in 2000, is an example of a busway system that has exceeded expectations in patronage. In the first 6 months of operation, the number of passengers grew by 40% or by more than 450,000, giving a daily average of 58,000. Over the first 3.5 years there has been an 88% increase in patronage. It has been reported (The Urban Transport Monitor, 2002) that 375,000 private vehicle trips have been converted to public transport. Pittsburgh's 8 km third busway, which opened in September 2000, secured average weekday patronage growth of 23% over the first 17 months. Current Pittsburgh average daily passenger trips on the full busway system of 43.8 km is 48,000 and growing steadily.

On a number of reasonable assumptions, the patronage potential for a bus-based transitway can be as high as twice that of LRT. Results of Port Authority's busways[7] suggest that the average operating and maintenance costs per rider (FY 1995 data) are south busway = \$1.03; east busway = \$0.95; remainder of bus system = \$2.55; light rail system = \$3.22. Operating costs for Pittsburgh's east and south busways (1989) averaged \$0.52/passenger trip while cost/passenger trip for light rail lines in Buffalo, Pittsburgh, Sacramento, and San Diego averaged \$1.31[8] Sislak (2000) undertook a comparison between light rail and BRT options in Cleveland and Nashville: Cleveland's operating and maintenance costs are around one sixteenth that for the light rail option and capital costs are just over a quarter of that estimated for the light rail option; Nashville's capital cost for BRT under half of that estimated for light rail option (at grade). Operating and maintenance costs for LRT estimated to be \$4.6 million annually (\$18.28 per LRT car mile). BRT operating and maintenance costs estimated to be \$3.2 million annually (\$12.73 per bus mile). The relativities will be determined by the sophistication of the design of the bus-based transitway system. Establishing actual patronage is another issue, although we have yet to find any unambiguous evidence to suggest that you can attract more people to LRT than a bus-based scheme. This arises because of the difficulty of finding very similar circumstances in which both LRT and a geographically comparable bus-based system are in place. Certainly the performance of the dedicated bus-based transitway systems in Curitiba, Bogota (Estache and Gomez-Lobo, 2005), Brisbane, Pittsburgh, and Ottawa deserve closer scrutiny.

Menckhoff (2005) has reviewed the specifications and performance of 10 existing BRT systems (totalling 320 km) and 11 systems (adding another 240 km) that will be in place within two years in Latin America as part of a World Bank assessment. Describing Latin America as a 'fascinating urban transport laboratory', Menckhoff documents the distinctive image and high productivity of public transport systems that has arisen out of the South American initiatives. Key to the success is institutional reform and the specification of a BRT system that delivers feeder-trunk operations, bus overtaking at stops, four lane (2+2) busways for high-demand corridors, limited stop and express services, high-capacity trunk-line articulated (18 m, 160 passenger) and bi-articulated (25 m, 260 passenger) vehicles, high-level 'heavy rail-like' entry into buses often through centrally located bus stations, and prepayment of fares. A novel reverse of practice elsewhere is the decision to elevate the bus stop/station platform so that buses can be built on a truck chassis, which is much less costly than low-floor buses. In addition, two-directional bus stations in the median were first introduced in Bogota's TransMilenio, which required offside doors for all trunk-line buses. This has the advantage of savings in physical space and station labour.

BRT in Latin America has shown itself to be capable of moving passengers at a fraction of the cost of other high-capacity modes; and most importantly has helped to reshape the less than desirable image of road-based public transport. The political windfall has been substantial to the

[6]In some countries, BRT avoids the stranglehold that rail unions often have on the system, usually leading to inflated costs.

[7]see http://131.247.19.10/media/presents/trb-04/wohlwill.pdf.

[8]See http://trb.org/publications/tcrp/tcrp_rpt_90v2.pdf.

Mayors responsible for their implementation. A limited comparison of selected BRT, light rail, elevated rail, and subway systems suggests the appeal of BRT in terms of passenger flows and costs. At relatively high commercial speeds (15–32 km/h), Curitiba is carrying peak volumes in excess of 14,000 passengers/h/direction, increasing to over 20,000 passengers/h/direction where extra passing lanes are provided at bus stops. In Bogota the Transmilenio double-width busway accommodates 35,000 passengers/h/direction with a mixture of all-stop and express bus services (Menckhoff, 2005).

The success of BRT in Latin America should not be seen as a regional peculiarity but rather a reflection of the particular period in time in which opportunities to work with specific technologies has occurred. Light rail is more common in Europe, in large part due to the inertia associated with the availability and promotion of this technology by European manufacturers in earlier periods. Bouf and Hensher (2006) indicate that part of French strategy to support public transport was the desire to create an industry with public subsidies in conformity with the "colbertist" model and to export public transport technology, especially LRT.[9] To a certain extent this has been successful although the main expected market (China) is now heading increasingly toward BRT rather than LRT. The demonstrable success of BRT in South America is clearly changing the terms of the debate!

A recent by the Canadian Urban Transit Association (2004) identified a number of major benefits of BRT, which have repeatedly been reported in many other jurisdictions:

- *Service speed and reliability*: With average operating speeds of 45–50 km/h and consistent travel times, BRT services on busways and bus lanes are more attractive than conventional transit routes operating at half that speed and with lesser reliability due to congestion.
- *Greater patronage*: BRT projects build patronage because they offer a premium service with faster speeds and greater reliability. The use of special branding to promote BRT services also helps attract new users.
- *Lower costs*: The faster average speeds of BRT reduce operating costs and BRT facilities cost less to build than light rail because they do not need specialized electrical, track, vehicle maintenance or storage infrastructure.
- *High capacity*: High-capacity vehicles, frequent service, and flexible routing structures allow BRT to match or exceed the passenger volumes of the busiest light rail systems.
- *Operational flexibility*: BRT allows a variety of customer services, with a single running way able to support express, local and skip-stop services—a difficult and expensive proposition in a rail environment.
- *Incremental implementation*: BRT systems can be implemented in stages. Buses can use a BRT facility to travel through a congested area, then switch onto a roadway to serve a relatively uncongested corridor.
- *Land use change*: BRT can stimulate the development or redevelopment of compact, pedestrian- and transit-friendly land uses, when supported by complementary land use and zoning policies. This contradicts the claims by proponents of light rail that only rail-based investments can deliver such development stimulus because it is 'permanent'.

A review of US BRT experience (Federal Transit Administration, 2004) indicated significant increases in transit patronage in virtually all corridors where BRT has been implemented. Though much of the patronage increases have come from passengers formerly using parallel service in other corridors, passenger surveys have revealed that many trips are new to transit, either by individuals who used to drive or be driven, or individuals who used to walk, or by individuals who take advantage of BRT's improved level of service to make trips that were not made previously. Aggregate analyses of patronage survey results suggest that the patronage increases due to BRT implementation exceed those that would be expected as the result of simple level of service improvements. This implies that the identity and passenger information advantages of BRT are attractive to potential BRT customers. Patronage gains of between 5% and 25% are common. Significantly greater gains, such as 85% in Boston's Silver Line represent the potential for BRT.

3. Conclusions

This short paper is designed to reinforce the appeal of BRT systems over other public transport investment strategies. The growing evidence globally about the broad-based advantages of BRT over other systems such as light rail, and even heavy rail in some density contexts, is so strong on the main measures of performance that, at the very least, all governments should seriously evaluate the appeal of BRT. We acknowledge the big challenge in even referring to buses, given the emotional overtones and imagery that has not served the bus well in the past. But the incessant contrasts between buses in mixed traffic and light rail (which often mixes with other traffic), has failed to capture the real meaning of a BRT system in which the buses move along dedicated infrastructure. The challenge is to continue, through evidence, to reinforce this position and hopefully to move away from un- and mis-informed blind commitment to sensible outcome-based decision making.

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[9] We understand that part of the reason for the popularity of LRT over BRT in France is attributable to the availability of significant discounts on capital costs—even though this does not solve the problem of ongoing high maintenance and operating costs.

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