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and also the case for further investigating busways and tramways

THE CASE FOR BUSWAY TRANSIT

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1. INTRODUCTION

There is an immense and growing need for public mass transit at intermediate levels of passenger demand in cities of both less developed and industrialised countries.

In the main corridors of the largest cities, metro and suburban rail are the only modes capable of reliably carrying very high passenger volumes (ie 30,000+ passengers/hour/direction); in smaller cities, where passenger volumes are modest, transport systems can be developed from a wide variety of paratransit and conventional bus services. But there exists a very large "middle ground" - corridors with passenger flows between about 10,000 and 30,000/hour/direction during peak periods - where the transport profession has had few affordable alternatives to offer. This middle ground comprises secondary corridors in the largest cities (including feeder corridors to metro lines) and the more important corridors in secondary cities.

Basically, two families of systems are available to meet intermediate demand levels: light rail transit (LRT) and what we term here "Busway Transit". Although relatively few Busway Transit systems exist, there are even fewer LRTs in the developing world. Consequently, there is considerable uncertainty about how effective such intermediate capacity systems would be in possible future applications.

In order to begin to assess the effectiveness of Bus Transit in this context, a "Study of Bus Priority Systems for Less Developed Countries" was carried out during 1988-90 jointly by the Transport and Road Research Laboratory (TRRL) and consultants. The views given in this paper are based on preliminary findings from the study. The paper summarises the levels of performance which can be achieved by Busway Transit and indicates its advantages and disadvantages relative to alternatives. This paper should be read in conjunction with a parallel paper by Gardner and Fouracre (1), which reports on other aspects of the study.

Although the TRRL study was aimed primarily at the needs of less developed countries (LDCs), many of the underlying principles apply equally well in Europe and other industrialised countries.

2. WHAT IS BUSWAY TRANSIT?

We use the term "Busway Transit" to denote a system which includes a right-of-way for the exclusive use of buses, with at least one section of busway physically segregated from general traffic, and some or all of the following:

(a) a collector/distributor system at one or more ends of the busway, most likely including bus priority measures in the "CBD" area;
(b) bus stops (physical layout; management etc.);
(c) fare collection methods (eg on- or off-board collection);
(d) bus fleet (vehicle capacity; door configuration etc);
(e) operations (eg bus ordering; express services), and
(f) marketing (passenger information; corporate image etc).

It must be said that few cities have treated buses in a comprehensive way and taken action in all these areas, notable exceptions being Curitiba (Brazil) and Ottawa (Canada).

The busway itself is a section of road, usually (but not necessarily) one traffic lane in each direction, dedicated to the exclusive use of buses at all times. In general, busways are either located along the centre of the road, with island stops, in order to minimise enforcement problems and disruption to frontage access, or are totally segregated new roads. Passengers usually walk to and from bus stops via traffic signal controlled crossings of general traffic lanes. In high-capacity schemes, bus overtaking facilities at stops and grade separation at intersections may be provided. This particular definition excludes high-occupancy vehicle lanes (HOVs) as used for car pooling and bus services in the USA.

For the busway track, many physical cross-sections and configurations are feasible, which makes generalisations about performance and impacts almost impossible. The comments in this paper concentrate mainly on busways constructed along existing roads (in much the same way as street-running LRT) although many of the comments apply equally well to purpose-built new roads (at-grade or elevated) constructed solely for use by buses.

3. WHERE HAS BUSWAY TRANSIT BEEN IMPLEMENTED?

The earliest schemes were implemented in Europe - for example, the first of three radial busways was built in Liege (Belgium) some twenty years ago. And the first purpose-built busway roads were commenced in Runcorn New Town (UK) in 1971. Then in the late 1970s and early 1980s a series of innovative busways was implemented in various Brazilian cities. Perhaps the most famous of these is Curitiba, where busways form structural axes which are integral with the city land use plan. Detailed and sophisticated attention has been given to passenger interchanges, bus design and many other aspects. Busways were also implemented during this period in Sao Paulo, Porto Alegre, Belo Horizonte, Recife and elsewhere, many with World Bank assistance.

In Abidjan (Cote d´Ivoire) three busways were implemented as part of World Bank-assisted projects. And busways have also been built in many other cities: Ankara (Turkey), Bogota (Colombia), Hamburg (West Germany), Istanbul (Turkey), Lima (Peru), Nagoya (Japan), Ottawa (Canada) and Pittsburgh (USA).

Busways are being planned currently in various other cities, including Bangkok (Thailand), Jakarta (Indonesia), Karachi (Pakistan), Nairobi (Kenya) and Shanghai (People´s Republic of China).

4. BUSWAY TRANSIT PERFORMANCE

Performance should be measured by means of a series of quantitative and qualitative indicators. But the first point to establish is: "how many passengers can be carried at what speed?". The TRRL study set out to address this question and some preliminary answers are given in the accompanying paper by Gardner and Fouracre (1).

It is important to remember that busway "capacity" is influenced by many factors, including passenger demand. Without bus stops, very high bus and passenger flows are possible. But with stops, as the number of boarding or alighting passengers increases, so bus dwell times increase, and bus and passenger flows along the busway tend to diminish. Because of this effect, the "supply" of passenger places measured during surveys may be greater than the sustainable passenger "capacity" if passenger demands were to increase. The TRRL surveys measured both "available passenger places" and actual passenger flows.

At the time of writing, work is proceeding to try to define some planning guidelines, but it seems reasonable to suppose that for general planning purposes, passenger flows of up to 20-25,000 passengers/hour/direction can be achieved with appropriate infrastructure design (track and stops), vehicle fleets, and assuming well-managed operations. The precise figure in any particular location will depend on very many factors including: right-of-way characteristics; degree of segregation from general traffic; local traffic engineering capability; passenger demands (boarding/alighting); passenger characteristics; and so on.

5. CUSTOMER NEEDS

All but the smallest cities sooner or later will have to face up to the impossibility of fully accommodating demands for travel by private motor vehicles. Unless politicians are prepared to implement sensitive demand management measures, rich and poor alike have to learn to live with road traffic congestion. However, there are real choices about how city authorities allocate scarce roadspace between private and public transport vehicles, and whether resources should be invested in segregated public transit to "by-pass" road traffic congestion.

There is a common misconception that mass transit (usually meaning rail mass transit) will "solve" the congestion problem. Yet the TRRL Study of Mass Rapid Transit in Developing Countries (2) found that: "The general conclusion is that contrary to expectations, metros do not appear to reduce congestion." It appears that metro passengers are mostly captured from bus and whatever road capacity is thereby released is soon taken up by suppressed demand or growth in road traffic.

Now consider market diversity and segmentation. In many cities, there exist radically different groups of travellers, characterised at one extreme by the low-income worker in the informal sector and at the other extreme by the car-owning office executive. Their expectations of transit "quality", and their ability to pay, are vastly different.

Yet many urban transit systems are designed as if passengers were homogeneous. It is virtually impossible for single-class rail transit systems to meet these disparate needs. Meeting the qualitative needs of the office worker would result in fares unaffordable by the mass of lower-income people, unless large subsidies are provided (eg Mexico City) - and in that case, the system may become unacceptable to higher income people. To be affordable without large subsidies, relatively basic standards are inevitable, and often will not be acceptable to those who have an alternative.

Compared to rail systems, bus transit can potentially offer a much wider differentiation of services in terms of routes (origin-destination links without interchange) and service quality (eg air-conditioned; express...).

6. STRENGTHS AND WEAKNESSES OF BUSWAY TRANSIT

This section sets out some of the strengths and current weaknesses of Busway Transit in the context of a city considering alternative transit options. This discussion deals primarily with alternative at-grade Busway Transit systems, although some comments are made subsequently on grade-separated and tracked bus systems. Some strengths and weaknesses are inherent to Busway Transit; others are scheme-specific and depend on particular design, management, operations and marketing characteristics.

Inherent Strengths

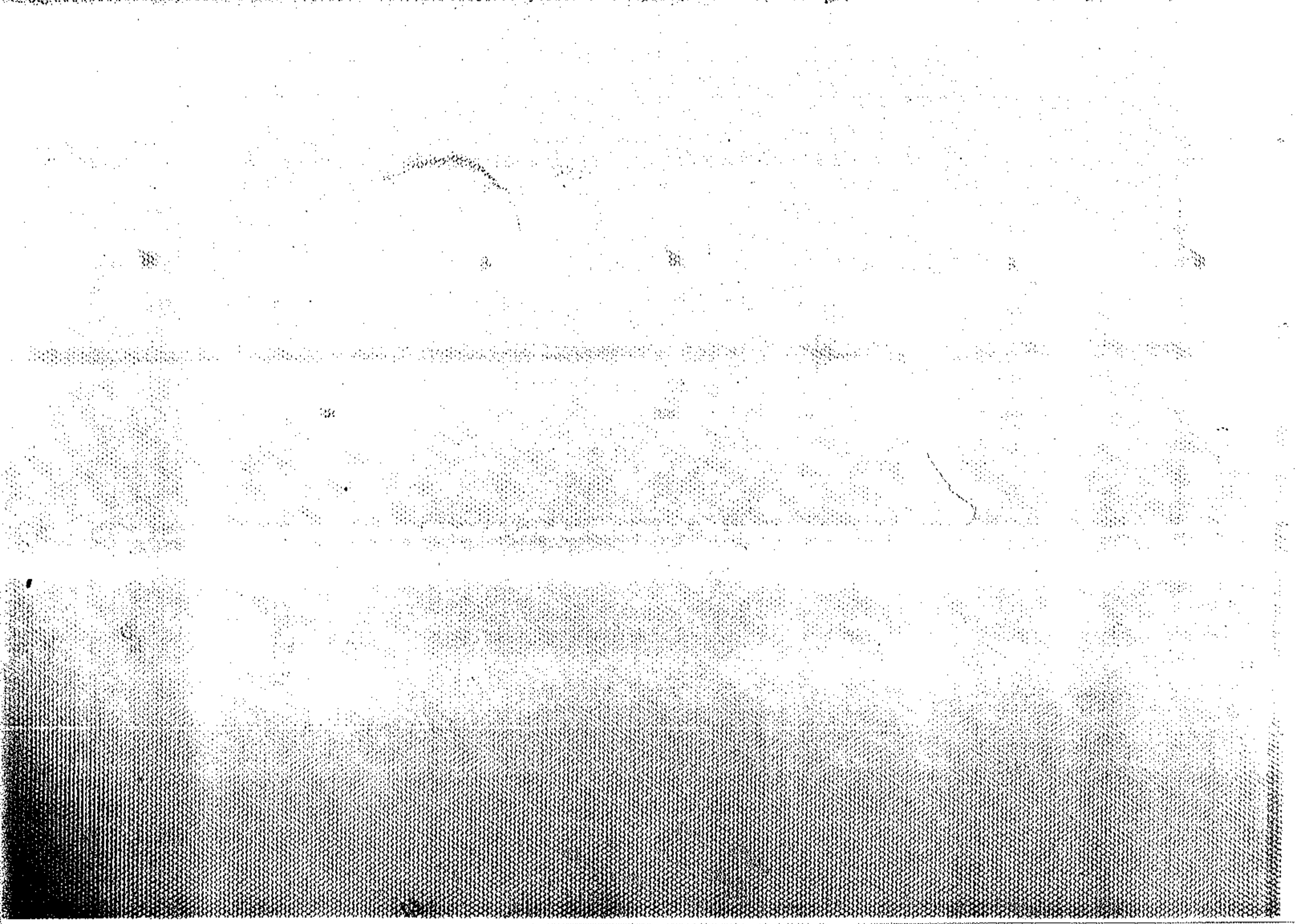
Busway Transit has six main strengths:

(a) Capacity and speed;
(b) Flexibility and diversity;
(c) Affordability;
(d) Scope for incremental development;
(e) Implementation speed; and
(f) Self-enforcement.

Capacity and Speed: The capacity of a well-designed and efficiently managed busway can be equivalent to that of an LRT, on a comparable basis (eg degree of segregation; stop spacing).

The surveys recorded peak hourly available passenger places along a busway of up to 39,000/hour/direction (Farrapos, Porto Alegre), although this "capacity" was underutilised - actual ridership was only about 15,000 passengers/hour/direction. With regard to passenger flows, the Avenida 9 de Julho Busway in Sao Paulo, carries up to 20,000 passengers/hour/direction and the Assis Brasil Busway in Porto Alegre carries about 18,000 passengers/hour/direction. (The figures quoted are for the predominantly boarding direction; corresponding figures for the predominantly alighting direction are generally higher.) Passenger conditions are not ideal at high volumes, but it is likely that an LRT would also be crush-loaded at such levels of demand. At the lower levels of demand found in many corridors - say 10-15,000 passengers/hour/direction - good passenger conditions are achievable.

Provided buses are segregated from general traffic, and bus stops are well managed, average commercial speeds can be equal to or greater than those of an LRT (with equivalent segregation). When bus overtaking facilities are provided along a busway, express (limited-stop) services can operate at attractive speeds (light rail vehicles cannot generally overtake one another). During the study, average commercial speeds in the range 16-29 kph were recorded along busways in radial corridors during peak periods (3).



Flexibility and Diversity: An enormous advantage of Busway Transit is its operational flexibility and its ability to respond to diverse passenger demands. Since buses can join and leave a busway at intermediate points, it can be used by many routes over a part or all of its length. This means that busway systems can directly serve a much wider passenger catchment area than an equivalent fixed rail line, with significantly fewer passengers interchanges from one mode of transport to another - a major advantage to passengers.

Busway transit can match the supply of services and capacity closely to passenger demands at different times of the day and as demand changes through time. Bus routes can be changed quickly, if necessary, in response to evolving passenger needs and larger buses can be used as demand grows (eg services may start using midibuses, then progress to standard-sized vehicles, and then mature to articulated buses if and when such capacity is required). In contrast, LRT has fixed routes and uses relatively large (and expensive) vehicles.

As indicated in Section 5 above, different quality bus services can also be offered to meet the demands of different market segments (eg air-conditioned/standard and so on).

Affordability: An at-grade busway along an existing right-of-way is likely to cost in the range US$4-900,000/km (end-1989 values), depending upon the need for utility relocation and other local factors. This cost estimate includes reconstruction of the busway track, and necessary traffic control devices, but excludes the cost of buses, terminals and collector/distributor systems.

The cost of an at-grade busway track with the required traffic control system will be considerably less than the infrastructure cost for a corresponding rail system. A busway may be grade separated at critical intersections (elevated or depressed) and some sections may be on structure, but overall, the system cost is still likely to be less than that of any equivalent rail-based system.

Incremental Development: Busway Transit can be implemented in stages, and sections of even a few hundred metres can be useful, whereas rail transit requires a depot and a significant route length before it can attract many passengers. Busway Transit can be extended incrementally and can be enhanced step-by-step through the addition of measures such as bus actuated traffic signals, grade separation at critical intersections, new passenger facilities and operational improvements (such as off-bus ticketing).

Implementation Speed: A busway may be implemented relatively quickly since usually no special legislation is necessary and because the track and vehicles are inherently less complex than those of LRT or other rail systems. Nevertheless, negotiations with existing operators can be politically sensitive and protracted.

Self-enforcement: Because a busway physically segregates buses from general traffic, schemes are virtually self-enforcing and are therefore superior to traditional "paint-and-sign" bus lane priorities. A busway can be designed in a similar manner to a street-running, segregated LRT.

Current Weaknesses

Busway Transit has six current weaknesses: three are institutional and three relate to physical impacts:

(a) Institutional fragmentation;
(b) Lack of political "visibility";
(c) Apparent complexity;
(d) Impact on other traffic;
(e) Severance; and
(f) Land-related impacts.

Institutional Fragmentation: Despite its technical merits, adoption of Busway Transit is severely inhibited by institutional fragmentation on the part of both potential "owners" and suppliers.

To implement Busway Transit along an existing right-of-way requires close political cooperation and technical coordination between at least four agencies: (1) the highway authority (Municipality or Ministry of Public Works), (2) the Traffic Police, (3) the regulatory authority responsible for bus licensing, and (4) any municipal, state-owned or private bus operator(s). Where bus services are operated by private bus companies, the situation becomes further complicated as existing route concessions may be affected. Implementation also requires the explicit or implicit acceptance by any authority vested with responsibility for urban rail services. The fact is that cooperation between all these agencies rarely exists. Special circumstances have to be created, by local political leadership or via a high-profile internationally-supported project to generate consensus between all the participants. And even then it is difficult to maintain commitment to maintenance and management when political power changes (as in Porto Alegre) or after the project finishes (eg Abidjan).

On the supply-side, the industry is highly fragmented: bus manufacturers sell buses; road contractors build roads; consultants make studies. In stark contrast, the rail transit industry has evolved complex organisational arrangements ranging from supplier contracts through joint-ventures to build-operate-transfer companies, and involving financial instruments ranging from supplier credit through loan syndication to equity participation. Needless to say that the sophistication of political lobbying by interest groups matches the scale of financial interests.

Lack of Political "Visibility": Low-technology Busway Transit lacks political "visibility" at two distinct levels:

a. Physical: Quite simply, what is there to see? ... the busway itself looks like an ordinary road (there is no "track") and bus stops are not visibly impressive unless they incorporate electronic passenger information devices combined with attractive urban design. Schemes may or may not incorporate attractive buses and appropriate marketing; and

b. "Critical Mass": Any scheme needs to have a certain "critical mass" to command political attention and support. This critical mass may be generated by sheer size (eg building a new metro system), by responding to public concerns (eg air pollution), by introducing new technology (eg computer systems), by domestic lobbying (eg by local industries) or by external pressure (eg World Bank).

When buses are mentioned in political circles, they usually conjure up a poor image - sometimes a disastrous one. Politicians often perceive the way forward as doing something "modern" with new technologies rather than continuing to grapple with seemingly intractable bus-related problems which have often existed for years. To date, busway schemes have tended to be low-technology applications - and consequently have found it difficult to command political support.

Complexity: One of the greatest advantages of Busway Transit is its flexibility - yet this very flexibility gives rise to one of its disadvantages: apparent complexity. There exists a vast range alternative combinations of infrastructure, bus characteristics, organisational arrangements etc - as yet there are no standard or packaged solutions. As a consequence, concepts can be difficult to describe and to "sell" to would-be decision makers. Furthermore, because of their diversity, there is also a lack of demonstration effect for any particular configuration.

Impact on Other Traffic: A busway located along an existing road will have an impact on general traffic, particularly at intersections. The precise impact will depend upon the volumes of buses and general traffic, and how close to capacity the various road sections and intersections are operating. Under some circumstances, physical separation of buses and general traffic may be beneficial to both; under others (eg provision of a median busway), it will be necessary to remove some roadspace from general traffic and this may impinge adversely on general traffic capacity. This factor is crucial to the political acceptability of Busway Transit.

Our case studies suggest that bus priorities can be acceptable where they are introduced as part of an overall traffic improvement programme in which general traffic gains too (eg Abidjan); they can be acceptable where there is currently sufficient capacity to implement them without adversely affecting general traffic; but circumstances arise where Busway Transit would benefit the majority of travellers, and result in net economic benefits, but is rejected on political grounds due to the adverse effect on cars.

The impact of Busway Transit on general traffic need be no more severe than for an equivalent street-running LRT. The issue is whether existing road capacity can be reallocated for transit use or whether additional capacity has to be provided.

Severance: The effectiveness of Busway Transit (and LRT) depends on its segregation from general road traffic and from pedestrian movements. This means that traffic management measures (eg one-way streets) are required to concentrate vehicular crossing and turning movements at selected signalised intersections, and pedestrian movements must be channelised and limited to signalised or grade-separated crossing points (eg at stops and intersections). Fences or walls may be placed along the median to enforce the required segregation and thus a severance effect is created. This severance effect is more or less the same for bus or for rail transit, but may be more acceptable if related to the introduction of new technology or "higher-image" transit.

Land-related Impacts: Busways have played a significant land development role in only a few cases to date: notably Curitiba (Brazil) and Runcorn New Town (UK). Elsewhere, their impacts have probably been negligible. The infrastructure required for a conventional busway does not represent a clear "fixed", long-term public sector commitment to a particular area or corridor - there is no "track", no power systems etc - and in principle, a busway could be relatively easily converted to an ordinary road. Without visible commitment from the public sector, why should the private sector direct development resources to a busway corridor rather than elsewhere? Rail systems are perceived quite differently and increasingly mass transit and land development interests are being integrated, for financial and other reasons.

Scheme-specific Factors

Several important factors may act for or against Busway Transit, depending upon scheme-specific proposals:

(a) Service quality;
(b) Environmental quality;
(c) Safety; and
(d) Central area issues.

Service Quality: Although buses are often perceived as a low-quality mode and suffer from a poor image, the technology exists to provide a "modern" system: for example, bus stops can be well engineered and provide bus- or passenger-actuated electronic passenger information concerning bus arrivals (as used in Nagoya, Japan). And, most importantly, high-quality buses (eg low floors, wide doors) are available at a fraction of the cost of an LRT vehicle. With appropriate marketing, modern Busway Transit can offer a cost-effective, quality alternative to LRT.

Environmental Impact: The popular tendency is to compare existing buses (sometimes poorly maintained) with "modern", electric rail systems as shown in manufacturers' videos and brochures. There is no reason why Busway Transit cannot be operated using modern, environmentally-friendly diesel, electric trolley, gas-fuelled or multi-mode buses.

Safety: Little hard evidence is available relating to busway safety. Street-based systems, LRT or busway, both involve safety risks, but with careful traffic engineering, such risks can be minimised.

Central Area Issues: We stressed earlier the need to conceive Busway Transit as a system, including collector/distributor priorities in and around the central area. Even with one radial busway, careful attention needs to be given to how high inbound volumes of buses and passengers are distributed around the central area. When several high-volume corridors are served by transit (eg Curitiba; Porto Alegre) careful consideration has to be given to the layout and functioning of the whole central area, including pedestrianisation, parking and other measures. These comments apply to both Busway Transit and LRT.

7. CONCLUSIONS

Busway technology has been around for more than 20 years. Yet after a burst of activity, particularly in Brazil, during the late 1970s and early 1980s, few new schemes have been implemented. Why? Are busways ineffective? Are they too difficult to implement and to manage? Or have other factors camouflaged or overshadowed their achievements?

There are no simple answers. Some schemes are well-designed and function effectively (eg Avenida 9 de Julho, Sao Paulo), whereas others function despite a series of adverse influences ranging from past political neglect (eg Porto Alegre), through poor design (eg pavement failures in Abidjan and Recife) to organisational difficulties and inadequate technical support.

The TRRL study has confirmed that Busway Transit is capable of carrying high passenger volumes at attractive commercial speeds - stated simplistically, existing (sub-optimal) schemes carry: "up to 18-20,000 passengers/hour/ direction at about 18-20 kph". And it can be argued that the busway schemes surveyed compare very favorably with a string of less-than-successful rail mass transit schemes in the same cities and elsewhere (eg Belo Horizonte; Istanbul; Porto Alegre etc) (4).

So what prospects are there for promoting the strengths and overcoming the current weaknesses of Busway Transit? Several key factors emerge:

Bus Industry: The first issue relates to the bus industry, interpreted in the widest sense. Until suppliers perceive a market, invest in product development and organise themselves to offer integrated packages which include more advanced technology, environmentally-friendly buses, finance and management, relatively few new Busway Transit applications are likely.

"Owner Organisation": In order for Busway Transit to be fully effective, there is a need to create a single "client" or "owner" organisation in a city, with the participation of all relevant agencies. Unless this is done, Busway Transit may be more difficult to implement than an urban railway, and operational performance may be jeopardised.

Credibility and Image: Due largely to lack of technical information and non-existent marketing, Busway Transit is sometimes perceived as a second-best option. Little attempt has been made to promote Busway Transit as a cost-effective and flexible modern transit system; or to investigate possibilities to stage mass transit development by initially constructing at-grade low-technology busways to geometric standards which permit subsequent upgrading, as and when extra capacity and/or quality are affordable. Busway Transit is not a second best solution for

LDCs and more needs to be done to disseminate information on high-tech and industrialised city examples: for example, Adelaide (Australia), Hamburg (West Germany), Liege (Belgium), Nagoya (Japan), Ottawa (Canada) and Pittsburgh (USA).

And what of future prospects? Given the physical difficulties and practical skills needed to insert an at-grade busway into an existing road, some cities are turning their attentions to elevated busways (eg Jakarta and Karachi). In principle, there is no reason why elevated busways should not function effectively, if appropriately designed and operated. But will city authorities be prepared to pay around US$10 million/km for an elevated bus track? This may be politically acceptable if it comes with more advanced technology (eg possibly guided-bus) and new management techniques (eg computer systems); but it seems unlikely for low-technology applications.

To become more widely acceptable and successful, the quality and image of Busway Transit will have to be upgraded. This requires the combination of modern technology, finance and marketing, together with good management and imaginative organisational arrangements. The potential market exists; the technology exists; but who will meet the challenge?

Finally, we note that despite the current wave of LRT proposals, and the fact that considerable resources have been invested in various LRTs (eg Manila; Hong Kong; Rio de Janeiro etc), we know of no LRT in an LDC which outperforms our surveyed busways in terms of productivity (passenger volumes x associated commercial speeds). We look forward to updating our files.

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