TOPIC 34
URBAN PUBLIC
TRANSPORT

CHOOSING A MASS TRANSIT SYSTEM FOR A DEVELOPING CITY

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Abstract

Passenger transport is a growing problem in most developing cities. The current paper examines the suitabilities of three main mass transit options from the point of view of costs, capacity, speeds, evaluation of economics performance and other, less tangible factors such as political and institutional issues.

INTRODUCTION

Public transport is a growth sector in most developing cities. A World Bank estimate put the number of daily bus trips in 1980 at 600 million, with the expectation that this number would double by the year 2000. As cities grow in size, so attention focuses on the mass movement of travellers along major corridors. Developing cities exist today which must provide for 10-15 million public transport trips per day; corridor flows can be in excess of 1 million passengers per day. To cope with this scale of demand requires a high-capacity transit system.

Selection of the most appropriate mass transit mode can be difficult, and there are many pressures on civic leaders to favour a particular system. This article examines the technical advantages and disadvantages of these options for developing cities, and refers to ongoing research on the decision-making process. The research has been documented in three TRL publications; by Fouracre et al. (1990), and Gardner et al. (1991) and (1994).

AVAILABLE OPTIONS

The term mass transit as used here refers to any urban transport system carrying large volumes of people, usually along well-defined corridors connecting suburbs to city-centre. This article focuses on those mass transit systems that commonly use a reserved right-of-way for some, or all, of their route length, this includes;

Metro: A metro is often referred to as an underground railway, but can be any grade-separated urban railway. The track and electric vehicles are similar to suburban railways, though with closer station spacing. Trains may have 6-8 cars, with a total capacity of up to 3,000 passengers.

Busways and bus lanes: Both include right-of-way for the exclusive use of buses, segregated by lines or by physical means. A busway transit system would include additional features like well-designed bus stops, special operating methods (bus convoys or express operations), efficient fare collection methods, and clearly defined routes with names like 'green line' or 'circle line'. Busways have good carrying capacity, have flexibility and are cheap to install, but still suffer from a poor image.

Light Rapid Transit (LRT): thought by many to offer an intermediate solution, with lower costs than a metro, but a better image than a busway. Some systems, including those of Manila and Istanbul, use exclusive track and high platforms similar to a metro. Other systems have at-grade crossings and low level platforms. LRT trains may be made up of two or three cars, with a total capacity of up to 750 passengers.

The most usual categories for comparing mass transit options are cost, capacity and speed. There are also, however, additional important considerations which are discussed below.

Costs

Out-turn cost data vary according to design standards, construction procedures, exchange rate variations, and so on. The overall capital costs for a complete system are estimated in Table 1. The more grade-separation, tunnelling, use of heavy rolling stock and sophisticated control equipment, the higher the cost.

Table 1 Capital costs of mass transit schemes: costs in US$ millions (1993 prices)

	Bus lane	Busway transit	Tram	LRT	Metro
Capital cost per route-km	< 0.5	2.0-10.0	5.0-15.0	10.0-30.0	20.0-90.0

Note: includes rolling stock, except in case of bus lanes

A metro is an order of magnitude more expensive than a busway. A new scheme involving underground construction could easily exceed one billion US dollars. At such prices city (and even national) economies can be affected.

Operating costs

The key components of operating a transit system are labour, energy and replacement of materials. However, operating costs over the entire lifetime of a rail project can still be less than the capital costs: operating cost alone is not a good indicator of the real costs for a city.

Privately operated buses on busways can provide a service that requires no operating subsidy. In contrast, few, if any, public-sector bus or rail services can rely on direct revenue alone (Armstrong-Wright, 1993). Very different results can be achieved from LRT and Metros according to the income of passengers, population density, and depending on the political decision of whether to maximise occupancy or minimise subsidy. Hong Kong, which is a very special case, has a farebox/operating cost ratio of 2.2, but two-thirds of the metros studied by Fouracre et al. (1990) required operating subsidy.

Capacities

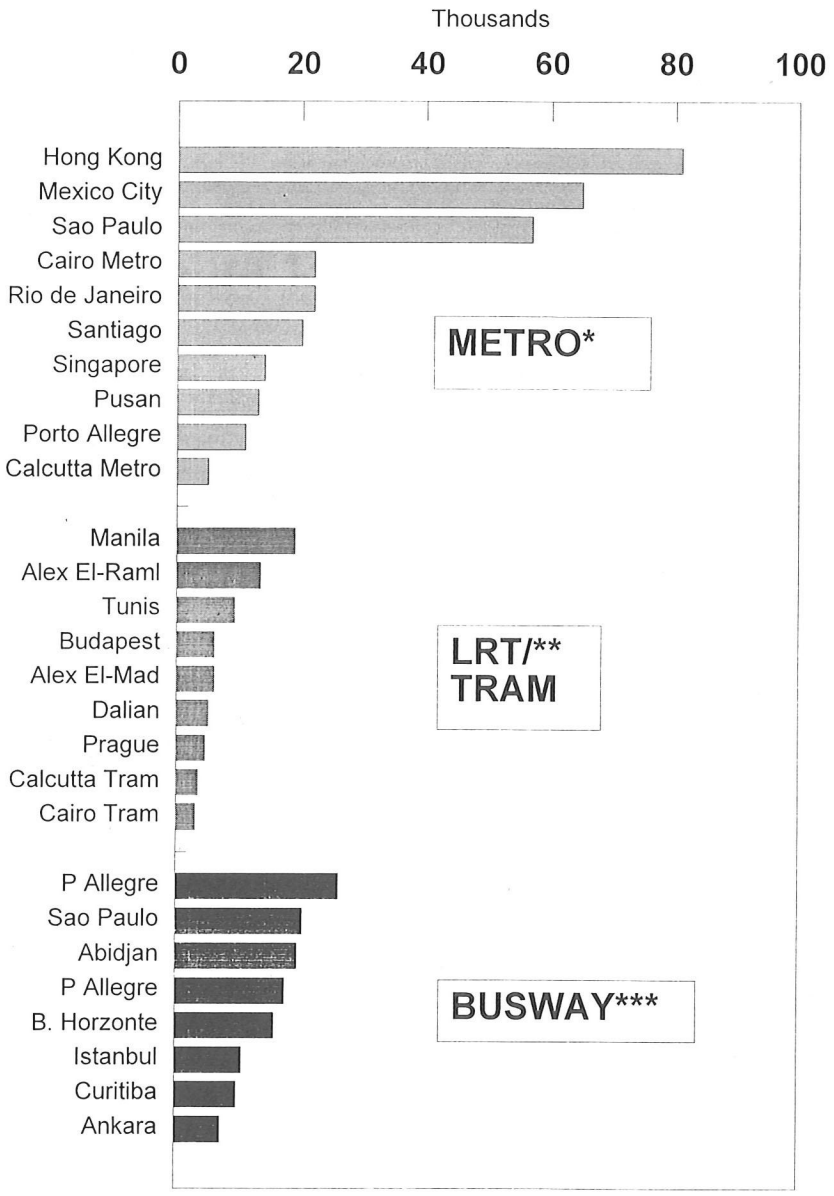
The TRL research placed a high priority on fieldwork on-site at mass transit systems in order to judge the actual capacities, and the factors which influence it. The results are shown in Figure 1. It is clear that the two largest cities of the World (Mexico City and Sao Paulo), and the highly densely populated Hong Kong, have conditions producing flows only a metro could carry. For many other cities, however, and for the secondary corridors on the largest cities, alternatives are available.

TRL research has questioned the generally accepted idea that LRT has a higher capacity than busways. In fact the opposite appears to be true. Even in Manila, where the LRT is operating under near-saturated conditions, and where there is full segregation from other traffic, passenger flows are less than on several busways. In order to attain high capacities, LRT needs short, regular headways. This requires a level of control and regularity that most developing cities find difficult, especially with on-street operations.

In contrast, the busway has unrivalled flexibility and appears perfectly suited to a range of conditions. Delays to a single bus affect only one hundred people, and other buses can overtake, if necessary, to provide a continuous high-capacity service.

Speeds

An important consideration for an operator is the commercial speed. That is the average speed that can be achieved when allowance is made for passenger boarding, time at termini and for traffic control (Table 2). This influences the service that can be provided for customers, but also determines the number of vehicles and drivers that will be needed.



**Fouracre, Allport & Thomson, 1990 **Gardner, Rutter & Kuhn, 1994*
**** Gardner, Cornwell & Cracknell, 1991*

Figure 1 Passenger flows

Table 2 Approximate estimated commercial speed for selected systems

	Bus in CBD mixed traffic	Busway transit	Tram	LRT	Metro
Commercial Speed km/h	10	18-26	12-16	19-29	29-36

The commercial speed is also related to the maximum speed of the vehicle, and to braking and acceleration characteristics (Vuchic, 1981). It might thus be expected that electric trains would be significantly faster than buses. In practice, TRL field surveys revealed little difference and research using multiple regression analysis, to allow for factors such as station spacing, suggests that the inherent difference between busways and LRT is not statistically significant.

Intangibles

The choice of a mass transit system is made according to many factors. These can be divided into two main categories; the first of these include 'practical' issues, such as transport planning and engineering, while the second category includes institutional and 'political' issues. The practical factors, such as cost and system performance, have been shown to be measurable and, to some extent, predictable. Other effects, for example 'electioneering' and civic pride, are more difficult to quantify and analyse, but appear to play a major part in influencing choice.

The Calcutta metro, for example, was built in one of the World's poorest cities in which basic traffic management is almost nonexistent. At the time of the study by Fouracre et al (1990), the cost of providing a kilometre of track carrying 6000 passengers/hr/direction was US$45M compared with US$0.2M for the Ankara busway which carries 12,000 pax/hr/dir.

The choice of system made in Calcutta, or the extent of the system in Bucharest, for example, would not have been acceptable to funding agencies using standard Western evaluation methods, such as cost-benefit analysis. There appears to be a gap between what the Western evaluation methods consider 'appropriate', and what developing city decision makers themselves consider the right choice.

REASONS FOR THE EVALUATION 'GAP'

Examples such as Bucharest and Calcutta raise the question of whether the decision to proceed suggests some kind of 'failure' of local decision makers to take the proper course of action. An alternate view is that the local politicians are not wrong, but are simply applying criteria that are different (not worse) from those used in the West. Either way, there is a difference between evaluation procedures of aid agencies and the methods used by their 'clients'.

For the purposes of this research, a broad categorisation has been made of some reasons for this evaluation gap. This paper examines the evaluation process itself; the quality of advice available to decision-makers; and institutional and political issues. Many of these will be inter-related, and some will have more influence than others, depending on the circumstances.

The evaluation process

One of the reasons for the evaluation gap may be because of the evaluation process itself: either because the method itself is flawed, or because insufficient information is considered by it.

Cost-benefit analysis is a broad term covering the analysis that compares the costs and benefits of a particular action: the most comprehensive form being social-cost benefit analysis. There are many inputs to this process, and some disagreement exists over what should be included. Some

have questioned the basic philosophy of costing a large number of small time savings made by poor people in a developing country (Stopher, 1980).

Value of time is a concept that is difficult to quantify accurately, and yet it is a key to the economic feasibility of most transport schemes. It might be argued that value of time should be at least as much of a political choice as an objective measurement. For example, computerised traffic signals can save many millions of travellers a few seconds each. Totalling these up might suggest that an investment in traffic signals would be preferable to a health or sanitation project even in areas lacking these basic necessities. A properly representative local leader should be the best placed to make choices of this type involving fundamental human needs.

Inputs to evaluation

For the true benefits of a scheme to be assessed, every possible benefit and disbenefit should be considered. Pseudo-quantification methods can be used for factors that are difficult to quantify, such as road safety and environmental damage. Besides these, there are factors that are usually considered impossible to quantify. These are the intangible benefits.

Some intangible elements associated with a project may be positive, for example where the project acts as a catalyst for other beneficial things. Overlooking such issues means that a project that could bring real benefits might be rejected. A determined effort is needed to ensure that every possible legitimate benefit and disbenefit is considered fairly. However, promises of intangible benefits should not be used to support projects that could be seriously detrimental to a city.

Some of the main benefits not explicitly included in a standard evaluation can be categorised as follows;

User benefits

There is little doubt that travelling in a modern LRT on a newly-constructed track is one of the most comfortable forms of land transport. Transport planning methods can allow for the reduction in trips caused by extra time or distance travelled. It is more difficult to allow for the 'comfort and convenience' offered by a particular mode, or for individuals' peculiar preferences.

Studies by Smyth (1994) in Essen have shown that potential MRT passengers when asked before a scheme is constructed will tend to favour rail-based systems. When the scheme has been in place for several years, however, the preference for mode is determined by more local issues such as cost and walk/wait times.

Benefits for the city

In addition to the considerations for passengers, there can be benefits to a city of pursuing a policy that includes some form of mass transit.

The essence of a city centre is that it is the most accessible point from both within and without the city. This superior accessibility is important for many activities, and in particular for those central functions that serve a wide area and/or need a wide labour market: head offices, central government offices and legal institutions, financial institutions, media firms, theatres, department stores, and all the supporting organisations (catering, hotels, etc.) that exist to serve these central functions.

One of the key findings of the metro report by Fouracre (1990) was that mass transit can play a vital part in sustaining these central civic functions. This can be a very important consideration for a senior city leader. If it is thought that a metro is essential for the very survival of the city, then it is not surprising that they will fight (against any contrary evidence) for a metro to go ahead.

Property development

It is often said that the implementation of a metro can boost the confidence of a city, and thus encourage property development. In the USA it was found that even *non*-users consider a visible above-ground LRT a symbol of civic improvement equal to more expensive, but hidden, underground systems (TGM, 1990).

Recent evidence casts doubt upon the magnitude of the development catalyst effect. In 'Can Rail Save the City?' Hall and Hass Klau (1985) concluded 'transport improvements by themselves can never achieve anything; they merely facilitate urban change'. Simpson (1990) reached a similar conclusion after studying metro and LRT systems in Europe and N. America. He stated that "if there is interest in developing in the locality, urban railways usually attract development: if there is no interest, urban railways will not create any".

Civic pride

A new metro can be a powerful symbol of a city's status, disproportionate to its function as a people mover. Comparisons might be drawn with Medieval cathedrals and Victorian town halls, whose size and grandeur far exceed their practical functional requirements.

The problem arises for a city when this pride is misplaced. As the report by Fouracre et al. (1990) shows, several cities in the World have suffered financial hardship because of introducing metro systems which still carries fewer passengers than a similar busway.

Knowledge about MRT

The research described here represents one of the first known examples of a comparison of modes using real surveyed data from developing cities. There is still no universally accepted means of quantifying the benefits due to time savings with any kind of precision. Despite these substantial gaps in current knowledge, there is no shortage of advice, either commissioned or unwanted, regarding the merits of MRT.

Many of the World's metros have been built despite a catalogue of disastrous events that beset them. These include natural catastrophes such as rockfalls, floods; personnel issue and strikes, financial problems, and almost every other type of difficulty. The extent to which these should have been predicted is debatable. An examination of Table 3, showing predicted and actual costs, does suggest that forecasts have been particularly optimistic. Despite this, there is no record of any recrimination against those who produced the inaccurate forecasts.

Table 3 Capital cost overruns

Per cent difference from target cost	Number of Metros
-10 to +10	3
+10 to +20	1
+20 to +50	3
+50 to +100	4
+100 to +500	2

Institutional and political issues

The capability of countries to organise, integrate and implement any infrastructure project is dependent on the institutional structures in place and their level of accountability for the goals or objectives. Levin (1988) has proposed examining decision making under the two headings of rationality and democracy.

A rational decision regarding investment would be based upon sensible, reliable information. There are many examples of different reasons why this has *not* been so (although unfortunately

they are rarely documented). In practice, almost every system has its own peculiar factors that have influenced implementation and it is difficult to generalise on the relative influence of what often appear to be peculiar and random events. In Prague, for example, the city's underground metro was built during the 'Cold War', and following the Soviet invasion of the city. Some of these unpredictable influences may prove, with the passage of time, to be fortuitous: others have resulted in financial and economic hardship.

Mass transit activities are usually the responsibility of several different government agencies and private bodies. Many cities in transition have difficulty in ensuring institutional cooperation, and this can lead to irrational decisions being made. Equally important, lack of cooperation can hinder any kind of decision being made—this has been a particular problem in Bangkok. Institutional problems have contributed to several metro projects running over-budget. Operationally however, most metros studied by Fouracre et al. (1990) were well organised and well maintained.

Busways are also subject to institutional problems. As they require the active cooperation of the highway authority, the licensing authorities, the police and bus operators, many cities find implementation impossible. There is not the weight of an effective lobby to promote cheaper bus schemes (this was one of the reasons for the production of the TRL busways video). Paradoxically, it appears that it is easier for a city to organise a one billion-dollar metro, than a ten million-dollar busway.

Politicians face a difficult task to balance the excusable desire to obtain the maximum benefit for an electoral constituency versus what is best for the nation as a whole. This is thought to cause disenchantment in many developing countries, where the regions complain about the dominance of the capital city.

Less excusable is the influence of non-altruistic decision making. There are many pressures on political leaders, not least in countries in transition, to choose a particular mass transit option. The status or image benefits that a modern transit system can bring to a city appear to have a significant part to play in the decision making process. Furthermore, in some societies where "commissions" and informal payments allegedly add around 10 percent to a project cost, the attractions of a billion-dollar metro are obvious. The political desire to 'do something' to build a city's image or bolster support may also influence the choice of system. This favours prestige projects such as modern rail systems, even when these might not be the best practical or cost-effective solution.

The International rail business is a multi-million dollar industry. Rail projects require a high proportion of imported equipment to be paid for using hard currency. Teams of skilful negotiators and advocates can be called upon to entertain city officials, to organise study-tours to Paris and Vancouver, and to produce attractive and persuasive publicity material.

A NEW EVALUATION OPTION

There are, then, many elements that must be considered, other than costs and benefits. A method is required to examine all elements of a scheme and to consider whether their influence on a project is beneficial or damaging. A method is needed which will not require an undue amount of data collection, and yet makes optimal use of the information available.

There are several methods available for evaluating the effectiveness of a large project. In practice, evaluation methods often rely upon discursive methods. As Grabe (UNESCO, 1983) points out "the essential problem for the evaluator lies in determining the points of evaluation at which information on valid and significant changes can be obtained through reliable measures and at reasonable cost".

The method selected for the next phase of the present research is a variation of the Disaggregated Effectiveness Evaluation (DEE) framework (Ross, 1992). The DEE method was chosen as it enables a clear definition of objectives, outputs and indicators, and it provides a systematic means for monitoring and evaluation. It brings into the open factors that might otherwise be considered only implicitly, or without consensus.

CONCLUSIONS

The TRL research has found little to justify the high demand for rail-based mass transit. While there can be no doubts over its comfort, and the prestige that it can confer on a city, there are serious doubts over its cost and even its performance. Conversely, the busway offers unrivalled performance and value for money. The fact that recent experience has seen a strong and growing demand for metros and LRT suggests that the influence of intangible factors is as strong, if not more so, than the technical evidence.

An ideal decision making process would allow consideration of the intangible benefits of mass transit options, while screening out projects that would cause severe financial hardship.

An important pre-requisite for the successful implementation of any infrastructure will be institutions capable of steering a true path through the decision making process. In this case, the Western aid-agencies have a responsibility to ensure that aid is well focused. One architectural advisor to the Czech President Vaclav Havel said;

> ....If I could spend the development money Prague is receiving, such as that from the Prince Charles Heritage Fund, I would use it to build a modern, intelligent, creative, city council. Both our town, and our historic buildings would benefit. *Miroslav Masak, (in Kennedy, 1993)*

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