Department for International Development

World Bank Urban Transport Strategy Review - Mass Rapid Transit in Developing Countries

Final Report

July 2000

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in association with Traffic and Transport Consultants

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Glossary

AVL	Automatic Vehicle Location
BLT	Build Lease Transfer
BOO	Build own Operate
BOT	Build Operate Transfer
CBD	Central Business District
CNG	Compressed Natural Gas
DFID	Department for International Development
DBOM	Design Build Operate Maintain
FSU	Former Soviet Union
IRR	Internal Rate of Return
IT	Information Technology
ITA	International Tunnelling Association
KL	Kuala Lumpur
LNG	Liquefied Natural Gas
LRT	Light Rail Transit
MRT	Mass Rapid Transit
NMT	Non Motorised Transport
Pphpd	Passengers per hour, per direction

Abstract

This position paper provides an input to the World Bank Urban Transport Strategy Review. It considers the appropriate role for Mass Rapid Transit (MRT) in developing and transitional economies. MRT is defined to include bus and rail-based systems – busways, LRT, metros and suburban rail. The paper is based on the authors' experience, together with contributions from correspondents and comments form the World Bank, and DFID who financed the work.

It reviews available experience and research, identifies the sector issues, and assesses what is known about the impact of the MRT options on government's policy objectives; particular emphasis is placed on the potential of MRT policy to alleviate poverty. The paper considers the factors influencing the choice of system, and how projects should subsequently be developed and implemented. It suggests an approach to the identification and development of MRT options. The main findings are brought together in the first Synthesis Chapter of the report.

Synthesis

S1.1 ***Context***

S1.1.1 This position paper provides a review of the role and nature of MRT (Mass Rapid Transit) systems in developing and transitional economies, based upon the authors' experience and comments from the World Bank and DFID. A companion paper reviews public transport competition, and how competitive markets can best serve public policy objectives.

S1.1.2 Its purpose is to review available experience, examine the processes by which MRT systems can impact upon public policy, identify the issues in project development, and insofar as this is possible provide guidance in addressing two decisions:

- The choice of MRT system, and
- Given this decision, how to approach the issues which should be considered during the project development process, to maximise the prospects for success

S1.1.3 The role and form of MRT of course depends upon the city context, its size, income level, asset base, institutions and the characteristics of its public transport system. Superimposed upon these are cultural and behavioural factors and attitudes, all of which may be important.

S1.1.4 There is a broad recognition that MRT needs to be developed as part of a comprehensive land use and transport strategy, and that its potential benefits will be much enhanced when it forms a central part of a package of measures. It is particularly important that targeted restraints on private car use are introduced, to realise its potential in shifting policy towards a less car-dependant urban form.

S1.1.5 MRT impacts upon the following public policy areas:

- The macro-economy effects, particularly in the case of metros whose call on resources is large relative to national and city resources
- Economic growth, which results in increased incomes and benefits for society
- Poverty alleviation, and impacts upon the travel-disadvantaged (including the encumbered, frail and disabled)
- The environment, both directly and long-term, and
- Land use and development, both immediate and through long-term changes to the structure of the city

The central question is how MRT should be applied to secure the balance of impacts, which best give effect to government's overall policies.

S1.1.6 This has been a desk-based exercise, which has sought to bring together the available information and experience, and applied it within a clear framework. The subject matter is one in which strong views are sometimes held and we have sought to provide an objective analysis, so far as possible based upon fact and realism. What happens in practice is often as much the product of political attitudes and imperatives as technical analysis, and we have sought to understand the overall context. But facts are often few, and much is required to remedy the existing absence of knowledge and understanding in the sector.

S1.1.7 This synthesis first draws a simple classification for MRT systems, and identifies the real options available to decision-makers, their similarities and their defining features. It then summarises what we know about their impacts upon the above four policy areas, and highlights the conflicts at the heart of MRT policy, which can be problematic. The following section considers the key issues, which affect project development, and how we might best approach these. We then draw things together, by considering what we know about the applicability of MRT systems.

S1.2 Mass Rapid Transit

S1.2.1 The core requirement of mass transit in developing cities is that it carries large numbers of passengers, rapidly. Given public funding constraints this usually requires fares, which are not low, and given the need to attract a mass ridership, fares cannot be high either. Speed is critical to securing its impacts; hence the terms mass *rapid* transit is used in this review.

S1.2.2 The literature is full of attempts to categorise these modes, and there is no single fight 'answer. They may be categorised in terms of their technology, right-of-way exclusivity, grade-separation, guidance and operational regimes. There is a large range of possibilities in practice. We have reviewed the MRT systems actually operating in developing cities and categorised them by technology and degree of segregation, which broadly translate into level of service, capacity and cost.

S1.2.3 Four generic forms of mass transit currently exist in major cities, which we define as follows:

- **Busways** – these are generally segregated sections of roadway within major corridors, with horizontal protection from other traffic, and priority over other traffic at junctions, which are generally signalised
- **Light rail transit (LRT)** – this is at-grade, with similar horizontal protection to busways
- **Metros** – these are fully segregated, usually elevated or underground. It is the segregation that is critical to providing a rapid service, and the technology that allows a high mass ridership to be carried

- **Suburban rail** – these services are usually physically part of a larger rail network, usually at-grade and fully-segregated incorporating road-rail segregation or controlled level-crossings

S1.2.4 The MRT systems have much in common. They utilise a right-of-way, which allows operations to be optimised. They are systems, which comprise several elements (vehicles, track, control systems, stops, operational plans), that need to be optimised one with the other to achieve high performance. They need to be coordinated with feeder bus/ paratransit services; and they need institutional coordination for implementation, and regulation to secure the public interest.

S1.2.5 They also have major defining features, notably in respect to:

- *Use of space* – busways usually involve reallocation of existing roadspace, LRT often does the same, but may also add new capacity, when using former rail alignments for example. Metros add new capacity, typically increasing the passenger-carrying capacity of a major corridor by a factor of 3 (they may have no impact on *road* capacity, or if elevated lead to a small reduction)
- *Integration* - all systems require interchange to provide an integrated public transport system. Rail systems, and busways operating 'trunk-and-feeder' services require more interchange
- *Capacity*. Busways, depending on specification, have a practical capacity of 10 - 20,000 passengers per hour per direction (pphpd), or occasionally higher. There are no examples of LRT carrying flows in excess of 10,000 pphpd, and there is reason to doubt whether they can achieve much higher flows. Metros by comparison carry very large passenger volumes – 60,000 pphpd or higher; and high-specification suburban rail can typically carry 30,000 pphpd.
- *Level of service*. Rail systems can generally provide a high quality ride, and when segregated, regularity. Bus systems perform less well in these respects.
- *Ability to segment the market*. Bus systems have this ability, by running basic and air-conditioned/guaranteed seated/express buses. Rail systems exceptionally provide women-only carriages, but otherwise do not segment the market.

S1.2.6 The options perform different roles, and ideally should perform complementary roles. Thus in medium-sized and low-income cities busways may provide the basis of the MRT system for many years. If affordability increases or environmental concerns become critical, then LRT may perform a similar role. In the largest corridors of major cities, metros may be required, and when affordable may be justified. The secondary corridors may then justify busway or LRT lines, which also may feed the metro. Where the conditions exist, suburban rail systems may be upgraded, and again busways or LRT lines may feed them.

S1.2.7 The development of MRT systems should be carried out in a holistic manner, within the context of a city development plan and transport strategy. The transport strategy will normally define the primary road and public transport networks, the latter defining the MRT network, which is to be developed, by coordinating the existing bus/paratransit system with MRT. Often MRT is part of a package of measures which may include environmental/urban design improvements (e.g. in the city centre), car controls, improved accessibility for the travel-disadvantaged etc, and it should be developed in this broader context. This is the core approach to LRT development in many developed countries.

S1.2.8 We now briefly review the characteristics of the options, and consider the prospects for future innovation. Much more is known about some of the MRT options than others. **Table S1** summarises the key features of the MRT options. These do not in some cases compare the options on an equal basis (for example, busways exclude the costs of the buses while for the rail systems the rolling stock is included). We now look to the individual options.

TABLE S1 THE MRT OPTIONS

Characteristic	**BUSWAY**	**LRT**	**METRO**	**SUBURBAN RAIL**
Current Applications	Widespread in Latin America for 20+ years	• Widespread in Europe • Few in dev ğ cities, none with high ’ ridership	Widespread, skewed to Europe and North America	Widespread, skewed to Europe and North America
Segregation	At-grade	At-grade	Mostly elevated/u ğd	At-grade
Space req ł	2-4 lanes from existing road	2-3 lanes from existing road	Elevated or u ğd, little impact on existing road	-
Flexibility	Flexible in both imp ħ and op ś, robust operationally	Limited flexibility, risky in financial terms	Inflexible and risky in financial terms	Inflexible
Impact on Traffic	Depends on policy/design	Depends on policy/design	Reduces congestion somewhat	May increase congestion when frequencies high
PT Integration	Straightforward with bus operations. Problematic with paratransit	Often difficult	Often difficult	Usually existing
Initial Cost US$mn/km	1-5	10-30	• 15-30 at-grade • 30-75 elevated • 60-180 u ğd	.-
Practical Capacity Pass/hr/direction	10-20,000	10-12,000? (no examples)	60,000+	30,000
Operating Speed Kph	17-20	20? (no examples)	30-40	40-50+

S1.2.9 ***Busways*** – There are few cities with operating busways, and all the cities with busways *systems* are in Latin America, with Brazil prominent. Busways usually require the reallocation of existing roadspace together with traffic management in the corridor, as a result of which bus passengers benefit from increased speeds. The impact on other traffic is a matter of policy and design, busways may increase congestion for other traffic, but they may also reduce it by channelling traffic more efficiently. Not all cities have corridors that can accommodate busways, but many have and they do not need to be continuous. Not all cities have public transport systems that can benefit from busways (those where paratransit is predominant require a change to buses if their capacity is to be utilised and this may or may not be desirable and achievable); but many have. There is little doubt that busways could be applied much more widely than they are.

S1.2.10 There are two forms of busway, 'open' in which buses join and leave, providing convenience for passengers who do not need to change bus; and 'trunk-and-feeder' which operates like light rail and requires interchange, often involving 'through-ticketing' and requiring more sophisticated institutional arrangements. The advantage is the additional operational control and capacity, which is created. Busway output depends greatly on road network configuration, junction spacing and stop spacing. It typically has been demonstrated to be high at about 10,000 pphpd at 20 kph on arterial corridors and 15-17 kph on urban corridors for a 1-lane each way busway. If provision for bus overtaking at stops is provided, passenger throughputs of 20,000 pphpd have been demonstrated and schemes with 2-lanes each way are reported with even higher passenger flows.

S1.2.11 While implementation is quite demanding (in terms of institutional co-ordination and traffic engineering/control skills), the evidence is that thereafter the operational performance is robust. Cost is relatively low – the infrastructure is typically US$ 1-1.5mn/km and the all-in cost including buses at the top end of the range is US$5mn/km. A major advantage of busways is their flexibility in implementation and operation. While continuous, segregated busways are desirable, short discontinuities (where the road cross-section does not allow implementation) can be overcome using traffic management techniques. Busways can be implemented incrementally as funds allow, and their performance can be upgraded over time.

S1.2.12 Existing busways have not however been problem-free. Issues have included operational control on the busiest busways at heavily used bus stops, environmental problems associated with large numbers of old, badly maintained diesel buses culminating in degradation of the corridors through which they run, and sometimes a resulting 'down-market' image. There are solutions available, or in sight, to some of these problems. In particular the prospects for private sector concessions holds out the prospect of better operational management, further extending busway performance while also developing 'promoters' for busway systems (they have suffered in relation to rail systems in this respect). A range of measures exist to tackle the worst of the environmental problems: high-specification buses with low emissions, trolley or dual mode buses, and better urban design to overcome adverse land use and development aspects

S1.2.13 ***LRT*** – this technology is widely known in many developed cities and transitional economies as trams, but these do not tend to carry large numbers of people at speed, which is the required role of MRT in larger developing cities. While much is known about them, the major issue concerns their ability to perform this role. We have reviewed the evidence, and concluded that the performance is likely to be bounded by a capacity of about 12,000pphpd and an average operating speed of 20kph. This is lower than the capacity of many busways, and it may be wondered why this should be. It arises for two reasons: LRT achieves high speed by using a signalling system to avoid bunching, and by obtaining priority at traffic signal-controlled junctions over other traffic; and it achieves high capacity by having large vehicles which take advantage of the signals. In practice the distance between signals defines the maximum vehicle size, and the need to provide for crossing traffic limits the number of vehicles per hour. Secondly, LRT systems are operationally vulnerable to the everyday events that happen in the centre of developing cities. Whether this is junctions being partly blocked, or road maintenance work, or a breakdown, or an accident, while bus systems are often able to get round the problem (they can overtake, leave the busways etc), LRT is not.

S1.2.14 This capacity problem becomes an issue in the large corridors of the biggest cities, but many cities are not large and there are many corridors where this is not a problem. Then, LRT is often considered a more affordable alternative to a metro, while having the up-market and 'green' image which busways have so far usually not had. In particular, LRT is often considered to be compatible with city centre pedestrianised environments, contributing with complementary measures to more liveable cities.

S1.2.15 ***Metros*** – are widely known. They alone of the options can carry very large passenger flows, indeed several times more than any other option, and this, together with their operating speed which derives from complete segregation, underlies their strategic impacts upon city structure. Alone of the options, they may decongest the city corridor significantly. But they come at a very high cost, both capital and operating, and they can be risky: much needs to go right for a project to be successful, and a bad mistake can spell disaster. In other words, particular care is required in considering and developing them. Integration with the bus system is particularly necessary to metro viability, and often difficult to achieve.

S1.2.16 ***Suburban Rail*** – most cities have, or have had suburban rail lines, and often their apparent potential appears to be under-utilised. Sometimes this is appearance, and in reality the line no longer serves passengers' existing travel requirements, or it cannot be upgraded without disrupting other traffic unacceptably, or the right-of-way cannot be secured (it may be subject to frequent, uncontrolled level crossings, or be encumbered with squatters who cannot be rehoused). Sometimes there can be opportunities, but the railway institutions prevent suburban rail services developing effectively – this is common, and a separate organisation is required, able to manage the suburban system as a separate business. Sometimes too there are problems of non-standard technology, or of terminal capacity in the city centre.

S1.2.17 ***Future Innovation*** – There are several opportunities for future innovation. Technological advances may offer new opportunities to improve service or reduce costs, the MRT options may be used more imaginatively (for example improving the environment associated with busways), and private sector participation may offer prospects for better and more commercial management, and develop system promoters. We consider the first two of these opportunities here, the third is considered subsequently.

S1.2.18 The first opportunity concerns innovation within the individual MRT options. Here, the prospects for busways are substantial, and for rail systems significant in extending the applicability of today's options now. There are considerable opportunities to change the often down-market image of busways, by creating environmentally green (or at least much greener) systems, including higher quality buses, low-emission buses, electrically-powered buses and better urban design. There are also opportunities to improve and extend performance, through better operational control, which technology and private sector concessions are making possible. These changes should defer the perceived need to replace busways by rail systems, at least for a period of time.

S1.2.19 In the case of rail systems there are likely to be progressively reducing costs, but no dramatic changes. The main change, which will potentially affect busway systems too, will occur in ticketing, where smart -card technology will increasingly facilitate integration of the public transport system, provide new marketing opportunities, reducing fraud and also costs.

S1.2.20 The second opportunity concerns the incremental development of the MRT system over time. For many dynamic developing cities, where growth in demand and affordability are matched with rising environmental perceptions, this would seem to be the natural course of development; yet so far it has rarely happened. In principle there is no reason why busways could not be partially grade-separated, or converted to LRT, why LRT could not be partly grade-separated, and eventually be fully grade-separated (becoming a metro), or why suburban rail could not be extended underground beneath the city centre. There are many examples of such upgrading, for example in Europe, creating pre-metro and S-bahn/RER systems.

S1.2.21 Because there is little experience of these approaches, the requirements to plan for such upgrading are not widely known. Certainly, such changes are not straightforward, and are likely to benefit from advance planning and provision.

S1.3 MRT Impacts on Policy Objectives

S1.3.1 It is now recognised that MRT policy and city sustainability are inextricably linked, and that the level of sustainability which a city can achieve will in some ways depend upon the effectiveness of its MRT system. At the highest level, when the right policies (notably to manage demand by private vehicles) are adopted at broadly the right time, congestion may be controllable and with this wide-ranging benefits can follow. At a less ambitious level, MRT can allow the city centre to grow and avoid the worst excesses of a car-dependent low-density suburban sprawl. This allows the city to 'live with congestion', while mitigating some of its worse effects. Otherwise, MRT policy is likely to have a lesser strategic role, by making worthwhile investments, but failing to achieve wide-ranging benefits.

S1.3.2 At the centre of MRT policy for developing cities is the apparent conflict between tackling poverty alleviation, for which affordable service is critical, and attracting car users (hence impacting on congestion and pollution), for whom service quality is critical. The issue that arises in trying to simultaneously satisfy these objectives is that the public finances can probably not sustain the subsidy resulting from both low tariffs and high quality service. There is no simple answer to this dilemma. All MRT options have impacts upon low-income households and the environment, and what is required is a process that recognises and analyses these, to provide the basis for informed judgements in each case.

S1.3.3 The issue at the heart of poverty alleviation is that MRT policy has multiple impacts, and that assessing overall impacts is by no means straightforward. The impacts can be any/all of the following: MRT-generated economic growth through so-called 'trickle-down' effects, specific pro-poor MRT policies, changes in air pollution and safety, the direct effects of implementing/operating MRT projects, and distortions in the allocation of public funding resulting from the unexpected consequences of MRT megaprojects. Some of these impacts are readily identified, while others are not.

S1.3.4 The issue at the heart of controlling traffic congestion and its associated pollution is that the evidence on which to base policy is poor. We know something about the immediate impact of metros (for example they usually attract few car users), but little about their long-term impact on car ownership and use, and how this is affected by the scale of the network. Yet these impacts could be substantial and should be critical to overall strategy. Similar problems occur in understanding the linkage between MRT policy and land use/city structure. It is clear that in some cases this can be profound, yet in others the long-term impacts are much less clear. With this context, we consider what is known about the impacts of the specific MRT options on the main policy objectives.

S1.3.5 ***Busways*** - There are, as far as is known, few published ex-post evaluations of busways. Those that exist confirm the intuitive judgement that they should provide high economic benefits, providing they are well designed – there are major benefits to bus passengers, other road users may or may not benefit (this is partly a matter of policy), and implementation costs are relatively low. Rigour is required in their evaluation however, since there can be adverse and inadvertent consequences, in terms of congestion for other road users and disbenefits resulting from restructuring the bus/paratransit system; but some of these are at least amenable to change and fine-tuning in operation.

S1.3.6 Busways are clearly beneficial to the poor. Many of the poor use buses and busways create major accessibility benefits for them, particularly when they live in the outer city areas, and particularly with 'open' systems, or 'trunk-and-feeder' when there is through-ticketing. If 'greener' busways were developed, then the poor in particular would benefit from this through better health (they often spend long hours living, working or travelling in the street environment), but maybe at the expense of higher tariffs.

S1.3.7 Many of the travel-disadvantaged are also poor. While many of them will find bus systems (hence any MRT system) impossible to use because of problems with the buses, unacceptable sidewalks, the absence of pedestrian phases at street signals etc., some such as the encumbered will benefit.

S1.3.8 The impacts of busways on land use and city structure have been little researched. Curitiba has demonstrated that busway transit can form the core of an integrated land use and transport strategy, but Curitiba is exceptional and is a developed city. For the most part the evidence is limited to the immediate and sometimes adverse impacts on city corridors.

S1.3.9 ***LRT*** – the comments on busways apply also to LRT. Rigour in planning is even more essential, because successful implementation is more demanding (in particular bus/LRT coordination is essential), once implemented changes to the core system parameters are not readily made, and the system must so far as possible be insulated from disturbances arising from other traffic. LRT is sometimes the centre-piece of a package of measures which may be broad-ranging, planned to create a 'liveable city/city centre' for example. Its impacts should be judged against the overall objectives, insofar as the LRT system and complementary measures are inter-dependent.

S1.3.10 ***Metros*** – we have reviewed the economic viability of the case study cities examined in 1990, and been reassured that the conclusions reached then are broadly supported now. The economic evaluation of long-lived rail systems, which can have such wide-ranging impacts is recognised to be problematic. The 1990 research confronted the key issues and developed an approach, which has since been subject to critical review but from which no better approach has yet emerged. This provides the basis for the conclusions reached. These are in summary that well-prepared projects, implemented purposefully in the right environments can be worthwhile economic investments. These are of course demanding requirements to be fulfilled, and where they do not obtain then the projects are risky and can be a poor use of available resources.

S1.3.11 Assessing the overall impact of metros on the poor is complex, because they impact in all the possible ways. The available evidence suggests the following:

- They may, by contributing to city efficiency benefit the poor through 'trickle-down effects'. Also, to the extent that they contribute to a transport strategy which reduces congestion, pollution and accidents, the poor will benefit
- They may benefit from jobs during construction, and their buses may be slightly better once they are open - more efficient through somewhat reduced congestion, and less overcrowded

- When MRT policy can target the poor effectively, it will benefit them; but this is often quite difficult to do. Instead, public transport tariffs are sometimes held down, where the public finances allow. Holding tariffs down will benefit the poor (and other too) but is becoming less feasible under public funding constraints.
- Metros can have adverse consequences during implementation and operations. They often require the relocation of the homes and jobs of the poor, and enhanced land values near stations and depots may force them to move elsewhere. Metros often provide a facility that the poor cannot afford to use in a CBD radial corridor they often have no need to frequent.
- They may impact substantially, and adversely on pro-poor programmes, because they pre-empt resources on a large scale. If the metro costs overrun, and/or traffic fails to materialise – which are common occurrences – then this may be substantially exacerbated.
- Many of the mobility impaired may find use of a metro impossible, while others who are also poor may be unable to afford the tariff. Others however will be able to use the metro if lifts are provided. It is probable then that they will be well used – not so much by the physically disabled as by the other travel-disadvantaged groups.

S1.3.12 Metros have two distinct sets of environmental impacts. The first concerns their impact on air pollution, resulting from any reduction in congestion, changes to the vehicle mix and the impacts on urban structure. Here the conclusions are that the scale of impact depends upon the polluting characteristics of the existing vehicle fleet, and steps which are taken (in the 'do nothing' situation) to improve this. It also depends upon the size of the MRT network (a substantial network will likely be necessary to deliver strategic improvements); and the strategic impacts will be critically reinforced by complementary measures to control private vehicles, as part of a balanced transport strategy

S1.3.13 The second set of impacts arises from metro construction and operations. This particularly concerns elevated construction, where the impacts can be substantial. Aesthetics may become an issue, even if it is not yet, and particularly where there is an accumulation of elevated infrastructure planned. The cost of good design is small and effort should normally go into the design and construction process to create an aesthetically pleasing design, which will stand the test of time. Overall, as well as conforming to the normal requirements of Environmental Impact Assessment (EIA) legislation, government should determine the project specification, where this impacts significantly upon the environment.

S1.3.14 The impacts of metros on land uses and city structure are not obvious, neither are they fully understood. However, empirical evidence suggests that:

- Metros can help achieve desired land uses, but their impacts are sometimes different from expectations. Thus their effects may be large, but they cannot always be used confidently as a policy tool

- Metros can help achieve a desired city structure, when this is of a concentrated form. This is likely to require government capacity, which is well developed and (other than in linear cities), public finances which can afford a substantial network relative to the size of city.

- The major structuring effect is in large cities, when the metro allows the CBD to grow, when the dynamic for its growth already exists; without it, an alternative land use would be forced. This requires the metro network to extend into the city, overcoming the bus capacity bottleneck, which is the constraint on growth of the CBD.

- The development of a few lines deeper into the city may overcome the capacity problem, and over time lead to significant restructuring of the city towards these sectors of the city. The alternative of a 'small metro' network extending along many corridors, but which does not extend far, may have little impact on development.

- Development in the vicinity of stations and depots, and links into existing developments in their vicinity can be made to happen. They require advance and purposeful action, usually by government.

S1.3.15 ***Suburban Rail –*** this often has the potential to integrate communities within the metropolitan region, of which the city is the core. Many suburban railways have traditionally carried the poor from very long distances, who benefit when they are upgraded, and when affordable tariffs are levied.

S1.4 Issues in Project Development

S1.4.1 This review has concluded that there are fourteen critical issues face MRT planners and decision-makers, and we review them here, suggesting how they may be approached. They are in three groups which concern process, the options and procurement strategy:

PROCESS

1. The necessary role for government (as opposed to the private sector)
2. Appropriate role for the private sector
3. The requirements of the project development process
4. Coordinating transport and development strategy
5. Incorporating attitudes to MRT
6. Forecasting requirements
7. Public sector affordability

8. Scale of challenge
9. Institutional planning

OPTIONS

10. The package approach
11. Route and station locations
12. Vertical Alignment
13. Technology
14. Incremental development
15. Integration with the public transport system

Process

S1.4.2 ***1) The Necessary Role for Government*** – the growing interest and experience of private sector participation during the last decade has tested and to some extent redrawn the boundary between the roles of governments and the private sector. We have learned that to be effective the private sector needs government to carry out its core functions, and when government has not done this and the private sector has tried to step in then problems have arisen. So what are the necessary functions of government?

S1.4.3 First and foremost government needs to determine the project development process, including the basis for effective decision-making and drive this forward, ensuring that the analysis which is necessary to inform decisions is resourced and undertaken, and that consultation processes are properly carried out. Government must identify MRT projects in some detail, within the context of the overall transport strategy. This should include the route / station locations / depot site and vertical alignment, it should confirm the acceptability of the environmental consequences, the tariffs and necessary changes to integrate it with the public transport system. It should commit the necessary public funding and maybe provide guarantees. It should commit to acquire the necessary land and provide for access to rights-of-way, and obtain the necessary permissions. It should define the public service requirements and define how these are to be paid for. It should define the appropriate role of the private sector in procurement and operations. If development at stations is required it should often facilitate the creation of large land holdings. Without government action to specify these, the private sector in practice can do little.

S1.4.4 ***2) Appropriate Role for the Private Sector*** – this should be defined following analysis of the project financial structure and risks, the effectiveness of government's private sector participation process, sentiment towards the country and the project, and the interests of the private sector parties likely to be interested in bidding. The private sector has an increasing role to play, and the frontiers of potential application are currently being tested. We are clear as to the necessary role of government, and this is something private sector increasingly recognises as being the most effective way forward.

S1.4.5 While government must lead, the private sector does have a role in some of these functions. For example, there have been several successful examples of government working with private sector partners at the planning stage to develop projects to be implemented as public-private partnerships, without losing the benefits of competition in procurement. The private sector has brought a focus on implementability, financing and risk assessment, which is wholly beneficial.

S1.4.6 We are optimistic as to the prospect for busway concessioning. This should lead to the improved operational management of existing busways and create promoters to extend busway development. The concept may be a management contract with incentives for operational performance, it may include collecting revenues from operators who use the busway (say a payment per month), or it could be a BOT for a new busway system. A core issue is how to provide incentives to the private sector, while avoiding monopolistic behaviour.

S1.4.7 The Latin American experience of suburban rail concessioning has comprised a three-prong approach, which appears to be successful: decentralisation of responsibility, concessioning to the private sector, and negative concessions in which tariffs are defined by government to be affordable to the poor. In effect this creates ‘surface metros’ at low cost, which can benefit the poor. When it is possible to separate responsibility for suburban services, and to manage them separately, then this approach is likely to be applicable.

S1.4.8 To date the metro experience has focused on the BOT model, and this has been problematic. In part this is because of the project financial and risk characteristics, which have not always been appreciated. Large public funding support is always likely to be necessary, and in the light of recent experience few entrepreneurs are likely to take all the commercial risk. In part it is because of the interests of the private sector players, which are dominantly concerned with securing profits from construction, equipment supply and property development. There has often been little interest in the operational phase. While the projects may have generated construction and supply profits, they have left systems with poor commercial prospects, and property-related profits have often been found to be illusory.

S1.4.9 There is likely to be far more caution as to future projects. This is timely, as there is a need to better align the interests of the public and private sectors, given the characteristics of the project and the project environment. Thus the rules of engagement for the private sector, laid down by government, will determine what the private sector brings to the table in terms of role, commercial expertise and funding. There is a range of concessioning possibilities, for example:

- Public sector implementation and initial operations, followed by concessioning the commercial operations
- Public sector implementation of the infrastructure, and a concession for equipment supply and operations

- Design-build-operate-maintain (DBOM), and

- Full BOT

S1.4.10 ***3) The Requirements of the Project Development Process*** – this is to interface with decision-makers and systematically transform their policy objectives into implementable projects, which so far as possible deliver desired impacts. We have seen that MRT policy confronts strategic choices of far-reaching importance. It usually faces an inescapable tension between the conflicting requirements to alleviate poverty and control traffic congestion. All MRT systems have multiple impacts on the poor and the environment, and the project selection and development process needs to identify and forecast these impacts, and so far as possible mitigate the adverse impacts of the chosen system.

S1.4.11 The following issues need to be addressed as part of the analysis:

- The ability to target the poor effectively in other ways
- The geographical location of low-income and higher-income households (which affects the ability to target MRT initiatives geographically)
- The characteristics of existing public transport supply and performance, and the feasibility of upgrading this through regulatory reform, and introducing busway MRT
- The overall objectives, and the progressive development of MRT with complementary measures which follow from them, as a package
- How to integrate rail systems and 'trunk-and-feeder busway systems with the public transport network effectively
- The feasibility of integrating property development with the MRT system
- The scale of funding realistically likely to be available from the government budget

S1.4.12 Each city has its own institutions and decision-making process, and these, together with the requirements of funding partners, are likely to define aspects of the process. Experience has shown that :

- There needs to be a close interface between the 'planners' and the political decision-makers. This is the only way of avoiding conclusions that are unacceptable to decision-makers. The planners normally bring a technical expertise and knowledge of what is technically possible, and this has to be combined with local political imperatives, in order to develop a strategy that will be acted upon.

- The requirement of the planning process is that it generates a broad consensus behind a doable, affordable, 'good' and robust strategy. This recognises the realities of the typical developing city environment, and is rather different from what is sometimes sought (developing an optimum strategy based on a single set of assumptions, which are then subject to sensitivity testing)

- There is a requirement that the process develops consensus among the broad body of stakeholders, including both technocrats/ decision-makers and those likely to be affected, suited to the particular environment. This requires a process involving some level of participation/ consultation, and when this does not take place either the project specification has been ill-suited to need, or implementation has been problematic. The process needs to be designed with time for participation/consultation to be effective. It also places a considerable responsibility on technical experts to present the results of analysis in a form that is both balanced and comprehensible, so that interaction is effective.

- The process should comprise progressive 'building blocks', progressively leading to the identification and implementation of the MRT system that meets local circumstances. Governments often take advantage of international development assistance to progress the series of technical studies that are necessary, and in some cases these may extend to 'free studies' which are sometimes promoted by vested interests. They may not provide the necessary basis for sound decision-making, and care is required to ensure they do not prejudice the process.

S1.4.13 Finally, it should be noted that political and professional careers have been built around constructing rail systems. They appear to have many friends – commercial, civic, political and environmental – and few enemies… ..at least, until the bills come in for the next administration to pay. The project development process requires, so far as possible, to provide authoritative advice, independent of vested interests.

S1.4.14 ***4) Coordination of Transport and Development Strategy*** – MRT planning needs to take place within the context of the city development and transport strategy, as it will materially impact upon the city, and the implementation of complementary transport and development policies will maximise its benefits. The city development plan (or structure plan) should define government's objectives, set sectoral priorities within available resources, develop a future city structure and define the future spatial strategy for the city. When these matters are well researched, and government investment and policies are based upon them, the prospects of developing in a sustainable direction are enhanced. And when this context exists, MRT planning can be targeted to achieving it.

S1.4.15 MRT planning also requires a transport strategy to define the role of MRT, identify the primary MRT network (comprising the MRT options and feeder bus services), determine policy in respect to managing private car demand, air pollution control etc.. When a soundly researched strategy exists, and government bases its actions upon it, then MRT planning has a clear context.

S1.4.16 But without this framework, MRT planning cannot be expected to be as effective, and the development of consensus behind an MRT strategy may be problematic, since the issues which should have been defined in advance are confronted, and often cannot be readily answered. Then, MRT planning takes place in something of a vacuum, and its benefits are likely to be substantially reduced compared to the situation where its impacts can be targeted, and complementary policies developed which will reinforce them.

S1.4.17 ***5) Incorporating Attitudes to MRT*** – there often appears to be a gulf between the results of apparently rational technical analysis and what is actually implemented, and this often points to a weak project development process. This particularly concerns the support for rail systems compared with bus systems by politicians, when analysis shows bus systems to be more affordable and more readily implemented.

S1.4.18 It has been suggested that a core reason may be that what are often considered to be the disadvantages of rail – its high cost and inflexibility, appear differently to politicians. They may in political terms translate into a visible a sign of commitment (making a confident, futuristic symbol for the city) and security (the population is confident that the new system being taken away, and they can make decisions knowing that the system will be there for the future). By the same argument, what are usually assumed to be the advantages of bus systems – their low cost and flexibility, usually result in implementation that is too cautious. It is certainly true that rail systems tend to be large, because of their economies of scale, whereas busways do not. The result is that the service improvements, while positive in terms of value for money, are too small to make a great impact. Maybe it requires a much bolder political will to make success of (low cost) busway systems than (high cost) rail systems.

S1.4.19 Part of the answer may also be that politicians are conscious of the need to attract inward investment to their city in the face of sometimes global competition. There is some evidence that MRT systems are relevant to inward investment as cities seek to compete for global investment. In London t a wide range of factors were considered to be important attributes of a World City. The most critical focused on wealth creation (through recognition as a commercial and financial centre) and enabling infrastructure (being a central hub of efficient transport networks and having state-of-the-art telecommunications facilities). It seems likely that rail systems would fulfil this role better than bus systems, because of their expected reliability, quality level of service and image.

S1.4.20 So-called 'rational' analysis needs to help shape these attitudes, so far as possible ensuring they are shaped on the basis of real evidence, and then building them into the project development process, by ensuring effective interaction between the planners, funding agencies and decision-makers.

S1.4.21 ***6) Forecasting Requirements –*** we have reported on the poor record of forecasting costs, ridership and revenues, and have analysed the probable causes. This has created a heavy burden of expectation, and then produced problems when they have failed to materialise. To some extent forecasts will always be uncertain, but much can be done to avoid them being misleading.

S1.4.22 The main lessons for the future appear to be the following:

- There are a number of political factors that put planners under pressure to produce an attractive MRT scheme, particularly when it is being funded largely by non-local taxes. Part of the answer is to minimise distortions in the funding system, to remove distorting incentives

- Forecasts should be benchmarked against actual performance of systems which exist, to validate estimates of capital costs, operating costs, ridership/revenues and the farebox ratio (revenues divided by direct operating costs)

- Forecasts should formally incorporate uncertainty, and advise decision-makers on the risks created by the external environment, and the factors they can control, in the development and transport sector, and in the development of MRT policy and projects

- To do this, transport planning activities require properly resourcing, and this is sometimes not done. MRT studies require to be based upon a foundation of fact, and models require to be developed appropriate to the stage in the project development process. Then they need to be applied, making realistic assumptions about the inputs, and formally assessing the scale and nature of risk. A series of ever-more focused studies is required, upon which to base sound decisions. These studies are on the project critical path, and when 'short-cuts' are taken to do without them, or to avoid substantial elapsed time, then either they are not 'building-blocks', or decisions are ill-informed, and in either case problems occur downstream.

S1.4.23 ***7) Public Sector Affordability*** – busways require a small initial outlay, and even if maintenance and operations are improved (as they should be), the costs will be small. LRT systems require a much greater initial outlay and have substantial operating costs. Metros require large initial outlays and also have substantial operating costs. Alone amongst rail systems, the Hong Kong MTR funds all its costs (capital, asset replacement and operating) from its (mainly farebox) revenues, and may be considered profitable. All other rail systems require support from the public sector, often substantial.

S1.4.24 Often one reason for support is government's policy to hold fares down, so that they are affordable to the urban poor. This is the policy in Brazil for example. In the last decade however the evidence is that levels of support have reduced, under public expenditure constraints, just about everywhere.

S1.4.25 The advent of private sector concessions was expected by many to change this situation, and create profitable rail systems. But the evidence is that the new build BOT projects are all in financial trouble and nowhere achieving this. Even allowing for improved procurement processes there is no reason to expect the situation to change dramatically. All the evidence therefore suggests that new rail systems will continue to require high levels of financial support, even when tariffs are not low. Because the scale of support is so large – the typical project is estimated to require US$1-2bn in support, we need to consider how government should assess its ability to provide such support, when faced with competing priorities.

S1.4.26 This is particularly important because optimistic forecasts have often left governments facing substantial unexpected extra calls on their budgets (this is not confined to developing countries). Some argue that all big public sector projects have a record of overshooting budgets and the performance for the rail sector be put in context. But the numbers are so large that the consequences for other programmes (for example pro-poor programmes) of getting things badly wrong may be unacceptably large.

S1.4.27 Of course the normal political process determines the allocation of political funds. What planners should do is to make the trade-offs of such large expenditures clear. From the earliest stage in considering MRT, a broad budget envelope should be determined, assessing the scale of possible funding. As studies develop, and decisions are taken about institutional responsibilities, the ability of central and local governments to service debt and provide guarantees needs rigorous analysis. Finally, by the time a decision is taken to proceed, commitment to the financing needs to be in place, including stand-by credits to cover possible overruns.

S1.4.28 ***8) Scale of Challenge*** – All MRT systems are demanding to implement, and this should influence when and how they can be implemented and operated successfully. Metros are particularly demanding, something which derive from their size and multi-dimensional impacts:

- They are particularly costly, and require substantial public support
- While much can be learned from experience, every project is different, and there is no template 'for developing a successful metro
- Most projects pose demanding requirements for institutional coordination
- They require land to implement, and if redevelopment around stations is an objective, large land holdings to be assembled. This can be problematic
- They are complex to design. The prospect of transporting 60,000 passengers per hour/ direction underground, maybe in difficult terrain, maybe in the tropics is a major challenge to safety.
- They are disruptive to implement. They pass through the centre of the city.. Over several years (typically 4-6) traffic is likely to be disrupted, and the prosperity of businesses potentially harmed.
- Once constructed, the environmental impact may be large
- Integration often requires a restructuring of the existing bus/paratransit system, on which most of the people travel. Often the operators oppose change, and can frustrate attempts to bring it about
- They are demanding to operate efficiently.

- Once embarked upon, there is a requirement on the government planning system to take coordinated actions

S1.4.29 These features of metro projects pose a challenge for any government, however skilled, and for those cities where institutional capacity is not yet well developed, questions may arise as to whether the challenge can realistically be met.

S1.4.30 ***9) Institutional Planning*** – effective institutions are necessary for MRT development, which will often need changes to existing institutions. With notable exceptions such as Curitiba, busways are not treated in this way, which is one reason for the problems encountered, and a reason to be optimistic about the prospects of private sector concessioning. Metros are radically different from existing bus, tram or national rail systems, in terms of technology and traffic density. Without high standards of operations, maintenance and administration the system will rapidly deteriorate and become dangerous. The culture, managerial standards and attitudes often found in bus companies and railway corporations of developing countries are unsuitable for a metro. Accordingly, it is usually necessary to set up a new institution with new people and fresh ideas, unhampered by the conventions and attitudes of existing institutions.

S1.4.31 Institutional planning is the process of determining what changes are necessary and acceptable, and it should be linked to the implementation decision (in the sense that if the right institutions cannot be put in place, then there should be concerns in particular as regards rail projects). This will normally require a stakeholder analysis and appraisal of the capacity of the main organisations involved in planning, implementing and regulating potentially complex projects. When new institutions are created, the key appointments will to a considerable extent determine their effectiveness. These usually require the top management to be recruited on competitive terms to attract the necessary high calibre of management.

S1.4.32 While usually accepting the need for government stewardship, most governments have separated ownership from management by setting up a public corporation as the operating agency. These have often been established as provisional authorities for the implementation phase. The evidence is that the greater the management focus and autonomy provided, the more effective the metro operation is likely to be. Factors which are important include control over key staff appointments, clear financial targets and control over the costs and revenues to achieve them, and arrangements for financial support from government which are contractually secure. Similar conclusions concern suburban rail. A separate management, accountable for suburban rail services with substantial autonomy has been found to be necessary to effective operations

MRT Options

S.1.4.33 ***10) The Package Approach –*** we have noted that MRT systems require complementary measures to be identified to maximise their impacts. Sometimes the MRT project may be the centre-piece of a package of measures designed to create a liveable 'city/ city centre. These could include a reorganisation of the city centre to provide for pedestrians and cycle traffic, controls on car use, priorities for buses, a restructuring of the bus system to feed the MRT, provision of low-floor accessible transport facilities, urban design and landscaping to improve the environment etc. MRT projects should therefore be identified in this context. Complementary measures may be necessary to enable the MRT system to proceed, or to reinforce its impacts, or extend them, or they may be necessary to placate critics. One issue that arises is how the package of measures (comprising the MRT project and complementary measures) should then be evaluated. Where the MRT project is directly dependent upon them they should be evaluated as a single package

S1.4.34 ***11) Route and Station Locations –*** The critical factors in project identification concern the alignment (route, station locations, provision for interchange, and vertical alignment). To the passengers, the critical issue is station numbers and locations, the former substantially determining speed and the latter convenience of access. For rail projects additionally the availability of a depot site is critical because it requires a large, unencumbered land area, which can be difficult to locate in a city. Busways may require bus stations to be located, and these may be in the city centre or alternatively elsewhere. The transport planner should beware of alignments that are chosen because they are easy, and in particular any rail system alignments that do not run into and through the city centre should be suspect. Station locations need to be located at the heart of the traffic objectives, and while this is often difficult and costly to do, if stations are not in the right place the loss of system ridership is often large. Care should therefore be taken before assuming that passengers will walk substantial distances to traffic objectives or to interchange.

S1.4.35 ***12) Vertical Alignment -*** Because underground alignments typically increase the cost of an elevated system by 2 or 3 times, the alignment decision sometimes comes down to a choice, between building an at-grade or elevated alignment now (and accepting its environmental and other consequences); or maybe building an underground alignment at some future date.

S1.4.36 This vertical alignment decision often interacts with the choice of alignment. Sometimes underground alignments breach natural barriers such as rivers and hills, when they can have major traffic impacts. Otherwise mass transit systems tend to follow the same corridors (usually roads) that elevated systems would follow, and their impacts upon demand are small. This is partly because underground alignments may need to pass under piled foundations, which may be physically problematic, and in any case reduces the accessibility of the system. This also substantially increases the financial risk, and this may be unacceptable in a project environment where firm timetables and costs are required.

S1.4.37 Decisions about the vertical alignment need to plan for efficient interchange with existing and future lines and systems. Interchange between elevated and underground systems is never convenient. When interchange is to be accomplished underground the alignment is often constrained by geology, for example the desirability of keeping within a stratum which is suitable for tunnelling.

S1.4.38 ***13) Technology –*** Technology is not generally an important issue, and there is sometimes a danger of becoming overly involved with technology at the planning stage. At the risk of over-simplification, rail systems are, for the planner, essentially 'guided boxes on wheels', and there is a well-developed industry that creates equipment that delivers performance levels that do not differ markedly, at costs that are not materially different in the context of overall system costs.

S1.4.39 New and advanced technologies should however be treated with some care. Metro development has many stories of new technologies failing to work as expected, resulting in serious difficulties, and it is wise to ensure that technologies are proven in a similar application, before trialling them for the first time. A particular issue arises with proprietary technologies, as for example with automated transit systems. Such systems do promise much, but there is a downside in that procurement is usually linked to a single supplier (now and for the future), and the benefits of competition may then be difficult to secure.

S1.4.40 ***14) Incremental Development*** – we have noted the sense in planning for the development of MRT systems, on a case by case basis, by a combination of progressive grade-separation and conversion between the MRT options. There are also decisions about the need to upgrade them over time which confront rail planners at the design stage. These concern the system capacity, comfort standards accessing the trains (escalators or stairs?), comfort standards on the trains (tunnel dimensions are critical to comfort as well as capacity standards, and air-conditioning is important), access by the travel-impaired (need for accessible lifts), ticketing equipment, and aesthetics (external and internal).

S1.4.41 We have considered the possible approaches to dealing with these factors. It is likely that the sum total of most of the above measures, if designed into the system from the beginning, would be small (perhaps 2% of the initial cost at a 'guestimate'). Moreover, most would be justified on commercial terms, that is they would increase revenues more than costs. The answer therefore is usually straightforward. Capacity should be based on traffic forecasts, which have been benchmarked against existing systems. Escalators should be provided when the vertical separation demands it, from the outset in most situations; otherwise planned into stations for future installation. Lifts should usually be provided from the outset, together with modern ticketing equipment . And effort should go into the design/construction process, producing visually attractive viaducts and stations which will stand the test of time. The cost may however be significantly increased if stations are designed for their aesthetics, particularly when underground stations are created with a sense of space.

S1.4.42 ***15) Integration with the Public Transport System*** – MRT systems need to be effectively integrated into the public transport network. When busways are superimposed on normal bus operations, with an 'open' system (allowing buses to join and leave the busway), then the most important aspects of integration are readily accomplished. But in other situation, for example when paratransit is the main form of public transport and for other MRT systems, when additional interchange to a line-haul trunk mode is necessary, many practical problems arise. These may involve opposition of the existing incumbent, or the capacity of the relevant institutions to regulate the public transport sector. This is not always well-developed, and it can not be assumed that changes that are desirable can be implemented.

S1.4.43 The failure to implement effective integration may undermine the case for such projects. Alternatively, MRT may be a catalyst for desirable change, facilitating greater competition in the public transport market, with outcomes that strongly support public policy.

S1.4.44 There are many possible aspects to integration, and an understanding is required early of which are important, the prospects of their being implementable, and their probable impacts.. An integration plan needs to be developed hand-in-hand with the MRT implementation plan.

S1.5 Applicability of the MRT Options

S1.5.1 We attempt to identify the circumstances when the options should be considered and may have application. We would emphasise that it is not possible to draw simplistic conclusions, because every city is different, and requires its own study of the potentially realistic options. But this section provides some context, and should help narrow down the potentially applicable options, based on the available evidence.

S1.5.2 ***Busways*** – where they are politically acceptable, busways should often be the first step in MRT system development, and for many cities they will remain the MRT system for the foreseeable future. We have seen that they can – in the right environment, effect major improvements in accessibility, benefiting most of the city's population, and particularly the poor. And they can achieve this quickly and incrementally as conditions and funding allow.

S1.5.3 The 'right environment' is however quite demanding to achieve. It requires effective government institutions, access to a well-developed traffic planning/ management capability (this may be bought in initially), bus/paratransit operations which can and should be restructured, and the road space for busway development.

S1.5.4 There is a broad raft of possible busway concepts, suited to differing situations. Most in operation are 'basic' and we have seen these have sometimes been criticised for their adverse environmental and land use impacts. They can and should be designed to remedy these problems, creating a better image and 'stretching' their role and applicability.

S1.5.5 ***LRT*** – is likely to be developed in cities where existing tram operations exist, which may be cost-effectively enhanced, and in cities where environmental issues are uppermost and there is a perceived need to attract car users (it may be the environmentally-acceptable component of a package of measures designed to create a 'liveable 'city for example). But where the core requirements are operational effectiveness, busways are likely to be superior, and cost less.

S1.5.6 ***Metros*** – are a different order of challenge, cost and risk.. When they are well developed, we have seen that they can be rational economic investments. These projects need to fulfil demanding requirements to be justified. Most of the following conditions are considered to be necessary.

- Corridor size - high existing public transport flows down the main corridor - of the order of 10-15,000 passengers per hour per direction
- City income - city incomes which are not low (typically at least 1,800 US dollars per person)
- Growth prospects - prospects for sustained growth, notably economic growth
- City centre growth - an expanding centre, preferably of a national/provincial capital city
- A low-cost metro alignment
- Fares policy - a fares policy on metro and bus systems to encourage ridership yet limit the need for financial support
- City management - government institutions which were stable and have demonstrated competence, and
- Metro management - strong, largely autonomous management, with clear objectives

S1.5.7 It follows that metros are most likely to be applicable to serve the largest corridors of the biggest and more affluent developing cities.

S1.5.8 ***Suburban Rail*** – we have seen that much should be possible to improve suburban rail operations, when institutional separation and management autonomy can be created.

S1.5.9 ***Incremental Development*** – we have concluded that it will be desirable to develop the MRT system incrementally, to meet operational and environmental requirements. There is some lumpiness is some MRT technology (e.g. rail depots), which provides some constraints to what is possible. But overall there is a wide raft of possibilities.

S1.5.10 ***Role of the Private Sector*** – we expect there to be a substantially larger, and different role for the private sector, with considerable potential for innovation.

S1.5.11 ***Applicability in Different Regions*** - We started by noting the difficulty of prescribing an approach, when developing cities themselves differ so markedly. Nevertheless, and at the risk of being accused of over-simplification, the following table (**Table S2**) attempts to provide some regional overview for MRT future strategy.

In all cases this needs to be provided within the framework set out above – designed to encourage cost effective, safe and less polluting public transport systems.

TABLE S2 REGIONAL MRT STRATEGY

City Characteristics		Strategic Focus					Comments
		Busways	LRT	Metros	Suburban Rail	Rail Infra concessions	
Central Europe	• Stable population • Rapid car growth • Existing infrastructure • Modes: bus, LRT, sub.rail	?	✓	(✓) exceptional	✓	(✓)	• Conserve PT integration • Maximise effectiveness of existing trams/LRT • Improve suburban rail • Some metro dev ŧ
Africa	• Rapid urbanisation • Inadequate road infra. • Modes: cycle, bus, paratransit	(✓) large cities		-	(✓)	-	• Create competitive PT • Improve roads • Busways where possible
India	• Rapid urbanisation • Inadequate road infra. • Modes: cycle, bus, sub rail	(✓) road infra?		(✓) exceptional, biggest cities	✓	(✓)	• Improve bus operations • Improve suburban rail • Busways, some metro dev ŧ
China (most cities)	• Rapid pop ħ growth • Rapid car growth • Rapid road-building • Modes: cycle (bus)	?		(✓) exceptional wealthiest/ biggest cities	?	✓	• Create competitive bus op ş • Change bus image • Improve concessioning process
South-East Asia	• Rapid pop ħ, car growth • Rapid road-building • Congested roads • Modes: paratransit, bus, metro	?		(✓) exceptional, wealthiest/ biggest cities	✓	✓	• Create competitive bus ops • Improve suburban rail • Improve concessioning • Integrate BOT concessions
Latin America	• Rapid pop ħ growth • Rapid car growth • Congested roads • Modes: bus, parat ŧ, sub rail	✓	(✓)	(✓) exceptional, wealthiest/ biggest cities	✓	✓	• Exploit , enhance and expand busways • Further suburban rail concessioning • LRT, metro dev ŧ

Key ✓ **applicable** ( ) **sometimes applicable** ? **acceptability questionable**

S1.6 *Research Requirements*

S1.6.1 The importance of MRT policy and the scale of investment often involved sit uncomfortably with the limited available research and consequent substantial gaps in knowledge, some of which go to the heart of policy and decision-making. A substantial effort is required to remedy these shortcomings, with priority focused on the impacts of actual projects, through before-and-after studies, focused on

- Policy research focused on core issues. In particular, understanding the impacts of the options on the urban poor, and
- Research focused on procurement involving the private sector

A CONTEXT

1 Introduction

1.1 ***Background***

1.1.1 The World Bank is undertaking an Urban Transport Strategy Review. This is the first comprehensive and detailed examination of this subject since the previous Urban Transport Strategy was published in 1986. The Review is to be informed and supported by a series of position papers collating experience and best practice on different topics in urban transport. One of the topics for which a review is required concerns the role and nature of urban mass transit systems in developing and transitional economies.

1.1.2 DFID shares the wish of the World Bank to enhance understanding and collaboration in this way, and is commissioning the review as a contribution to the knowledge base of the review. DFID is committed to the aim of the elimination of poverty, in line with internationally agreed targets, and therefore takes a particular interest in the impact of urban mass transit on the well-being of the urban poor.

1.1.3 The World Bank has for many years been sceptical about urban rail systems on the grounds that:

- the fiscal burden of maintaining unremunerative urban rail systems may be very damaging to the capability to finance other urban services

- peak hour peak directional flows of up to 20,000 passengers per hour could be effectively, and much more cheaply, accommodated by bus priority or busway systems

- metros were suspected of being affordable only by relatively wealthy cities and yielding benefits mainly to the wealthier section of the population

1.1.4 More recently it has been argued (Mitric, 1998) that rail systems need to be looked at more holistically as part of an urban development strategy, implicitly viewing the opportunity costs of the investment in rail resources as the extra costs of the provision of other public utility services (water, sewerage, etc) in the less dense development that can be sustained without urban rail facilities. But there still remains a problem about the affordability of such systems, either to passengers or to the municipal budgets**.**

1.1.5 Much of the conventional wisdom on mass transit in developing countries is derived from a series of studies of mass transit rail, busways and light rail systems undertaken about a decade ago (Allport et al, 1990, Cornwell et al, 1992 and Gardner et al, 1994 respectively). The focus of that previous work varied between the modes:

- The metro study had a planning orientation and was published in 1990. It was undertaken in consultation with parallel research into Latin American metros, funded by the French Government
- That for busway transit had an operational orientation and was published in 1992
- The LRT research also had an operational orientation and was published in 1994

1.1.6 These studies predated the large number of ambitious private sector (so-called BOT) projects in cities like Kuala Lumpur, Bangkok and Manila. And in Latin America comprehensive busway programmes are being developed, new metro investments have been planned or implemented in many cities, and major programmes of rehabilitation of existing railways have been developed. For these reasons it is desirable to revisit the earlier analyses, update them and place them in a broader transport and urban development context.

1.2 ***Objectives***

1.2.1 The objectives of this study are to:

- Compare the technical and economic capabilities of different forms of mass transit for different levels of demand and in different geographical and topographical conditions
- Re-estimate the financial and economic viability of different forms of mass transit project
- Evaluate the poverty reduction and related social benefits of mass transit projects

- Reassess the quality of life impacts of different modes of mass transit;

- Assess the net effect of mass transit projects on national economic growth impacts

- Identify the policy and institutional conditions under which different forms of mass transit can best contribute to urban development developing and transitional economy cities

- Consider the role of private sector participation in the development of mass transit systems

1.2.2 It was recognised that, as detailed material on new case studies may prove difficult to assemble in the context of the resources available (the review took place over a period of 4 months), it would need to attend to the more important issues, including in particular issues relating to institutions and strategic choices.

1.2.3 Our interpretation of these objectives is that an analysis is required of the core issues in the sector, identifying, based upon the available experience, how these should be addressed. This should encompass both the approach to achieving public policy objectives and the processes by which projects should be identified, developed and operated. The overall objective is to contribute to better decision-making in project selection and development.

1.2.4 Ideally the review would provide the answers to the many questions which face us. To the extent possible this is the objective, while recognising that in some areas the issues are intractable and/or little is understood, and that budgetary limitations do not allow fundamental new insights to be developed. In these areas the study has sought to ask relevant questions.

1.2.5 The study output is not intended to be a manual of mass transit planning. Neither is it intended to identify the role for the Bank or DFID in the sector, but rather to provide the basis for dialogue with developing countries.

1.3 ***Approach***

1.3.1 With the exception of a visit to The World Bank, the work has relied upon the consultants 'experience and a range of contacts who have generously given of their time. They are listed in Annex B, and their assistance is much appreciated.

1.4 *Policy Framework*

1.4.1 Mass transit is recognised as central to the sustainability of large cities, indeed its deployment may enable cities to achieve differing levels of sustainability. Singapore is an example of a city that has applied MRT as part of a comprehensive development and transport strategy, the core of which is the control of traffic congestion. MRT forms the centre of a quality public transport system, which is considered to be necessary to secure acceptance of traffic restraint measures. In other large cities such as Seoul and Sao Paulo, the absolute control of traffic congestion (as opposed to mitigating its worst effects) is not considered realistic. Here the role of MRT is to allow the city to continue to function as a city, and the CBD to continue to expand – to allow its economies of scale to be secured. In yet other cities, where MRT is not developed and traffic congestion takes hold, the city breaks down into 'villages', the CBD cannot grow and the scale economies of the city are lost.

1.4.2 In most developing cities, roadspace is scarce and public transport needs to share the same corridor as other traffic. Even for metros, where undergrounding in theory frees their alignment from the geography of the street system, in practice alignments are usually under major highway corridors (and sometimes under actual barriers to movement, such as rivers and hills). So, in developing cities, MRT is often located down major road corridors. This compares with cities where a more developed network, perhaps amplified by the development of an urban expressway network, permits a hierarchy of roads, with public transport and other traffic concentrated down different corridors.

1.4.3 Its role as a minimum is to provide for the travel needs of citizens and business. Sometimes the role can be much more than this, to provide the basis for a transport strategy which can control traffic congestion, mitigating its attendant costs, and creating a sustainable city form. In particular MRT is often inextricably linked to the future of the central business district (CBD), in a permissive sense - allowing it to grow, where the dynamism is there for growth.

1.4.4 It seems likely that in developing cities, the requirements for decision-making in this sector are particularly demanding. Whereas developed cities usually developed over many years, providing considerable leeway in decision-making, developing cities are often different. The wrong MRT decisions, or decisions deferred by a decade can have far-reaching strategic consequences for city development, by allowing car-oriented city sprawl to develop in the absence of the right transport strategy; and this once in place is to all intents irreversible.

1.4.5 The decades ahead pose new challenges for transport policy. It is increasingly recognised that policy must be sustainable, and that planning must be for the long-term, as well as for tomorrow. Policy is required to meet the diverse and changing needs of consumers and producers, partly the result of global competition. New challenges need to be met too - the need to develop intermodal transport chains, address the predicted large increases in motorisation, reduce the large and increasing toll of traffic-related deaths and injuries, and address the profound concerns associated with increasing air pollution.

1.4.6 The World Bank published its conclusions on how transport policy should 'meet the needs of the present without compromising the ability of future generations to meet their own needs'[1] after a substantive review of policy. This provides the basis for transport policy development. There are four strands to the approach:

- *Economic* sustainability: this recognises that economic growth is a valid objective of society. This must go hand-in-hand with

- *Social* sustainability: the problems of poverty and protection of the disadvantaged are central to the sustainability agenda, and

- *Environmental* sustainability: congestion, pollution, sprawling development and the exhaustion of resources all threaten a sustainable future.

- *Financial* sustainability: the sector finances must be put on a firm footing

1.4.7 Competition is considered to be the key to promoting efficiency in the sector, and economic sustainability requires the creation of competitive markets. This is a central task of government, and it poses a challenge for governments not experienced in the skills of how to regulate in the public interest. When 'the prices are right' scarce resources will increasingly be allocated efficiently, cost recovery will improve, and the sector will become increasingly attractive to the private sector. Rational pricing in the transport sector therefore contributes to its secure funding.

1.4.8 These objectives - economic growth, poverty and environmental quality are often in conflict. An MRT line, or network designed to target the lowest-income

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1 This is the definition commonly adopted, from 'Our Common Future' (The Bruntland Report), World Commission on Environment and Development, Oxford University Press, 1987

travellers would likely be different in terms of service, route and fares from one designed to retain travellers who have access to a motor vehicle. The tension between the poverty alleviation objective and other objectives of transport policy is much greater for rail projects than for bus projects, where it can be handled by service and price differentiation.

1.4.9 This study asks how MRT policy can achieve public policy objectives, recognising its overall central role in transport strategy. The public policy objectives are classified as follows:

- Macro – economic: metros in particular are hugely costly, and the scale of this investment can have impact significantly on the allocation of public funds, with macro-economic effects

- Micro –economic: the conventional assessment of the worth of a project as measured by its economic viability

- Social – there is a strong concern that policies including MRT should assist the urban poor, and other disadvantaged groups.

- Land use / Development – MRT can impact on land use / development and in the long-term on city structure, and thus can contribute to the attainment of a desired city or metropolitan form

- Environmental – MRT can have direct and indirect externalities, such as air pollution, severance, visual impact etc

1.4.10 Development agencies have a major concern that corruption, nepotism and cronyism do not frustrate the objectives of project development. The involvement of the private sector has in some countries caused concern in this respect, although it is a feature of all procurement regimes. Policy is required to reduce these concerns, by encouraging transparent and competitive regimes and processes.

1.5 ***Organisation of the Report***

1.5.1 The approach to meeting the review requirements comprises five stages:

- Setting the context for analysing the role of MRT
- Diagnosis, investigating key issues

- Assessing MRT Impacts against policy objectives
- Determining the approach to MRT project identification and development
- Providing a synthesis of the broad arguments and conclusions

1.5.2 The context considers a typology for MRT within a broad understanding of the public transport system, establishes the defining characteristics of the main options, and reviews the findings of relevant research known to us.

1.5.3 The diagnosis analyses these key issues where we consider new insights or experience may be helpful in informing the debate. These concern:

- The scale of challenge involved in establishing and developing any MRT systems, but particularly metros
- Developing city attitudes to the MRT options and their consequences for project development. This concerns the choice of mode and vertical alignment
- Forecasting MRT impacts – this contrasts the record against requirements and suggests the required approach
- Planning for tomorrow – metros in particular are once built there for all time, and sometimes difficult to retrofit 'after the event'. This develops the approach to project design which can adapt to future circumstances.
- Experience of the private sector approach – this reviews the experience to date of BOT concessioning (applied in Asia), and suburban rail/metro concessioning and privatisation (mainly applied in Latin America)
- Affordability and the Private Sector – this seeks to clarify the appropriate role of government and the private sector, and draw realistic conclusions about the scale of public sector support and private sector funding.
- Public transport integration – identifies the issues and options.

1.5.4 The following metro impacts are reviewed, drawing on the available evidence:

- Economic Viability
- Poverty Alleviation
- The Travel-Disadvantaged
- Land Use and City Structure

- The Environment

1.5.5 Finally the issues concerning the approach to implementation and operations are considered.

2 Public Transport

2.1 *Introduction*

2.1.1 Public transport systems may be characterised as a combination of 'formal' bus (and rail) services, which are planned and regulated and 'paratransit', which is sometimes called 'informal' transport, is often unregulated and may operate illicitly. An understanding of the existing structure of public transport is necessary before considering MRT. This is because few travellers use *only* the segregated MRT modes, instead most need to use the MRT system, including also the access/egress mode.

2.1.2 In many cities supply is provided by a range of services. Some are formal – that is, they run scheduled services. Others are informal – they are unscheduled, often flexible and use small vehicles. Sometimes service is illicit – outside the law. Informal services can be legal, while there may be unlicensed paratransit which is not illegal, because there are no laws to break.

2.1.3 ***Paratransit Services*** – in an increasingly large number of cities, paratransit services are a major, or the dominant mode, and these pose particular challenges for the development of the MRT system. The UNCHS (Cervero, 2000) summarise their key characteristics in the following terms:

'Plying the streets of Bangkok, Lagos, Istanbul and other cities of the developing world are fleets of small, low-performance vehicles driven by private operators that serve low-income neighbourhoods. In some places environmental-friendly, pedal-powered modes, like the pedicabs of Manila, provide lifts between markets and squatters whose narrow alleys and walkways are impenetrable to motor vehicles. In other places, like Kingston Jamaica, station wagons and minivans fiercely compete head-to-head with public buses, providing curb-to-curb delivery for a premium fare. And in increasing numbers of cities and towns around the world, dozens of young men on mopeds and motorcycles congregate at major intersections, offering feeder connections between mainline bus routes and nearby neighbourhoods at a reasonable fare.

‘These privately operated, small-scale services are referred to as *paratransit*. The sector operates informally, sometimes illicitly, somewhat in the background, and outside the officially sanctioned public transport sector. While private, small-vehicle for-hire services, such as taxis, can be found in all cities of the world, what separates (paratransit) operators from others is that they lack, to some degree, official and proper credentials and certification. That is, they are unsanctioned. In some cases operators lack the necessary permits or registration for market entry in what is a regulated, restricted market-place. In other cases operators fail to meet certification requirements for commercial, common-carrier vehicles – such as minimum size, maximum age or fitness standards. Other violations include lack of liability insurance, absence of a commercial driving permit, and operation of an unclassified or sub-standard vehicle.

‘In spite of such transgressions, in many cases the informal sector is tolerated by public authorities, allowed to exist as long as it remains more-or-less ‘invisible’ to most motorists, confined to low-income neighbourhoods. Often however patrol officers and area ‘bosses’ must be paid off for the right to operate ‘their turf’.

‘(Paratransit) is about as close to laissez-faire transportation as can be found. Through the invisible hand of the market-place, those who are willing-to-pay for transport services make deals with those who are willing-to-provide. This informal transport involves commercial transactions.

‘(Paratransit) services are also notable gap-fillers. They exist in large part to fill service voids left by the formal public transport operators. Rapid motorisation, poor road facilities and the inability to strategically plan for the future have given rise to horrendous levels of traffic congestion and air pollution in many megacities of the developing world. Formal transport services are rarely up to the task of satisfying escalation travel demands. Most public transport operators exist as protected monopolies, and accordingly lack the incentive to contain costs, operate efficiently, or respond to shifting market demands. Buses are often old, break-down frequently and crawl in slow-moving traffic. Fares are frequently kept low to help the poor, however this reduces the revenue intake, which in turn precludes service improvements. All too often throughout the developing world, public transit finds itself in a free-fall of deteriorating service and shrinking incomes. It is only because regulations and rules are laxly enforced that unlicensed operators are ‘informally’ able to step in and pick up where (formal) public transport operators have left off.

'Notwithstanding these benefits, the informal sector is blamed for a long list of problems that afflict the cities of the developing world. Aggressive and unruly driving among drivers whose very living depends upon filling empty seats all to often causes serious accidents. Excess competition has produced too many idling and slow-moving vehicles that jam critical intersections. Traffic tie-ups, along with poorly maintained vehicles and low-stroke engine designs have worsened air pollution. Oftentimes the sector is chaotic and disorganised'."

2.2 ***Evolution of Public Transport***

2.2.1 There are several models of public transport development. In many countries there were once large bus operations – a single municipal undertaking or several large private companies, that operated large buses, and provided for the travelling needs of the population, through a system of regulation via implicit cross-subsidy. Over the years at some time the economics of these operations has changed, maybe because government has controlled fares when costs increased, critically undermining profitability. Or many state/ provincial/ municipal bus operations failed when investment flows were interrupted, or through political intervention, poor management or corruption. Lagos State Transport Corporation (Nigeria 1992), Punjab Road Transport Corporation (Lahore, Pakistan 1997), Central Transport Board, (Sri Lanka 1993) are three notable cases. The failure of state/municipal bus operators in the Former Soviet Union (FSU) is largely due to lack of investment, revenue and fare constraints.

2.2.2 These failures created a spiral of decline, with loss of investment, an ageing bus fleet, and deteriorating service. Sometimes this was compounded by disruptions in service for reasons of war, civil unrest or protest. The gap in supply, which was reinforced by growing population pressures was filled by paratransit services, often using converted pick-ups and trucks in the first instance. They usually 'cherry-picked' the best bus routes where fares were artificially high under the cross-subsidy regime; and because they were often illicit they charged what they could get. Over time paratransit became established and despite attempts to reintroduce control or to remove it, at some stage these services were accepted and implicitly or explicitly legitimised.

2.2.3 In other countries public transport developed in a different manner. In many cities, particularly those that have grown from a small base in recent years, city transport has always been the preserve of informal transport; this is the case in the small cities of Nigeria for example. As they have grown, this remained the main form of transport. Sometimes the colonial era brought formal bus services, which were superimposed, and sometimes these remain, while in other cases paratransit has reasserted itself as the main supplier of services.

2.2.4 The available evidence is then that (externalities aside) paratransit competes effectively with buses. Its costs per passenger-kilometre, hence fare in a competitive market, are no higher than for buses, and it is preferred by passengers, being easier to access (stopping anywhere), more frequent, easier to get on and off, usually providing a guaranteed seat once on and being faster (it weaves through the traffic better than buses). Not surprisingly paratransit progressively takes over from bus services, and in many cities this has happened and paratransit is the main workhorse, with buses marginalised.

2.2.5 The owners of paratransit are sometimes individuals – from poor families who have worked overseas and invest to provide some security for their family, people who invest windfalls or pensions, and often the military, senior government officials and middle-ranking civil servants. The drivers are sometimes the owners, but often other family members, or others who pay a fixed 'boundary fee' to the owner each day. Almost always government tries to control or ban paratransit, which is seen to be outside the system of control: the number of such small vehicles makes their regulation difficult or impossible. But, partly because of who owns them and partly because they are so popular with the riding public, such control fail; only exceptionally have paratransit services actually been reduced or removed. It thus seems that paratransit often has a 'ratchet effect': it appears when there is a supply interruption, it establishes itself, expands, and expands again, fuelled by the expanding demand in most developing cities. The question this poses is whether and how control can be implemented.

2.2.6 The public transport system therefore often comprises two elements: big buses, which are regulated because they can be regulated and there is a will to regulate them, and paratransit that is in many respects unregulated. The bus operators view this as an unlevel playing field, and society should have cause to be concerned in some circumstances, because paratransit can itself create major externalities, in congestion for other road users, air pollution and safety.

2.2.7 There is a further factor. Natural self-interest is reinforced by some types of culture, and in the case of the poor, pressing need. In some societies *personal* gain is the ruling imperative. The behaviour of passengers, bus operatives, operators and government all follow from this. Given the opportunity, passengers avoid paying or ride further than their fare, operatives pocket the fares, operators defy regulations in many ways and avoid paying taxes, government officials apply regulation to maximise personal take. In practice operators adapt in a variety of ways: usually by applying flat fares, and sometimes by using boundary fees whereby the operatives pay a fixed fee to the operator each day, and pocket the excess. Nevertheless the revenue loss suffered by the operators can be large, compounding their other problems.

2.3 The Travel Options

2.3.1 The travel options *prima facie* available in developing cities today are defined by a combination of technology, form of operation and management measures which can give them priority over other traffic. They are:

- Walking on sidewalks or in the street. Walking is rarely used for regular journeys longer than about 5kms

- Non-motorised transport (NMT) – this appears as bicycles operating in the street, both personal cycling and rickshaw 'taxi-like' services. The evidence is that bicycles are not used for journeys longer than about 10 kms

Attitudes to walking and cycling influence behaviour. In the Philippines both are counter-culture, and even poor people pay to ride jeepneys. In Pune, India where cycling is widespread, it is only now becoming socially acceptable for women to use two-wheelers. However in many African cities there are negative cultural attitudes towards cycling, although this may vary even within cities depending on the origin of the residents (e.g. Accra).

- Paratransit – small vehicles, often one-man owned and operated. These either operate as small buses carrying 3-20 passengers formally, or informally in areas not covered by formal transport, or as motor-cycle taxis. Paratransit services have developed before bus operations, or in response to bus service interruptions.

- Minibuses and Buses – typically carrying 20-35, and 60--100 passengers respectively, maybe air-conditioned and maybe travelling non-stop between major attractors. Buses are often ubiquitous, although in many small cities in Asia (particularly Indonesia and Thailand) and is some Chinese and Vietnamese cities are there no scheduled bus services. In many Chinese cities, buses are regarded as the mode of last resort, used only by those unable to cycle – the old/infirm, young and the 'floating population' who are do not have access to a bicycle permit. Fares for basic services are (unlike paratransit) often flat for social policy reasons or because graduated fares are not enforceable by the operators.

- Busways, Light rail, metros and suburban rail – these are the focus of this review, and are defined above.

2.3.2 In practice there is sometimes a wide range of options available to travellers. For example in Indian cities, buses typically offer the lowest fare per passenger-kilometre, followed by minibuses, cycle-rickshaws, auto-rickshaws and car taxis.

2.3.3 **Table 2.1** summarises the key characteristics of the modes today – their operational performance and the service level they provide, cost structure and externalities. These factors influence the prices that should be levied on passengers faced with the objectives of operational efficiency, allocative efficiency, and equity and environment improvement.

TABLE 2.1 CHARACTERISTICS OF THE TRAVEL OPTIONS

Mode	Walk	Bicycle	Paratransit	Minibus/ Bus	Busway	LRT	Metro	Suburban Rail
Operational								
Level of Service	Poor, in street env t,	Poor	Slow (in street env t), frequent	Slow (in street env t)	Quite good	Good	High	Varies, few infrequent stations
Amenity	Na	Poor	Seated	Low unless AC /seated	As bus but easier to board	Often AC, but standing	Often AC, but standing	Often standing
Operating speed kph • Service • Door-to-door	5 5	12 12	Depends on congestion – typically 12 <12	As paratransit <<12	Depends on op l design 15-20 12	With pre-emption: 20? 12?	30-40 18	40-50 20
Fare	0	0	Yes	Yes	Yes	Yes	Premium fare	Yes
System Capacity Pass/hr/direction	-	-	12-15,000	20,000	10-20,000	10-12,000?[2]	60,000+	30,000
Other Issues	Safety from traffic	Safety from traffic, security for bicycle		Threat under crush-loading	Threat under crush-loading	Threat under crush-loading	Threat under crush-loading/ underground	Threat under crush-loading
Cost								
Initial cost US$	Na	50, often deterrent to ownership	Often second-hand	Often second-hand	1-5mn/km (infrastructure only)	15-30mn/km	Grade 15-30mn/km Elev d 25-80mn/km U gd 60-180/km	
Operating Cost	Na	Minimal						

[2] No systems operating at these flows, so capacities uncertain

Mode	Walk	Bicycle	Paratransit	Minibus / Bus	Busway	LRT	Metro	Suburban Rail
Economies of scale?	Na	Na	No	No	Minor	Yes	Yes	Yes
Externalities								
Impact upon the poor	Accessible	Accessible for many	Accessible	Less accessible in low income settlements	Accessible for bus users	Accessible for some, more interchange	High fares, more interchange. Accessible?	Accessible if fares low
Impact upon travel-disadvantaged	Problematic	Problematic	Accessible for some, seat	Crowded, accessible for some	As for bus	Problematic, crowded, more interchange	Problematic to access, then crowded	Accessible for some
Road traffic congestion	Often need to walk in the road	Cycle in the road	Less efficient than bus	Efficient road user	Very efficient use of roadspace	As busway	Reduces congestion	Reduces congestion
Air Pollution					As bus			
• Created for others	Na	Na	Yes	Yes		No	No	No
• Problem for travellers	Yes	Yes	Yes	Yes, AC no		No	No	No
Visual intrusion, severance	Na	Na	Na	na	Depends on design	Depends on design	Elevated – yes, and depends on design	Severance yes
Traffic Accidents	Yes, particularly head-carriers	Yes	Normal traffic accidents	Normal traffic accidents	Minor	Minor	No	Minor (level crossings)

3 MRT Options

3.1 *Introduction*

3.1.1 Mass rapid transit is defined for the purposes of the review as public transportation services, which involve a substantial degree of 'collectivisation', or combining individual trips into shared trunk linkages. It comprises those modes based on specific fixed track, or exclusive and separated usage of a potentially common user road track. It thus includes separated or largely separated busways, but excludes bus lanes and other forms of priority for buses in mixed traffic. The nature and significance of secondary modes of access and egress to the trunk facility are considered as part of the overall system. The review considers urban settlements of different sizes, and is not confined to the experience of megacities.

3.1.2 The core requirement of mass transit in developing cities is that it carries large numbers of passengers, rapidly. In the absence of large subsidies this requires both low cost (hence low fares) and speed in operation. The speed is critical to securing its impacts, hence the terms mass *rapid* transit is used in this review.

3.1.3 The literature is full of attempts to categorise these modes. They may be categorised in terms of:

- their technology (bus or rail-based), which influences aspects of service quality, capacity, the ability to segment the market, and cost
- right-of-way exclusivity, which determines speed and reliability
- grade-separation, which allows new alignments, and strongly influences cost
- guidance which may offer new alignment possibilities, and other impacts
- operational possibilities, which may offer differing service qualities and flexibility

3.1.4 We have reviewed the MRT systems actually operating in developing cities and have categorised them by technology and degree of segregation, which broadly translate into level of service, capacity and cost. Four generic forms of mass transit currently exist. These are defined for use in this study as follows:

- **Busways** – these are unless otherwise stated *at-grade* with horizontal protection from other traffic, often with priority over other traffic at junctions, which are signalised

- **Light Rail Transit (LRT)** – this is unless otherwise stated *at-grade*, with similar horizontal protection

- **Metros** – these are *fully segregated*, usually elevated or underground. It is the segregation that is critical to providing a rapid service, and the technology that allows a high mass ridership to be carried

- **Suburban rail** – these services are physically part of a larger rail network, usually *at-grade* and fully-segregated by means of controlled level-crossings

3.1.5 The MRT systems have much in common. They utilise a right-of-way, which allows managers to optimise their operations. They are systems, which comprise elements (vehicles, stations/stops, track, control systems, operational plans), which need to be optimised one with the other to deliver high performance. And they need to be effective parts of the MRT system with feeder bus and paratransit services. They need institutional coordination for implementation, and regulation to secure the public interest.

3.1.6 They also have major operational and performance differences. The principle ones are:

- *Use of space* – busways and LRT require reallocation of existing roadspace, thereby substantially improving speeds, while having indeterminate impacts upon other traffic (they may reduce or increase congestion). Metros by comparison add new capacity, typically increasing the passenger-carrying capacity of a major corridor by a factor of 3, and decongesting the parallel corridor to some extent. Suburban rail is a special case providing at-grade exclusivity and high speeds, by securing priority over crossing traffic.

- *Integration with the public transport system*, specifically the need to interchange. The rail systems require more interchange, while busways may not. Except at high flows, buses can perform a collector role <u>and</u> run down the busway to the centre without requiring interchange.

- *Capacity*. Busways, depending on specification have a practical capacity of 10 - 20,000 pphpd, or occasionally higher. There are no examples of LRT carrying flows in excess of 10,000 pphpd, and there is reason to doubt whether they can achieve much higher flows. Metros by comparison carry very large passenger volumes – of 60,000 pphpd or higher. High-specification suburban rail typically carries 30,000 pphpd.

- *Level of service.* Rail systems can generally provide a high quality ride, and when segregated, regularity too. Bus systems perform less well in these respects.

- *Ability to segment the market*. Bus systems have this ability, by running basic and air-conditioned/guaranteed seated/express buses. Rail systems exceptionally provide women-only carriages, but otherwise do not segment the market.

3.1.7 The roles these options play depend critically upon public policy, notably in respect to fares policy and system design and specification – which may be 'basic' or higher quality, with the objective of attracting lower-income or higher-income passengers respectively.

3.1.8 The options differ and can perform different roles. In medium-sized and low-income cities busways may provide the basis of the MRT system for many years. As affordability increases or environmental concerns become critical, then LRT may perform a similar role. In the largest corridors of major cities, metros may be required, and when affordable can be justified. The secondary corridors may then justify busway or LRT lines, which also may feed the metro. Where the conditions exist suburban rail systems may be upgraded, and again busways or LRT lines may feed them. The MRT options are, and should thus be regarded as, complementary[3].

3.1.9 A defining characteristic of many developing cities is that demand grows rapidly, and it is necessary to plan for this, by means of improvements over time. This argues for the incremental development of MRT systems, but to date there has been very little experience of this in developing cities. There are several options:

- Upgrading the specification of existing systems , (increasing capacity by larger vehicles or improved frequency, making busways more environment-friendly

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[3] They are competing alternatives only in the sense that at the planning stage it is necessary to establish which option is appropriate for the elements of the primary network.

by introducing air-conditioning on buses, improving quality and efficiency by better passenger access, improved ticketing systems etc)

- Upgrading capacity and system penetration by investment (partially grade-separating a busway/ LRT, segregating a suburban rail system, converting a busway to LRT, extending a suburban rail system to/under the city centre etc)

- New technological options which are becoming available and may have application (use of electric power for buses, guidance for busways, automated transit systems etc.)

3.1.10 This section defines the realistic MRT options operational today and their characteristics, and reviews the prospects for significant change as a result of future developments. The focus of this study is not on technology, but on the impacts which MRT systems can have, with the MRT options the tools 'available to government to pursue its objectives.

3.2 ***MRT Activity in Developing Cities***

3.2.1 The main features of existing activity in developing cities are the following::

- There are few cities with operating busways. All cities with busway *systems* are in Latin America, with Brazil prominent. Looking ahead, there are signs of increased busway activity in Latin America, but not elsewhere[4]

- LRT (meaning at-grade LRT, interacting with traffic at signalised junctions, and carrying a mass ridership rapidly) is only operational in a few cities – notably Tunis, Hong Kong (Tuen Mun), Istanbul and Mexico City. Looking ahead, there is little evidence of significant expansion

- There is extensive metro activity, and substantial future activity planned and underway, in many cities

- There are marked differences in activity by region. In Central and Eastern Europe activity is focussed on rehabilitating existing systems, upgrading the tram systems and exceptionally, developing new metros. There is little systematic development of MRT systems in Africa and the Near Middle East,

[4] This is not so in developed cities, with increasing activity, notably in Australia, North America and UK

other than in Cairo and Turkey. South Asia has one metro operational (in Calcutta) but substantial activity is planned/ underway. East and South-East Asia have extensive metros operational and planned. In Latin America there are major busway programmes and metro developments and suburban rail concessioning too.

3.2.2 The main change from the situation a decade ago is the interest in private sector BOT projects. Substantial private sector participation is taking place in BOT metro projects in South-East Asia, and in Latin America in BOT rail, suburban rail concessioning and in (in prospect) busway concessioning.

3.3 ***The Need for Appropriate Solutions***

3.3.1 The scope of this paper covers a wide range of cities, in terms of size (it includes medium sized as well as large cities), rate of growth, incomes, asset base and public transport system. Appropriate solutions need to be developed in response to the specific conditions, and those valid in one situation may be inappropriate in others. The paper therefore attempts to keep in view these very different starting conditions, in developing conclusions. The following are examples:

- Many African cities have a poorly developed road network used by bicycles, paratransit and buses, rapid growth and low affordability. These face different problems from

- Many Chinese cities, who have a low modal share of public transport based on rudimentary street bus operations, and a high modal share of bicycles, a government policy of rapid road development and motor vehicle manufacture and rapid investment in transport infrastructure. This differs markedly from that in

- Central/ Eastern European cities, where the starting point is a stable population, high modal share of public transport, large rail-based networks integrated with even larger street bus networks. These in turn differ significantly from

- South-East Asian cities with their rapid growth in population and car use, and proliferation of paratransit (and sometimes 2-wheelers), or Latin America with its high population/ income growth and established record of busways and suburban rail concessioning.

3.4 ***Busways***

Description and Status

3.4.1 Conventional buses are frequently unable to provide rapid and reliable services due the effects of endemic traffic congestion in peak periods and at other times by random traffic events such as obstructive parking,. Bus operations may be improved by traffic management measures or by bus only lanes, either operating full time or part time and either with-flow or contra-flow. While these measures are very worthwhile and likely to form part of the traffic strategy of any well managed city, they do not constitute a mass transit system (see section 1 definition). A bus-based mass transit system requires a network of busways as its fundamental feature. A busway is defined as a track for exclusive use by buses and which is segregated to the maximum practical extent from other traffic. In most cases, the realisation of a busway network requires the reallocation of road space away from use by other vehicles although new construction and road widening may form part of the system.

3.4.2 The implementation of bus mass transit into an existing road network presents many issues and these are discussed in later sections. However, it a significant merit of busway transit systems that they be designed with considerable flexibility and can be implemented incrementally and are thus able to accommodate city-specific constraints more readily than fixed track systems. This flexibility leads to a wide range of bus mass transit options. It would not be possible in this review to present a detailed description of all aspects of bus mass transit nor to present design guidelines. Nevertheless, to provide the context for discussion of issues, a brief description is given of the key elements of busway mass transit.

3.4.3 There are few busway transit *systems* in the world. The most notable and successful system is that in Curitiba (Brazil), but other less extensive systems exist in both developed and developing cities such as Ottawa (Canada) and Porto Alegre (Brazil) and Runcorn (UK). Other systems are under active planning including Bogota (Colombia), Lima (Peru), Ciudad Juarez (Mexico) and Leon (Mexico).

3.4.4 There are many more examples of busways, which are not network wide (and in this respect the busways are similar to most LRT's – there are no LRT networks in developing cities). They fulfil passenger line-haul functions on major corridors in developing cities such as in Quito (Ecuador), Bogota (Colombia), Sao Paulo and many other cities in Brazil. There are also examples of busways in developed cities including Paris, Montpellier, Tours, Le Mans (France), Nagoya (Japan), Taipei (Taiwan), Liege (Belgium), Pittsburgh (USA), Leeds (UK) and others

3.4.5 A busway mass transit system involves more than the busway or bus track alone. It will require integration of technology (both buses and infrastructure), operations and institutions. The current status and planning considerations and busway technology are reviewed in the following paragraphs;

3.4.6 ***Buses*** – the type of bus is the central element of busway transit as it determines the speed, comfort and reliability of the service offered to users. Busway transit has been introduced and operated by a wide range of vehicle types but the general planning characteristics are:

- *Passenger capacity* – in general, busway transit is used for line-haul, high demand corridors. Thus, buses should be of high capacity. For example, Curitiba uses 23m doubly articulated buses with a capacity of some 250 passenger, Quito uses 17.75m articulated trolley buses with a capacity of 180 passengers and so on. If small, low capacity buses are used, problems of passenger stop and lane capacity can result. This has been demonstrated in schemes such as the busway in Ave Caracas (Bogota) which was used by over 400 small-medium capacity buses per hour per direction and, despite being two lanes in each direction, the busway suffered bus congestion at stops and generally poor operating and environmental conditions;

- *Bus configuration* – buses should allow rapid and convenient passenger boarding-alighting. This is particularly important as passenger demands on a line haul routes will be high and boarding-alighting delays at bus stops must be low to avoid bus stop congestion and slow journey times. Thus, multiple door and easily accessible buses are desirable coupled with simple fare payment systems (see below). Most buses dedicated to busway operations have multiple doors to decrease passenger boarding-alighting times – Curitiba buses use 5 doors and most articulated buses operate with 3 doors. Easy passenger access may be provided and stop time minimised by (i) level passenger entry-exit using low floor (and thus costly) buses although none are known to be operational in developing countries or (ii) conventional buses using raised passenger platforms (such as used in Curitiba, Quito and some busways in Sao Paulo). It is common practice to locate busways in the centre of the road (see below for reasons). To minimise the space required for bus stop platforms, buses can be equipped with doors on the "wrong" side and thus both directions of flow can utilise a single median platform. This system is used in a number of Brazilian cities;

- *Bus motive power* – while most busways are operated with conventional diesel buses, there is a growing need to ensure that bus systems play their part in reducing overall vehicle emissions. It is a major selling point for LRT that, as electric vehicles, they are more environmentally acceptable than busways system. In the past, this may have been the case (for example, the Ave Caracas (Bogota) and 9 de Julho (Sao Paulo) busways experienced severe air quality problems from bus emissions) but modern technology can do much to reduce the adverse environmental impact of buses. For example, the Quito busway system is operated by trolley buses (with an emergency auxiliary engine). The use of trolley buses is a financial decision but the all-up costs of the Quito system are likely to have been double the cost of the system if it had been operated by conventional buses. Other alternatives now exist for motive power such as (i) CNG or (ii) clean diesel buses using clean diesel to Euro II (or better) standards;

3.4.7 ***Track*** –the line haul services of busway MRT operate on predominantly bus only track. Most busways tracks have been created by the reallocation of existing road space. The busway track itself is of normal road formation but using design standards that account for the tracking of vehicles (unlike a standard traffic lane, buses will always follow the same path in a busway) and ensure that the road surface is well engineering to ensure a smooth ride. Busways operate best with the maximum practical segregation of buses and traffic. Segregation may be made up of islands, or kerbs or heavy weight road studs depending on available road width; a combination of segregation measures is feasible to account for the constraints in cross section likely to be encountered along a route.

3.4.8 The location and configuration of busways varies but the most successful are located in the centre of the road. The central location (analogous to most LRT systems) allow frontage access to premises, kerb-side loading-unloading and local traffic access to/from side roads along the bus corridor without interfering with bus operations. However, the central configuration brings other operational problems, which require good design solutions such as passenger access to/from stops and treatment of traffic turns across the busway at major junctions. Various solutions exist to these problems including signal control for pedestrians and passengers, grade separation for pedestrians/passengers and for traffic, special turning arrangements can be introduced at key junctions to allow crossing of the busways. In a few cases, there have been purpose built busways (or at least major construction to re-configure roads) such as in Curitiba busways and in developed cities schemes such as Ottawa (Canada), Runcorn (UK), Pittsburgh (USA) and Montpellier (France) and new construction is planned for Ave 80 (Bogota). However, most busways have been introduced into existing roads.

3.4.9 Most busways comprise one lane in each direction but if a mix of services (express and stopping) is to be operated or if there are very heavy demands at bus stops (and thus potential delays as one bus waits for another to finish loading), then the busway track should be widened to allow overtaking (as in Sao Paulo and proposed for major corridors in Bogota) to reduce bus stop congestion and minimise delays. Where road space permits and stop demand is high, the provision of bus overtaking is highly desirable and enables buses to capitalise on their inherent operational flexibility.

3.4.10 ***Traffic management*** – considerable traffic planning skill and attention to detail is required to ensure successful schemes. In particular, there is a need to:

- minimise the impacts of busways on other road users (as in most cases, busways will be introduced into existing roads and some reallocation of road space to buses from other vehicles will be required)

- ensure safe operations for passengers to cross roads and to access buses,

- preserve the necessary level of frontage and other access along bus corridors for businesses and other affected groups, and

- integrate the often conflicting interests and objectives of other traffic related agencies such as the highway authority, the traffic police etc.

3.4.11 As previously noted, the most successful busways have been located in the centre-of-the-road but there is considerable difference between the 'model' Curitiba system and most other schemes. Curitiba developed its busways with parallel traffic routes using residual road space on the busway road itself for local access and servicing. Most other busway schemes have tried to combine busways and traffic on the same road. Issues such as safe pedestrian-passenger access to/from stop platforms, limitations on traffic movements arising from centre-of-the-road busways, and similar operational problems require high quality traffic management (as they would for an LRT similarly located).

3.4.12 While the maximum degree of bus-traffic segregation is desirable, there will still be a need for a high standard of traffic management operations along busway corridors. In particular, buses should be given, as far as is practicable, priority at traffic signal; controlled junctions. With modern traffic signal; technology, bus detection and bus priority at junctions which busway cross is a straightforward facility. Bus priority can be provided by attempting to provide a green-progression (difficult because of the unpredictable times at bus stops) or signals green extensions or pre-emptions (more realistic as detection of buses in a segregated busway is relatively straightforward). As far as is known, few busways in developing cities have such facilities but it exists in Quito and to some extent in Curitiba but the technology is well established and with increasing interest and lowering of real costs of "area traffic control" (computer controlled traffic signals), bus priority at signals in a busway should be the norm

3.4.13 The traffic management planning task should not be underestimated. A balance will need to be struck between the various users of the road system (again, busways are the same as LRT systems). Some cities may not possess the necessary traffic planning and co-ordination skills and a poorly planned and designed scheme can undermine the case and acceptance of busway transit as a valid mass transit mode.

3.4.14 ***Operations*** – busway systems offers passengers two basic types of service:

- *A trunk-and-feeder system* . A fleet of large, high capacity buses is confined to operations on the busway network and passengers either access the trunk line buses directly at stops or terminals or access to and from the trunk line by use of other feeder bus services, which interchange at a limited numbers of terminals along the busway. The system requires good institutional arrangements as there is a high degree of service planning involved, and for maximum effectiveness, the system should be operated under an integrated fares regime (passengers paying once only for a journey).

  The system is analogous to a street-based LRT and offers the same advantages of a planned system in that use of the busways is controlled in terms of the type of buses (and thus size, quality, emissions etc) and volume (and thus bus congestion at stops etc is avoided. The system has been successful in many Brazilian cities, is now used in Quito, is to be implemented in Bogota and is planned for Leon and Ciudad Juarez (Mexico)

- *An open system*. The alternative is to operate a system in which buses are able to join and leave busways at intermediate points (for example, the system used in Sao Paulo, Porto Alegre, Lima, and formerly Bogota); although some bus services may still operate a trunk-feeder-integrated fares service on the same busway. The join-leave system capitalises on the flexibility inherent in bus operations and reduces the need for passengers to interchange. However, a multiplicity of bus routes on a heavy demand busway may result in bus and bus stop congestion problems. To overcome these problems, bus overtaking at stops has been provided by widening the busway (Sao Paulo) or providing two lanes for buses (Bogota).

3.4.15 The system selected depends on the city circumstances and on the ability of a city to manage the trunk and feeder system (a greater degree of regulation and control is needed). But if high passenger corridor capacity is needed, the "trunk and feeder" system is most likely to be appropriate. The free bus-entry exit system to busways has caused bus congestion problems on high demand corridors and is more likely to be appropriate to smaller cities or lower demand corridors.

3.4.16 *Automatic Vehicle Location* (AVL) – 'automatic vehicle location' comprises facilities which enable the movement of buses operating on a busway system to be monitored by identify the location of all buses at any time, and therefore provides the opportunity for greater operational control. Control may be exercised over frequency and operations and buses adjusted to meter operational goals. In general, AVL would contribute to the provision of reliable services but no known systems exist in developing cities. However, with reducing costs of technological equipment, such systems will become viable and in addition to providing operational benefits will enhance the state-of-the-art image of bus based systems.

3.4.17 ***Service levels and capacity*** – there is little published research on the operational of busways since the work carried out in 1991 (TTC/TRRL, 1991). Busway performance may be considered in terms of 'line haul capacity' coupled with 'commercial speed' of buses. However, the definition of specific values for capacity or speed are not possible as they depend on complex interaction between a range of factors. For example, commercial speed depends on:

- the extent of bus-traffic segregation;
- the number and spacing of road junctions which a busway crosses and the extent of priority given to buses at the busway/road signals

- the number and spacing and of bus stops and the passenger boarding-alighting volumes and patterns.

3.4.18 Similarly line haul capacity or passenger throughput of busways depends on

- the type of buses used (the range is large extends from bi-articulated buses with capacities of 270 to articulated with capacities of 160-180 to 12m buses with capacity of 100 to smaller vehicles);
- the type of service operated including frequency and service pattern (as above - trunk-feeder system or buses joining and leaving a busway)
- the operational characteristics of the system (such as multi-door buses, off or on bus fare payments, number of and balance between boarding and alighting passengers).

3.4.19 Planning of busways must take into account all these factors and its highly scheme-specific nature precludes definition of general performance guidelines. Nevertheless, to place the review in context, experience and previous research indicates that the performance achieved by busways is of the following magnitude:

- Where junctions are relatively closely spaced, say 400m or less and bus stop spacing is close, a passenger throughput of about 10,000 passengers per hour per direction is typical for conventional buses in a 1-lane busway and operates at a commercial speed of about 15-17 kph;

- On major radial roads where junction spacing is somewhat greater, say 450m, and bus stops are similar, large buses achieve a passenger throughput of about 15,000 passengers per hour per direction operating at a commercial speed of about 20 kph (similar to Curitiba);

- A passenger throughput of about 20,000 passengers per hour per direction can be achieved on major radial corridors with relatively large junction and bus stop spacing provided adequate measures are taken to manage bus stops (bus overtaking is normally required). A 2-lane each-way busway in Bogota (Av Caracas) has carried 30-35,000 passengers per hour per direction in the morning peak but under difficult operating conditions (notably bus stop congestion) and with adverse environmental impacts arising mainly from emissions from high volumes of low-quality buses.

3.4.20 The foregoing figures are maxima. Planning for a new busway transit would seek to adopt more generous design criteria. In the past, special operational measures were sought to increase busway capacity in Sao Paulo and Porto Alegre in Brazil. Essentially buses were assembled into a platoon of predetermined order at the start of a busway and maintained that order while on the busway – in effect acting as a 'train'. Considerable efficiency gains were made at heavily used stops and passenger throughput was high but the system was unable to be sustained under practical operating conditions on a day-to-day basis. However, given the increasing use of AVL and the control over bus operations which it offers, such platoon systems may have future potential.

3.4.21 Thus, although there are complexities in defining busway performance, it is apparent that busway MRT is able to offer a high capacity service at commercial speeds similar to other tracked systems with the same degree of segregation from other traffic. The greater degree that busways are segregated from other traffic and the more operational control is exercised (e.g. bus linked-activated traffic signals at junctions, bus stop management) then the better service will be in terms of speed, reliability and service to users.

3.4.22 Where busways exist, they have demonstrated that they can consistently carry large volumes of people at reasonable speeds. In many cases, the quality of the service offered to users is not high – poor environmental impacts on Ave Caracas in Bogota,, poor standards of infrastructure in Port Alegre and so on. However, these failings are not a function of busway transit – they are due to lack of finance or inadequate design, matters which may be resolved at costs which are orders of magnitude less that an LRT of similar capacity;

3.4.23 ***Fare collection systems and fare structure*** – most LRT schemes use some form of 'open boarding' with off vehicle payment; this is essential to capitalise on the rapid boarding/alighting potential offered by multi door vehicles. The same should apply to busway transit. However, as most busways are not part of systems, fare collection methods are mainly inherited from the existing conventional bus operations and payments on-bus to a conductor are most common. Where off bus payment exists, or is proposed, in developing cities, cash fares are collected manually at stops and terminals before passengers board buses. This system leads to rapid boarding times but requires permanent deployment of staff at each collection point. However, this is more cost effective than a fares collector on each bus. The system exists in Curitiba and Quito and is planned for Bogota and Lima. As technology costs reduce in real terms, other forms of fares collection –

such as magnetic tickets with or with or without stored value – will become more cost-effective in the future and of course, such technology is in common use in developing cities in metros.

3.4.24 Where a single payment (or integrated fare) system exists for 'trunk and feeder' services exist, some form of apportionment of fares revenue between the various operators or elements of the system is necessary. In Curitiba, all revenue goes to the City which then pays bus operators for the delivery of bus services – either trunk or feeder services. The regulatory agency makes systematic checks to ensure that contracted service are operated and provide data for proportioning revenue between operators. This requires an effective institutional set-up. In Sao Paulo, passengers pay once on a journey; thus in the morning the feeder service retains the fare and in the evening, the trunk service (which starts at an inner city terminal) retains the fare. Various other systems could be devised dependent on the institutional arrangements for ownership, regulation, operation and management of the busway system

3.4.25 ***Costs*** – Busway transit can be implemented at a basic level as essentially traffic management schemes using simple bus/traffic segregation and operated with existing buses but very few other supporting infrastructure or operational interventions. While such schemes will be of operational benefit to buses and passengers and while a city may have no alternative if resources are severely constrained, such schemes do not provide a true bus mass transit system.

3.4.26 At the other extreme, busway transit can be implemented at a comprehensive level. This would include new buses, segregated busway track, traffic signals systems to ensure bus priority at busway/junction crossings, high quality passenger facilities at stops and terminals, passenger information systems and, at critical locations on a busway alignment, could include new infrastructure constructed for buses. This latter will apply to the proposed Bogota busways and has applied in developed cities such as Ottawa (Canada) and Montpellier (France). Depending on the manner in which busway transit operations are contracted or operated, other costs may be involved such as bus maintenance facilities

3.4.27 Thus, generalisations on cost are difficult. However, based on experience and available data, busway transit costs are estimated to be of the following order of magnitude:

- The costs of a simple one-lane each way, busway with some junction modifications, at-grade passenger access to buses and basic passenger platforms/stops will vary city-by-city but, as essentially traffic management scheme costs, are likely to be less than US$1 million per km;

- The most recently implemented busway system was in Quito in 1997 (IADB, 1997). The scheme comprised a one lane each way, high standard busway introduced into the centre of an existing road and operated by electric trolley buses using the trunk-feeder system. Total cost was of the order of US$ 5 million per km. The cost included buses, infrastructure, terminals, closed stops, traffic management and ticket system. If articulated high quality "clean" buses had been used, it is estimated that the total cost of the system would have been about US$ 2.5 million per km. The cost of the busway infrastructure itself (stops, track, traffic works etc) was of the order of US$1 million per km but it is believed the roadway was not totally reconstructed. Estimates suggest costs could have increased to US1.5-2.0 million per km;

- The costs for a city-wide busway transit system have recently been estimated for Bogota (SDG, 1999). The full system comprises 94 kms of busway over 7 corridors to be operated by some 1000 trunk line buses (diesel – not electric trolley buses) and 1000 feeder buses. The estimated total cost was of the order of US$ 5 million per km. If bus costs are deducted from the total, the cost for the infrastructure and supporting equipment of the major busways (abut of course including other infrastructure) was of the order of US$ 1.5 million per km.

3.4.28 Thus, the orders of magnitude of infrastructure costs for a basic busway introduced into an existing road are estimated to be less than US$1.0 million per km. For high quality busway infrastructure, costs would average about US$1.5 million per km. System-wide costs are estimated to be of the order of US$ 5 million per km including the buses. The latter costs are for a high quality system and are orders of magnitude less than an equivalent LRT systems. If resources are limited, an incremental approach could be used and a basic busway system could be introduced at a lower cost, say less than US$1 million per km, and enhanced as resources become available. Of course if a busway is developed along a new corridor (as opposed to in an existing road) the costs would be increased.

3.4.29 ***Integrated Corridor Planning*** - the majority of busway alignments follow main radial routes to/from city centres. Such routes experience existing high passenger demand but also have high vehicle flows and probably, traffic congestion. Removing large numbers of buses from the kerb lanes and reallocating them to a centrally-located busway, for example, does not necessarily increase congestion; its impact is a matter of policy, available space and design. In some cities, busway proposals seek to minimise impact on traffic by using the space available from central medians or verges to create new capacity. Other measures are used to minimise busway road space requirements; for example, in Brazil and some other countries, there is innovative use of 'off side' bus doors to reduce the space requirements for stops as central busways can use a common passenger platform for both directions of bus travel. However, in many cases, the introduction of a busway into a major existing corridor requires reallocation of road space to buses from private vehicles with resultant increased restraint on those vehicles. Increased traffic congestion is not an efficient restraint mechanism and thus busway transit should be planned within a package of other measures which both promote public transport and seek to manage-reduce traffic demand.

3.4.30 There have been few new busway systems introduced since the 1990 (when previous research was carried out into the operational performance of busways) and thus there is little new research or quantified data on which to re-assess busway impacts. Indeed, it is recommended with a new generation of busways coming on-stream (Quito, Bogota, Lima, etc) such research is needed. However, based on previous work and experience, key points are still considered to be as follows.

3.5 ***Issues Affecting Future Busway Developments***

3.5.1 For cities in developing countries, busway transit has much to recommend it, in terms of:

- Operational flexibility - as passenger demand changes, busway transit capacity and operations can be readily augmented or modified
- Affordability – systems cost little to implement (relative to rail systems), and have low operating costs
- Capability to be implemented incrementally – unlike rail systems, limited busways systems can be operated effectively as funding allows, with high benefits (the Quito experience)
- Capacity - the capacity of a well managed system is high. As noted above, a well designed and managed scheme is capable of transporting at least 15,000 passengers per hour per lane at an acceptable level of service and higher

passenger flows per hour per direction of say 20,000 are feasible if the system is properly designed and managed etc;

- Level of service – busways can provide a level of service equivalent to an LRT with the same levels of bus-traffic segregation. In urban areas with normal junction spacing, commercial speeds (i.e. including journey time, times at bus stops, junctions etc) are likely to be of the order of 20 kph;
- Environment – busways can be made environmentally acceptable by use of clean fuels, low emission vehicles ad good design

3.5.2 Despite these merits (many being advantages over rail systems) busway transit has not been widely applied and indeed outside Central-South American countries has been applied only in a few exceptional cases. There are indications that the concept is gaining greater acceptance, with projects under active planning in Bogota, Lima, Mexico and Manila. Nevertheless, the lack of 'take-up' indicates that there are issues which have inhibited acceptance of busway transit.

3.5.3 A review of potential improvements to bus transit in USA (DOT, 1994) noted that the primary obstacles and difficulties in introducing improvements to bus services were:

- Lack of ideas and initiative;
- Lack of funds
- Lack of co-operation between other agencies
- Opposition by groups;
- Poor understanding of problems;
- Unawareness of possible feasible solutions;
- Lack of data and technical material;
- Scepticism.

3.5.4 Although the review was concerned with bus systems and was in the USA, much the same can be said for busway transit in developing cities. The following sections discuss the main issues:

3.5.5 ***Political and public perceptions*** – busway-based systems appear not to be attractive to either the public or to decision makers/politicians. To the extent that this concerns their technical merits, this view may be based on a misconception.

Travellers observe the current poor state and low levels of service offered by existing buses and cannot believe that the bus system can make the quantum change necessary to provide the type of service equivalent to an LRT system. There is often the view that buses are a second-best mode, which must be at best tolerated until something 'better' (such as a state-of-the-art rail system) can be implemented.

3.5.6 The introduction of imaginative, segregated busways into existing streets, can raise local opposition due to changes in local access and frontage and other servicing arrangements for business, residences etc. While such arrangements are likely to be similar to those necessary for RT, it appears that over-coming the opposition is politically acceptable for an LRT systems but not for a busway system.

3.5.7 A recent UK study (ETP, 2000) reported that busways could not be favoured as a policy in comparison with LRT as, *inter alia*, LRT demonstrates a strong commitment to public transport and LRT can help 'develop the political consensus to adopt a more radical approach to car restraint than bus-based systems have allowed'. Apart from unproven nature of this view in a developing city context, the perception is not untypical of busway transit. We conclude that if busway transit is to become a realistic candidate MRT option, it should be evaluated on an even basis against other modes, and to the extent possible the political and public adverse perceptions will need to be overcome.

3.5.8 ***Existing bus and paratransit operations*** - a key issue which will determine the implementatability of a busway transit system is its impact on, and integration with the existing public transport system. Unlike rail systems, every large city has a road-based public transport system of one form or another. In some cities paratransit has become a major, and in some cases the predominant mode. Paratransit has many excellent qualities – flexibility, rapid response to demand shifts, rapid personalised service, wide network coverage and so on. However, there are problems; in particular, small paratransit vehicles are unsuited to fulfil line-haul functions and intense vehicle-to-vehicle competition gives rise to vehicle congestion due to the sheer volume of vehicles. Safety issues are also often reported.

3.5.9 Bus/ paratransit systems are largely in the private sector, often deregulated (or at least operate under *de-facto* deregulated conditions), are owned by small (often one-man-one-bus) companies with little corporate organisation or finance, and they often comprise large fleets of small vehicles. The introduction of new busways will inevitably affect existing bus/ paratransit operators who at worst, may lose their livelihood and at best, will require to change their services and operations. Defining the relative roles of paratransit and busway transit is a key issue in planning a busway transit system. A greater issue will be the enactment of that defined role.

3.5.10 The difficulties were demonstrated by the busway *system* proposed for Bogota in the mid 1990's. A busway transit system was bid and a contract awarded to a consortium of bus manufactures, bus suppliers and bus operators but was not implemented partly as a result of opposition from existing companies.

3.5.11 However, such transitions must be made if busway transit is to become a realistic option. The issue can only be dealt with by consultation, negotiation and consensus. But any city aiming to introduce busway transit will likely need:

- a clear and defined strategy as to how it will integrate busway transit with existing bus/ paratransit operations
- committed political support for the policy changes, and
- competent institutions to plan, implement and enforce the policy.

Failure to deal with these issues can result in failure to realise busway transit proposals.

3.5.12 We conclude that: busway transit will affect existing bus and paratransit operators, and that a detailed organisational plan, preferably developed in consultation with existing operators is essential to implementation.

3.5.13 ***Lack of promoter*** **-** There is no natural, single promoter of low-cost busways[5]. Many city agencies (traffic, highway, licensing, traffic police, public works, bus companies, etc) will be involved in realising and operating busway system. In comparison, the rail sector is represented by single, powerful commercial companies, often supported by their governments, and these aggressively promote fully integrated rail projects including equipment, construction, operations and

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[5] Mercedes Benz were actively involved in the Australian 'O-bahn' system, transport companies are currently active in promoting busways in the UK, and Volvo were involved in the aborted attempts to introduce busways in Bogota in the mid 1990's; but this is the exception in developing cities

most importantly finance, often with little regard for whole-life costs and financial implications for the owners.

3.5.14 There have been a few attempts to promote busway transit on an integrated basis and above all, provide the necessary finance. In the mid 1990's, the Municipality of Sao Paulo launched a pioneering initiative for concessions to build and operate 10 busways totalling about 240 kms (World Bank, 1997). The initiative failed because of problems of obtaining finance by concessionaires – the risks involved in building and operating the system were regarded as too great and the market was not prepared to accept the innovative challenge. Nevertheless, it is reported that the State of Sao Paulo did successfully conclude one concession. This approach, although not successful in the Sao Paulo case, appears to offer real opportunities for finding a sponsor or promoter for busway transit.

3.5.15 We conclude that for successful busway transit implementation, it would be desirable to secure a promoter, and that private sector concessioning offers a promising approach..

3.5.16 ***Planning and agency responsibilities*** – Traffic and transport planning associated with busway transit is no more complex than for other major traffic or transport schemes. However, there is a lack of planning experience in dealing in an integrated way with all the aspects necessary for the successful operation of a busway transit system. This must include the busway and feeder bus route planning, servicing, access and other traffic arrangements, integrated fares systems, pedestrian access to/from stops, and so on.

3.5.17 In many cities, responsibilities for these various elements are fragmented and the system components are usually under control of various agencies. There is often a transport planning agency (system), highway agency (track), traffic agency (signals), bus licensing agency (franchise and regulation), bus supplier, bus operator, system management (usually the bus company if at all) and traffic police (enforcement of traffic regulations).

3.5.18 The development of an integrated system requires an institution to span the various activities. There have been examples of incomplete planning and design which has caused schemes to be abandoned an early stage before implementation; examples are busways in San Jose or Caracas and the C5 busway in Manila. These failures undermine political and professional confidence in busway transit.

3.5.19 We conclude that busway transit must be planned on an integrated basis by an agency or coordinating group with powers across all elements of the system, such as a 'metropolitan transport authority' or equivalent.

3.5.20 ***Image*** - busways undoubtedly suffer from an out-dated technology image. Schemes such as those in Curitiba and Quito (and the proposals for Bogota) have done, or will do much to reverse this image. The use of high capacity, modern buses, level passenger-bus boarding through closed platforms-stops, efficient ticket systems and "off side" doors to accommodate limited widths available for passenger platforms and stops all contribute to wards achieving this. Clearly, more could be done and modern techniques which apply to LRT's could be made to apply to busways – such as low floor vehicles or automated ticket systems.

3.5.21 ***Environmental impact*** - the environmental impact of some busways has been poor. Where busways have been operated by large numbers of relatively low passenger capacity diesel buses, this has degraded the environment through unacceptable levels of vehicle emissions, noise and severance and the corridor has generally deteriorated. These environmental problems must be addressed if the second best image is to be overcome.

3.5.22 There is no reason why busways should not be designed, as LRT systems are, to enhance the environment of the corridor in which they are situated. The provision of high capacity 'clean' buses, high quality passenger facilities, high standards of 'track' (road pavement) and routine maintenance of all facilities should be regarded as the norm. While these actions may increase busway system cost, that cost would still be small relative to an LRT alternative. Finally, as with any transit corridor, land use controls should be exercised to ensure, that over the long terms, development of busway corridors are compatible with their functions as a major transit corridor.

3.6 *LRT*

3.6.1 ***Operational performance*** - We have defined LRT as at-grade and rapid, more akin to high-performance trams. There are few high-performance LRT systems in developing cities. Previous research (TRRL/INRETS, 1994) reviewed the potential and actual performance of a number of systems, ranging from urban tramways to what we have classified as metros (the fully grade-separated Manila Line 1). Highest capacities observed were on the fully-elevated Manila Line 1 and the 95% segregated Alexandria-Rami systems (18,000pphpd). These operated 60 metre trains. The highest capacity for a true street-running system appeared to be for

Alexandria-Madina, with 275-passenger vehicles every 80 seconds (12,000pphd), but this was at low speeds (6km/hr) and relatively low patronage (6,000pphd). In Budapest and Prague street-running vehicles were larger and faster, but less frequent. Capacity was around 9-10,000pphpd, patronage again around 6,000pphpd. The capacity of the highly segregated Tunis system was estimated at 13,000ppdph, with observed patronage of 9,300.

3.6.2 The research concluded that 'only two of the case study systems demonstrated peak flows in excess of 10,000pphd, and one of these, Manila, verges on the status of a full metro'. It concluded that 'there is little evidence to support the view that LRT can carry more than busways. ... increasing the regularity of headways would increase capacity. However, in a developing country situation it is difficult to control regularity because of infringements on the track and lack of vehicle maintenance. Irregular headways... (cause)..bunching and overloading at stations which lead to further delays'.

3.6.3 This research concluded that LRT performance in developing cities is (relative to busways) quite limited. Typical at-grade LRT throughputs were about 4,000-6,000 passengers per hour compared to busway average of 15,000 at about the same commercial speed. There were no known LRT's operating at-grade which approach the passenger carrying capacity of the existing Curitiba, Quito or Bogota busways. The factors which prevented higher performance were summarised as follows:

'The results of the research point to some difficulties that may face the introduction of a successful LRT in a developing city. In order to carry the high passenger demands, vehicles must be large. This size makes them vulnerable to interference from other road users. Many developing cities are very crowded and have high levels of on-street activity: this causes delay to street-running transport of all types. Delays to an LRT vehicle carrying nearly 1,000 people can seriously reduce capacity, especially when cumulative. LRT operates best with regular headways, but this requires a high degree of control and organisation, which is uncommon in developing cities'

3.6.4 LRT achieves high speed by using a signalling system to avoid bunching, and by obtaining priority at traffic signals over other traffic; and it achieves high capacity by having large vehicles which take advantage of the signal cycles. In practice the distance between signals defines the maximum vehicle size, and the need to provide for crossing traffic limits the number of vehicles per hour. However, LRT systems are operationally vulnerable to the everyday events that happen in the centre of developing cities. Whether this is junctions being partly blocked, or road maintenance work, or a breakdown, or an accident, while bus systems are often able to get round the problem (they can overtake, leave the busways etc), LRT is not.

3.6.5 This Review has examined evidence from Budapest, Melbourne, Manchester and Tuen Mun, Hong Kong. In Budapest while nominally a tram service, BKV routes 4 and 6 are effectively LRT or pre-metro, running every 4-6 minutes each over the same semi-circular route Most of the route is on a central reservation, rather than sharing road space with other vehicles, with direct staircases between tram stops and the metro at some interchanges. The services are operated using BKV's largest trams, double-articulated with a capacity of around 180-200, operating in pairs. Metro line 4 will replace part of the route. With capacity of 360-400 people per "train" and a peak 30 trains per hour, capacity is 11-12,000pphpd. A higher frequency / capacity could probably not be operated – the trains are about 60m long and take some time to clear road intersections, such that only 1 each way per signal cycle is allowed to cross at some intersections.

3.6.6 In Melbourne Swanston Street is the main north-south tram route through the city centre. It is largely pedestrianised. All Swanston St. routes cross the Yarra River into south-east Melbourne, running along St. Kilda Road on a central reservation. Thus between Technical University, on the north side of the city centre, and Domaine Road in the south the streetcar effectively operates as LRT, only encountering road traffic at intersections. Frequencies are about 60-65 trams/hour in the peak. Most (routes are operated by non-articulated trams. Capacity per vehicle is around 80-100. Peak capacity is thus around 5,500-6,300pphpd. A higher frequency / capacity could probably not be operated – there is already congestion at the busier tram stops, with 3 or 4 trams arriving at the same time, and with no platforms, loading and unloading is slow. However, with better passenger transfer facilities (reducing dwell times) and larger vehicles, capacity close to Budapest's could be achieved.

3.6.7 Both Budapest and Melbourne are 19th century systems that have developed with the city. By comparison, a modern system, Manchester Metrolink has a similar design capacity - 20-30 double units per hour (18/hr currently operating in the peak between Cornbrook and Piccadilly Undercroft) on both street-running and segregated systems, i.e. around 10,000pphpd.

3.6.8 In Tuen Mun the capacity of the LRT is judged by one correspondent to be based on 60 movements in each direction per hour. Given two car trains with a capacity of 220 passengers per car, this gives a line capacity of 26,400 pphpd. We have been unable to confirm whether this has been achieved in practice, and critically whether it is possible to combine this frequency with a high operating speed.

3.6.9 We conclude that an LRT capacity of 10-12,000 pphpd at an operating speed of 20kph is likely to be the limit to what is achievable.

3.6.10 ***Cost*** – we have estimated the all-in cost of (at-grade) LRT systems as US$ 15-30mn/km, based on the available evidence. This includes the infrastructure and the rolling stock. Additionally, the operating costs for rail systems are much larger than for bus systems, in particular because of the need to maintain the equipment and infrastructure to high standards.

3.6.11 ***LRT and Busways*** - It has been the practice to consider LRT as a development from busways in terms of performance. There are two scenarios:

- 'Environment Scenario' - where the reason for conversion is to attract car users and/or to reduce pollution and improve the environment. This has been considered in some Brazilian cities. In the right circumstances, particularly as part of a wider package of measures to improve the 'liveability' of the city, this may be justified

- 'Capacity Scenario' - where the reason is to increase capacity and service level, faced with busways at the limits of their performance, there is no evidence that LRT provides an effective option, and the case for such upgrading is unlikely to exist..

3.6.12 As far as is known, there have been no busway - LRT conversions although it was proposed in the early 1990's in Karachi and there are examples of busway - heavy rail or metro conversion. Conversion of busway to LRT is not be a simple matter and would require careful evaluation. The issues would have to be dealt with either at the outset of the planning stage of the mass transit system (and thus would be likely to increase the cost of a busway) or dealt with at the conversion stage (and thus would be likely to interrupt operations of the busway-LRT for a considerable time). Factors to be considered include:

- geometric layout - buses are not bound by the same vertical and horizontal alignment constraints as LRT vehicles and in a 'tight' urban area, the more generous LRT design requirements will be more costly;

- utilities - operational flexibility of buses means that it is not necessary to divert all public utilities buried in the road; if there is a need to repair a utility line, then buses can be diverted around the works; this cannot be done for an LRT and public utility relocation will be required for the LRT;
- width - in some countries, for LRT it is necessary to recognise the width of the "Dynamic Kinematic Envelope" (DKE) but not for buses; this may impose different geometric standards, particularly at stops;
- stops - stop lengths are likely to be different for busways and for LRT's;
- service characteristics – in general busways can provide a more frequent service than LRT's but, in an evaluation of conversion, a key matter is the type of service offered. If the busways are operated under a 'trunk and feeder' system, there will be little difference to LRT other than the frequency of the trunk service. However, if the busways are operated under a "join and leave" system, then there is significant change to passengers which would need evaluation.

3.6.13 The comparison of costs between LRT and busways is a complex issue. System-wide comparison requires identification of capital costs, operation and maintenance costs and asset replacement costs, adjusted for levels of service and capacity and for a comparable operating period (whole-life costing). As far as can be determined, there have been few balanced cost comparisons of this nature.

3.6.14 While simplistic cost comparisons can be misleading, as far as existing data show, it is evident that full costs for similar passenger carrying capacity favour busway transit against LRT. For example:

- A study of alternative modes, utilising an old rail right-of-way, in San Jose (Costa Rica) showed the cost ratio of 6:1 in favour of busway transit (ICF-Kaiser, 1996)

- The most recently available implementation costs for a busway system are those for Quito. The system is 'expensive' in that it is operated by trolley buses and thus includes the costs of all the infrastructure for the supply of electric motive power. The inclusive costs for 11kms busway, 54 high capacity trolley buses, traffic signals, ticketing system, passenger facilities etc totalled US$57.6m or US$5 m per kilometre (IADB, 1997). If high quality diesel or CNG buses had been used (this is not to question the selection of electric trolley buses by Quito , which is affected by many factors), the cost would have reduced by some 50%.

3.6.15 ***Future Role for LRT -*** The factors which are essential for busway development are even more necessary for LRT development. These concern the probable need to fundamentally reorganise the bus sector, effective city institutions, traffic/transport planning ability and the availability of the right-of-way, which for LRT must be continuous.

3.6.16 In *developed* cities LRT is the mode in which the greatest aspirations for an expanding role for public transport are invested (ETP, 2000). There, however, demand is not high – typically up to 5,000 pphpd, and the role of LRT is to be the centre-piece of a package of measures designed to create liveable 'cities, by providing the acceptable alternative to the car. Sometimes there is also the advantage of extensive existing LRT infrastructure, which may be upgraded cost-effectively.

3.6.17 In some *developing* cities, there may be similar policies, to attract car users and/or to reducing pollution and improve the urban environment. This has been considered in some Brazilian cities. In the right circumstances, LRT may fulfil this role. However, the planning and implementation of the sophisticated package of policies designed to create balance between the modes is more problematic in developing cities, and the evidence is that even metros have (relative to developed cities) limited effect in attracting car users and hence on congestion, at least in the short-term

3.6.18 In other situations, particularly where the requirement is to carry high traffic demands at an acceptable level of service, LRT is unlikely to provide an effective option, as its passenger-carrying capacity is likely to be significantly less than a busway, and its service level is not appreciably better. Demand is often high – in the range 10-20,000 pphpd down the biggest corridors of major cities.

3.7 ***Metros***

3.7.1 ***Technology*** – metro technology is in widespread operation throughout the world. Technological development is continuous, but from the viewpoint of this study the important conclusion is that, with one exception, all deliver a broadly similar service at a known cost. The technology comprises railcars operating under signalling on fully segregated rights-of-way. The interesting exception is fully-automated transit, as recently installed for the Kuala Lumpur PUTRA system, and otherwise operated mainly in Canada, UK (Dockland DLR) and France (VAL). This offers smaller driverless trains operating higher service levels, with the ability to recover from system perturbations quickly. These systems are however, as we subsequently conclude, unlikely to have broad application in developing cities. For most developing cities, there is effectively a single performance delivered by metro technology.

3.7.2 ***Operations*** – metros typically operate at up to 2 minute headways (under heavy loads, averaged over the peak hour[6]) and have carrying capacities of 60,000 passengers per hour per direction (pphpd). Capacity depends upon the requirement in terms of traffic forecast and system configuration. Thus the Hong Kong MTR was carrying over 80,000 pphpd down the Nathan Road corridor for a considerable period at the upper extreme, while many metro systems have much lower design capacities in the range 30-40,000 pphpd.

3.7.3 Operating speed is critically important to the passenger, and depends primarily upon the number of stations. The 1990 research recorded end-to-end speeds on all metros studied and developed a simple relationship, which related speed to station spacing, as follows. Developments during the 1990's may have slightly increased speeds, due to better acceleration/deceleration characteristics, but this may still be used as a rule-of-thumb:

$$V = 28 + (S-800)/50$$

where V is the operating speed in kph, and S the average distance between stations in metres

3.7.4 Comfort levels on metros vary considerably. The nature of mass transit is always that large numbers of people are carried at peak times, and overcrowding is the norm. But planners do plan for very different comfort levels. Thus Singapore plans for relative comfort, in attracting passengers who have other travel options, while Mexico City or Sao Paulo have always carried passengers at crush capacity. The other major factors influencing comfort are air-conditioning/heating where the climate is inclement, and the existence of escalators at stations. There is increasing standardisation on air-conditioning for metros, and (with the perverse exception of

[6] The Moscow metro alone achieves average headways of 90 seconds

some so-called BOT projects) escalators for metros where vertical distances are large and passenger volumes high.

3.7.5 Tariffs and ticketing equipment vary. Tariffs vary hugely, and depend upon the metro's target market and government's social policies. There is increasing standardisation on automated ticketing equipment which allows differential fares to be charged, and provides valuable information for marketing. Increasingly smart card technology is being applied, which is expected to facilitate integration with buses, and reduce fraud.

3.7.6 ***Capital Cost*** - the 1990 research analysed all the cost data secured from case study cities together with other data available. It concluded that the dominant factor influencing cost was vertical alignment. It estimated the all-in capital cost of metros as follows (**Table 3.1**).

TABLE 3.1 METRO COSTS FROM 1990 RESEARCH

Vertical Alignment	All-in Cost US$mn per route-km (1987 prices)	Ratio
At-grade	8-27	1
Elevated	22-60	2.5
Underground	50-165	6

3.7.7 The cost depends upon many factors, and we comment on these as follows, updating previous comments. The major change is the recognition that cost depends critically upon effective organisation and management, and whether the work is the progressive extension of an existing system, as opposed to a new system (**Table 3.2**).

TABLE 3.2 FACTORS INFLUENCING METRO CAPITAL COSTS

	Factor	Impact upon Cost
	Organisation and Management	
1	Quality of management/organisation	Dominant
	Physical Factors	
2	New system, or progressive expansion of existing system	Dominant
3	Ground conditions (underground construction, and foundations for elevated viaducts)	Very large
4	Urban constraints and topography (utilities diversions, proximity to buildings, ability to divert traffic, environmental constraints, earthquake protection)	Large
5	System features (long trains, stations as civil defence shelters, AC requirements, special access etc)	Small-moderate
6	Design and safety requirements	Large
	Financial Factors	
7	Financing costs (during construction, influenced by availability of soft loans, and forex movements)	Very large
8	Land costs	Moderate
9	Competition in the equipment supply and construction market	Moderate
10	Labour costs	Small-moderate
11	Taxes and duties	Small
12	Freight costs	Small

3.7.8 By and large the costs quoted in 1987 US$ have remained valid. The changes in relative inflation between domestic and supplier countries have been offset by the depreciation of their currencies against the US$.

3.7.9 Outturn metro costs have been analysed over the intervening decade. In particular the expectation/hope that BOT projects would reduce costs was examined closely. The consultants concluded (Allport et al, 1998) that the all-in cost of metros in Asia today was as follows (**Table 3.3**).

TABLE 3.3 METRO COSTS IN ASIA

Vertical Alignment	All-in Cost US$mn per route-km (1998 prices)	Ratio
At-grade	30	1
Elevated	75	2.5
Underground	180	6

3.7.10 Recently, the International Tunnelling Association (ITA, 2000) carried out an investigation of the balance of advantage of underground and aboveground construction for metro systems. This was a major survey of all ITA member countries, which resulted in 28 responses from 18 countries in 4 continents. These were mostly in developed cities in Europe and Japan, but they included 6 developing cities.

3.7.11 The conclusions regarding capital costs are as follows. Removing the outliers which are clearly misleading, the costs excluding rolling stock are: (**Table 3.4**):

TABLE 3.4 ITA METRO COSTS

Vertical Alignment	Cost US$mn per route-km (Jan 1995 prices)	Ratio
At-grade	20	1
Elevated	40	2
Underground	85	4.5

Note: excludes rolling stock

3.7.12 However, these costs should not be taken at face value. It is likely that at least many of the questionnaire responses are not 'all-in' costs, including all the costs of metro development (from project development, land acquisition/compensation, relocation of utilities, supporting public infrastructure, design, civil works, equipment supply, consultants and project management, financing etc).

3.7.13 There is evidence for these mainly developed cities that increasing land costs and the mitigation measures for environmental impacts is narrowing the gap between underground and aboveground construction, and that the 'rule-of-thumb' ratios between at-grade: elevated: underground construction should be revised from the conventional 1:3:6 to 1:2:4.5

3.7.14 Evidence from other sources, notably in respect to Madrid and Mexico City, suggests that the all-in costs of underground construction can be markedly lower than the figures quoted above. In Madrid, 37.5 km of tunnelled extensions to the existing 11-line network between 1995-99 cost an average US$40mn/km. It is clear that these progressive extensions to the existing system were planned and executed with great competence, drawing on the considerable body of knowledge existing in the authorities. Mexico City costs averaged $73/mn for the initial Lines 1-3, but had reduced to $53mn/km for the last two Lines 8 and A (Henry, 1996). Here too there was a continuous programme of construction. These examples reinforce the importance of good planning and management and the economies from planned extensions to existing lines, when compared to the high set-up fixed costs of new-build systems. Station designs are critical to overall costs.

3.7.15 The conclusion that should be drawn in respect to developing cities is that:

- Metro costs can vary substantially, for reasons that are understood
- For new build systems, the following rule-of-thumb costs should be assumed:

TABLE 3.5 TYPICAL COSTS FOR NEW-BUILD METROS

Vertical Alignment	All-in Cost US$mn per route-km (2000 prices)	Ratio
At-grade	15-30	1
Elevated	30-75	2-2.5
Underground	60-180	4-6

- For programmed extensions to existing systems, considerable cost reductions may be possible

3.7.16 ***Operating Costs*** – metro operating costs are high, much higher than sometimes appreciated. This is not because of their operational requirements, but their substantial maintenance requirements, and to some extent their administrative needs. Many metros have thousands of staff on their payroll, undertaking essential functions. The conclusion that should be drawn in respect to operating costs is:

- That operating costs are necessarily large, because of the necessary functions which need to be undertaken

- That they are substantially under the control of the operators, and that they vary substantially. There is considerable potential to control costs, but this requires experienced operating as well as commercial expertise

3.7.17 ***Farebox Ratio*** - The 1990 research compared operating costs (excluding depreciation) with farebox revenues. Of 10 systems for which accurate information was available:

- 5 systems had a farebox ratio <1.0. In other words they needed an annual subsidy to operate (Cairo, Mexico City, Porto Alegre, Rio de Janeiro, Sao Paulo)

- 2 had a ratio in the range 1.0 to 1.5 (Pusan, Seoul)
- 3 had a ratio above 1.5 (Santiago - 1.6, Manila – 1.8, Hong Kong MTR 2.2)

3.7.18 The farebox ratio is strongly influenced by tariff policy. Since 1990, the mainly Latin American metros with low farebox ratios have improved, by raising their tariffs. The farebox ratios for other metro systems have changed little. Many metros have sought to improve their operating efficiency, using the results of benchmarking studies (such as the COMET exercise led by Imperial College London). Many expected/hoped that the private sector would set new financial benchmarks with BOT projects, but as section 10 concludes there is to date little evidence of this. Our conclusion is that, based upon the evidence, there is no evidence that the private sector will transform the best farebox ratios achieved by public sector operators

3.8 Suburban Rail

3.8.1 In many cities suburban rail services are an important, or vital component of the overall transport system. Bombay carries more than 1.8bn passengers/yr (5-6mn per day). Sao Paulo, Buenos Aires and Seoul carry 300-450mn per year while Rio de Janeiro, Johannesburg and Madras carry substantial numbers. However, many big cities have suburban operations and/or rights of way, which do not fulfil their potential role in overall transport terms.

3.8.2 *Institutions* - Experience suggests that there are several essential prerequisites to maximising the potential of suburban railway systems. In particular, suburban rail operations that are to contribute effectively to urban transport requirements are likely to require an institution which is separate from the national railway system, whose geographical coverage is broadly co-terminous with the main commuter catchment area, and which has some financial independence. This may involve corporatisation or, usually better, concessioning the railway to the private sector; this is considered in section 10 below. Railways are often reluctant in practice to give up their suburban operations, yet without this, apparently 'obvious' physical opportunities which should be attractive for rail operations cannot be effectively exploited. China is an example of a railway system that may be unlikely to be able to exploit the opportunities for suburban rail, unless China Railways restructures.

3.8.3 For suburban rail to fulfil its potential, it requires to be integrated fully into the public transport system, with buses increasing its catchment area, possibly via feeder busways.

3.8.4 *Right-of-way* - Suburban rail services usually share the right-of-way with other (long-distance passenger or freight) services, and operate at-grade through the middle of major cities. Sometimes the alignments do not serve the existing city centre, which makes their exploitation problematic – examples are Manila, Nairobi and Jakarta. Otherwise, effective operations require a secure right-of-way and secure level-crossings at road junctions; without these operating speeds are low. And attractive services require frequencies to carry the potential traffic. Common problems encountered in creating effective operations are:

- A right-of-way encumbered by squatters or other activities
- Level crossings which are open and not secure
- Capacity problems, created by the conflicting demands of road traffic and rail services, constraining peak frequencies
- Non-standard track gauges (e.g. metre or broad gauge), which constrains rolling stock and in some cases capacity

3.8.5 These can be difficult problems. The right-of-way issues require political leadership and are then soluble. The location of the railway is fixed, and is not readily diverted, other than by changing station locations. Grade separation can be a major problem, particularly in cities which are flat. Railways are constrained in their vertical gradients (to about 2.5%), and the creation of a large number of road flyovers can be problematic. Capacity can be increased at peak times by rescheduling non-essential rail services, by segregating suburban services onto dedicated tracks, by electrification, and by the introduction of double-deck coaches (reducing costs but increasing station dwell-times). Track gauge is not normally the problem it seems.

3.8.6 *Operational performance* - When the problems are overcome, suburban rail typically operates at high operating speeds, because the distances between stations are substantial. Thus speeds of 50kph with average distances between stations of say 3 kilometres are not uncommon. When trains are large (long and wide) and when frequencies are high, capacities are high, typically 30,000 pphpd or more (Bombay's trains unload 3-4,000 passengers at peak hours, albeit in very crushed travelling conditions).

3.9 *MRT Incremental Development*

3.9.1 With such a large disparity in cost, performance and impact between the MRT options, it would seem natural that MRT systems should be developed *incrementally*. The objective should be to establish a primary rapid transit network at the earliest opportunity, and progressively upgrade and extend this as conditions and affordability/ institutional capacity allow. By far the majority of passengers travelling down the main corridors of developing cities are riding buses, not cars, and introducing bus priorities early down the centre of these corridors would secure them for public transport, while also protecting them for future upgrading.

3.9.2 ***Busway upgrading*** - There are several opportunities to upgrade busways:

- Operationally, to increase output. - in the past, there have been impressive examples of operational control by grouping buses into 'platoons' at the commencement of a critical section of busway. Platoon of 4 – 6 buses have then been operated as a single unit (Sao Paulo and Porto Alegre). However, problems were encountered sustaining the arrangements. But if busways were provided with a similar management organisation to an LRT (a busway management authority as it is believed is being considered in Bogota), these types of problems might be overcome. The prospects for concessioning busways (Sao Paulo) may offer such opportunities for improved management;

- Capacity – increases can be achieved by changes to bus size and bus frequency, stop design and investment to overcome bottlenecks. There are few examples of grade separation e.g. bus-only overpasses (or parts of overpasses) in Paris (Val de Marne busway)and Montpellier (France). Provided the economics are sound and passenger accessibility needs served, more could be done with infrastructure for buses.
- There are possibilities for advanced traffic management (the 'traffic metering-traffic queue control–queue by-pass for buses' technique described above) where the right-of-way is constrained..
- Environmentally, buses on busways can be upgraded, to remove the criticism that they degrade the corridor. This may defer the need for conversion to a rail system
- To LRT or metros. The argument for conversion to LRT is likely to be environmentally driven, as noted above, while that for a metro (also) capacity-driven. The Central Busway in Seattle is to be converted to LRT in 2004. In developing cities, only in Belo Horizante are we aware of a heavily-used busway being upgraded to a metro; while Salvador, Brazil has advanced plans to convert a heavily used busway to a BOT metro. There was a major attempt in Karachi to develop partially grade-separated busways, convertible to LRT, but this came to nothing

3.9.3 There are also opportunities for busways to feed rail MRT systems. There are many examples of buses serving metro stations (Moscow, Mexico City, etc), but no known examples of busways serving other modes in developing cities. There is no reason why this should not be done; for example the outer sections of a metro line may not be viable and a lower cost busway could act as a feeder to the more heavily used section of the metro. This arrangement has been used in Miami, and is being considered in Manila.

3.9.4 ***LRT and grade-separation –*** It is not unusual in Europe for LRT systems to be upgraded, by undergrounding them to penetrate the city centre, and provide cross-city links, creating a 'pre-metro'. One of the merits of LRT is that, unlike metros, it is capable of climbing considerable gradients, keeping transition distances low (6% is common, with higher grades requiring specifically powered cars). In cities where the structure width is in scale with the corridor, and/or where visual intrusion is not a critical issue, then transition to elevated systems will be much cheaper. These possibilities have to date not been exploited in developing cities, but there is no technical reason why they should not be.

3.9.5 ***Suburban Rail Upgrading*** – City centre penetration and capacity constraints at terminals can be increased through running in tunnels beneath the city centre and/or by multi-decking. Cairo metro Line 1 was developed by linking and upgrading two suburban rail lines through the city centre, and in Seoul the suburban rail and metro services are closely integrated.

3.9.6 The perhaps surprising conclusion of this review is that many or most cities have not yet managed to establish the segregated centre-piece of a primary MRT system and that there are as yet few examples of the incremental development of an MRT systems.

3.10 *Technological Change*

3.10.1 Looking to the future, we have examined whether there are technological developments which are likely to materially reduce costs, create new products/ services to attract additional passengers, or increase revenue yields. Technological innovations can be applied in a number of fields, including the following, and these are reviewed in turn:

- Vehicle fuels and emission standards
- Electrically-powered busways
- Guided busways
- Rail system costs
- Automated transit systems
- Ticketing technology

3.10.2 ***Vehicle fuels and emission standards*** – Of the MRT modes, fuel issues apply to busways. To address bus pollution problems, there has been a resurgence of interest in electric buses (see below). However, these are costly (in terms of vehicles and infrastructure for power transmission and distribution) and improvement in type and volume of emissions from buses with internal combustion engines has been sought. Most buses use diesel fuel and various methods have been used to reduce emissions including 'clean' (low sulphur diesel), fuel additives, catalytic converters, particulate traps, oil treatment etc and these measures allow diesel buses to meet Euro 2 and, in certain combinations, Euro 3 standards. Various other fuels have been trailed (e.g. biodiesel) but the only fuels which reduce emissions further and might replace diesel in the short term might be compressed natural gas (CNG – which has increased hydrocarbon emissions) and/or liquid petroleum gas (LPG). There are issues with either or both fuels such as increased bus weights, slow refuelling (CNG), possible safety issues (LPG), additional cost (not only for each vehicle but for the refuelling system), availability of fuel in developing cities, costs of fuel storage facilities and so on. However, at a minimum, much can be done to reduce emissions from internal combustion engines in buses and the present poor air quality in busways such as 9 de Julho (Sao Paulo) and Av Caracas (Bogota) could be greatly reduced by measures applied to diesel buses.

3.10.3 ***Electrically-Powered Busways*** – buses can be electrically powered and a range of options exist such as:

- buses with battery power
- buses with internal combustion - battery hybrid, including diesel + battery for sensitive areas, battery + motor for generation-charging and battery + internal combustion booster
- buses with internal combustion – direct electric hybrid (duobus - in which buses have alternative propulsion systems, one electric and one internal combustion)
- electric trolleybuses

3.10.4 Not all of these options are practical or financially viable alternatives at this time, particularly in developing cities and there are numerous issues involved with the various systems – cost, weight, battery durability, battery range, etc. However, two systems - trolleybuses and duobus - are practical, and operational systems are proven. It is not suggested that all busways should or could immediately convert to trolleybus or duobus, but it is noted that the zero emissions argument for rail systems is bought at a high cost and that 'near zero' emission buses are available, as demonstrated by the Quito trolleybus-based busway. If air quality is of over-riding concern, such systems should be evaluated. In the future, it seems likely that 'near zero emission' bus systems will become progressively cheaper in real terms.

3.10.5 ***Guided Busways*** – conventional busways do not need an automatic guidance system. However, for many years, there has been interest in busway systems with guidance, either physical or electronic. In a few developed cities there are guided bus systems in operation. There is some evidence that they attract car users[7] and there is a resurgence of interest in them.

3.10.6 Guided buses operate on a segregated track (busway) but do not require to be steered by the driver. The most common form of guidance is provided by mechanical means, in which small lateral guide wheels are affixed to the steering axle of the bus, and make contact with, and follow, a physical kerb along both sides of the busway track (the 'O'Bahn system). The main mechanical busway guidance systems exist in Adelaide (Australia), Essen (Germany), Leeds (UK) and others are proposed for Caen (France, an experimental system). Electronic guidance (in which buses are guided by following a buried cable using on-bus sensors and thus which requires to be operated within a busway) is experimental and the only known busway system is a demonstration project comprising a 1.5km busway in London (UK). At this stage, the system is unproven.

3.10.7 The rationale for busway guidance is:

- Limited right-of-way. Buses need not be steered manually and thus a busway width can be narrower – which may be critical in urban areas - than if manual steering is used

- Image, partly from a perception of exclusivity and partly because access is restricted to a quality bus fleet. The 'high tech' nature of guidance lifts the image of buses as a 'state of the art' mode

- Ability to dock at stops, providing a high standard of same level access, particularly of benefit for the frail, encumbered and disabled

3.10.8 Against the advantages, there are a number of other issues:

- Operational flexibility – buses are unable to overtake in the event of incidents, or breakdown; mechanical guidance requires all buses in the fleet to be equipped, the operational flexibility of re-deploying buses from one route to another is lost; and recovery of broken down buses from guideways is problematic

[7] The Adelaide system, a completely separate segregated alignment, is reported to have attracted 40+% of riders from cars

- Build quality – the guidance depends upon a high quality and stable track and guidewall; this may be difficult to achieve in a developing city environment

- Maintenance - the guideway requires high levels of maintenance

- Right-of-way - the width savings are small over conventional busways – perhaps 0.5m-0.75m. Even then, as the guidance kerbs have to be particularly stable, the structural width can be greater than with a conventional busway

- Severance - the guidance kerbs can be a hazard to passengers-pedestrians crossing the busway

3.10.9 ***Rail System Costs*** - Overall a gradual reduction in cost is probable resulting from industrial consolidation and manufacturing innovation, securing scale economies in what is already a competitive market, and outsourcing. Vehicle maintenance costs should fall too, and lighter weights should reduce traction costs. But these could be partly offset by reduced government soft loans, constrained by world trading rules.

3.10.10 ***Automated Transit Systems*** - We have referred to the probably limited potential for automated metro systems in developing cities, in view of their cost, the limited number of suppliers and the problems of securing competitive procurement, and the need for maintenance of their high-tech systems. We have not considered people-mover systems (GRT, PRT and monorails) in view of their relatively low capacity.

3.10.11 ***Ticketing Technology*** - Considerable innovation and application of ticketing technology is already taking place. Technology can be applied to ticketing systems to:

- automate ticket issue, increasing customer convenience and reducing the operations labour requirement
- automate ticket checking, enhancing revenue protection and reducing the operations labour requirement
- increase the range and flexibility of fares that can be charged (increasing appeal to travellers and helping extract the high level of consumer surplus that can accrue to some travellers on a flat fare system), and
- provide sophisticated marketing information, which can be used to fine-tune tariffs, increasing revenue.

3.10.12 Adding smart-card technology to stored-value tickets allows the value of the cards to be topped up by the traveller. These tickets can then be used to pay for the services of more than one provider without the need for complex revenue attribution systems. For example, the Hong Kong cards can be used on the MTR, LRT, KCRC suburban rail, ferries and some buses.

3.10.13 The more high-tech systems now comprise contactless smart-card tickets (e.g. Hong Kong MTR's Octopus) which do not need to be passed through a ticket reader in a station turnstile, but are merely passed over a sensor. With this technology, use of the cards can be extended to payment for other goods and services which only need a touch sensor installed, not a turnstile, e.g. buses and automatic vending machines.

3.10.14 The impact of this technology is likely to be the following:

- It will assist create integrated systems, by providing a basis for revenue allocation between operators.

- It will increase revenues, by increasing customer convenience, increasing ticket price flexibility (reducing consumer surplus), and through reduced ticketless travel and fraud

- Its impact on overall life-time costs is likely to be strongly positive, with high levels of reliability for the equipment, and a reduced need for ticket issue and checking personnel

3.10.15 These technologies can be retro-fitted to existing operations. Many developing city systems have adopted automatic issue of single and some bulk tickets, but retain manual inspection (e.g. KTM and STAR in KL). Full application of the technology requires a significant investment in ticket verification turnstiles as well as vending machines, control systems and a skilled workforce to operate and maintain the system. It may therefore only be appropriate for larger systems, in cities where all public transport is under a single organisation, or where a number of operators have a mutual interest in an integrated ticketing system.

3.10.16 The main advantages to the traveller come from more convenient ticket purchase, but these are only really apparent to passengers making bulk purchases (multi-trip, time period or stored value tickets), i.e. to the more affluent travellers who can afford to spend quite large sums of money (typically US$10-20) on advance purchase of travel permits. These advantages will not be apparent to the poor, who do not have the spare funds for advance purchase, the occasional user, or many concessionary users, who would still need to verify their entitlement to the concession fare.

3.10.17 ***Summary*** – Our overall view is that the technological changes which are likely to have a material impact on MRT over the years ahead arise in two areas. The first is the introduction of 'clean' buses, and maybe electrically-powered buses in situations where pollution/ environmental issues are critical. These are likely to improve health, particularly for the poor and contribute to the growing acceptability of busways. The second is in ticketing, where – in certain conditions, and for many travellers, the impacts are likely to be strongly positive.

4 MRT Role

4.1 *MRT and City Sustainability*

4.1.1 MRT policy and city sustainability are inextricably linked. The effectiveness with which MRT policy is implemented, and the parallel complementary measures which are implemented, will substantially influence the city's future. For a rapidly growing city MRT decisions will arguably be of great strategic importance, and not only are sound decisions required, but they are required at broadly the right time. When this is done, then congestion may be controllable and with this wide-ranging benefits can follow, but this is something that few cities have achieved. At a less ambitious level, MRT can allow the city centre to grow and avoid the worst excesses of a car-dependent low-density suburban sprawl. This policy allows the city to 'live with congestion', while mitigating some of its worse effects. Many large developing cities are seeking to follow this strategy. But when circumstances are adverse and/or decision-making is poor then MRT policy has a lesser strategic role, namely to make the best of a difficult situation, making worthwhile investments, but failing to achieve the benefits of policy synergy which otherwise may be possible.

Core Issue

4.1.2 The core question for decision-makers in developing cities is usually how to balance the sometimes conflicting objectives of poverty alleviation (which implies a low tariff/quality MRT system) and controlling congestion with its associated pollution and safety costs (which implies a higher tariff/quality MRT system), within the means of government budgets.

4.1.3 There are two broad scenarios:

- MRT is a bus replacement, charges low tariffs, and has few 'competing' bus services. This is the model of Sao Paulo and Mexico City metros and the Tunis LRT. In Sao Paulo it has proved possible (with considerable difficulty) to integrate bus and metro tariffs, so that through journeys are affordable to the poor. In the latter two cities, strong measures have been taken to prevent bus services competing.

- MRT provides a premium quality service at a premium fare, compared with the buses. This segments the travel market, and results in 'competing' bus services, which are used by lower income travellers. The tariff is determined by the competing bus services, but is designed to attract all premium bus passengers (who formerly used premium express/air-conditioned/ guaranteed seating buses) together with a large number of lower middle-income bus passengers. Only then is the metro likely to attract the mass ridership which its high cost requires.

4.2 *MRT System Objectives*

4.2.1 What do we know about the reasons MRT systems are developed, and the performance achieved?

Developing Cities

4.2.2 We are not aware of such questions having been asked in connection with busway systems, but can probably assume it is a combination of improving the quality of transport, and increasing public transport capacity. The evidence appears clear that well-developed busways do achieve these objectives

4.2.3 Turning to rail systems, the 1990 metro research established the main reasons (HF/TRRL, 1990) in declining importance, as follows:

1) To improve the quality of public transport
2) To relieve traffic congestion
3) To increase public transport capacity
4) To promote land use policy

There were other less important reasons: to promote land use policy, bring prestige, protect the environment, develop a rail industry, and conserve energy

4.2.4 The research confirmed the impact of metros in terms of these expectations:

- Metros did indeed improve both 1) the quality and 3) quantity of public transport, often dramatically. Moreover the improvement in quality extended to some small degree to those who did not use the metro – their bus journeys were somewhat faster, and less over-crowded.

- The impact upon 2) congestion is less clear. Initially there was obvious relief, but after a short period, congestion re-established itself, not quite as bad as before – because the metro provided an alternative that at the margin passengers could turn to, but nevertheless still severe. The impact of metros on car ownership and use in the longer term is more conjectural. It seems most likely that, providing the metro system is developed into a substantial network, and especially when restraint measures on the private car are also introduced – which it may make more acceptable, then there will be such a long-term impact, and this could be of strategic importance

- The 1990 research demonstrated that experience of metros promoting land use policies was mixed. When government was effective in controlling land uses, and in particular when it was a major provider of housing, then indeed the metro could fundamentally change city structure and land use. Hong Kong and Singapore are much quoted in this respect. But when these conditions do not apply – which was the case in most developing cities – then metros were less effective and had impacts which differed from expectations. Their main effect was to facilitate growth of the city centre, when the dynamic for growth existed there. Often expected developments at and near stations did not occur, and when the metro was been used to guide city development (the Porto Alegre suburban rail system) a 'white-elephant' metro project resulted.

Developed Cities

4.2.5 The experience of developed cities is relevant in that it provides insights and approaches, which are relevant to developing cities. The main focus of attention in developed cities is the contribution of MRT in developing a balanced overall transport strategy. The extent to which this strategy has been achieved naturally differs markedly, but it is an emerging common approach. It typically has the following components:

- A rail transit system at its core, usually LRT although there is sometimes interest in bus MRT
- This provides public transport which is widely accessible to the encumbered, frail and disabled. Sometimes there are concessionary fares for classes of users to provide for their accessibility

- In the city centre, MRT is used as a catalyst to reorder the use of roadspace, introduce pedestrianisation, improve urban design etc. LRT is seen as particularly appropriate to this task and bus systems more problematic
- Restraints on the private car are provided, through pricing and/or physical controls on provision
- Increasingly priority cycle routes and facilities are provided to encourage the use of bicycles
- Some research has been carried to understand the reasons the underlying reasons why rail systems are supported, by decision-makers and users. This is reported in section 7 of the report (ETP, 2000).

4.3 ***MRT and City Competitiveness***

4.3.1 Increasingly city fathers recognise the need for their city to compete in the global marketplace, and MRT is seen to be part of the 'package' to attract inward investment. How valid is this argument? There are no conclusive evidence, but the following highlights the issues.

4.3.2 Research in London (Richard Ellis, 1992) sought to establish the factors that contributed to London's perception as a World City. Extensive interviews were undertaken with key decision-makers in world headquarters of major multi-nationals, and senior executives in London-based organisations. The conclusion was that a wide range of factors were considered to be important attributes of a World City, the most critical focusing on:

- *Wealth creation*, through recognition as a commercial and financial centre
- *Enabling infrastructure*, through being a central hub of efficient national and international transport networks and having state-of-the-art telecommunications facilities

4.3.3 The next most critical factors also focus in these areas, together with one other:

- *Wealth creation*, through the support of a strong national economy and access to a large market
- *Enabling infrastructure*, through good mobility in the city
- *Political status*, as a major player on the world stage

4.3.4 If this taken as a guide to the relative importance of different factors in establishing a city's international competitiveness, then urban transport is a factor, maybe not of primary importance but a factor. More to the point, it is one that government may be in a position to do something about. Taking the example of London 'poor mobility within the city' and 'the absence of integrated and forward-looking city-wide policies' were two of 4 identified weaknesses.

4.3.5 Of course the question then needs to be asked how important the MRT options might be in improving city-wide mobility, and here there is no reported evidence. Our judgement is that a rail system is likely to be critical, in terms of guaranteeing reliability, allowing more face-to-face meetings than otherwise and being acceptable.

4.4 Conclusions

4.4.1 MRT policy in developing cities confronts strategic choices of far-reaching importance. It usually faces an inescapable tension between the conflicting requirements to alleviate poverty and control traffic congestion and its economic and social costs. All MRT systems have multiple impacts on the poor and the environment, and the project selection and development process needs to identify and forecast these impacts, and seek to mitigate the adverse impacts of the chosen system.

4.4.2 The following issues should be addressed as part of this analysis:

- The ability to target the poor effectively in other ways
- The geographical location of low-income and higher-income households (this affects the ability to target MRT initiatives geographically)
- The characteristics of existing public transport supply and performance, and the feasibility of upgrading this through regulatory reform and introducing busway MRT
- The feasibility of integrating rail systems with the public transport network effectively
- The feasibility of developing complementary measures as a package (requiring relatively sophisticated government institutions
- The feasibility of integrating development with the MRT system (this is likely to require similar capacity)
- The scale of funding realistically available from the government budget

5 Research Results

5.1 *Available Research*

5.1.1 This section reviews the main results of previous research, before identifying the key sector issues. There has been little substantive research in the field since the earlier studies, referenced above. The World Bank have investigated the appropriate framework for decision-making for the costliest and riskiest of the options – metros (in Mitric, 1997). The need for the subject to be investigated within a broad urban and transport strategy framework is recognised. The French Government has funded some research into specific projects. In 1998 the Consultants published the conclusions from a worldwide review of private sector participation in the metro/LRT sector (Allport et al, 1998). This sought to understand whether the conclusions reached in respect to the earlier public sector projects was materially changed by the private sector procurement approach.

5.1.2 Throughout the last decade there has been substantial MRT activity, some of which appears to show new insights into the subject, opening up new opportunities. In developing and developed cities private sector involvement through BOT projects and concessioning has been extensive, with mixed results. Meanwhile there has been surprisingly little implementation of lower cost alternatives, or the (seemingly obvious) development of an incremental approach to MRT strategy.

5.2 *TRRL/HF Metro Study*

5.2.1 The aforementioned study (Allport et al, 1990) carried out case studies in twenty-one developing cities. These sought to establish the motivations behind metro development, and to establish by observation and analysis the extent to which the implemented projects met expectations.

5.2.2 The results are summarised in **Table 5.1.** The incontrovertible conclusion, summarised in **Table 5.2,** is that people's expectations of metros and their reality were usually very different. The main conclusions are considerd as follows:

reached were:

i) Nearly all systems were well operated, and gave good service to passengers. They were popular with passengers, and were often supported even by those who rarely used them. They were respected too - passengers behaved sometimes particularly well.

ii) **Metro Costs -** metros are hugely costly, often the costliest decision a city will ever take. A 15 kilometre line typically cost

- US$ $^1/_3$ bn if at-grade
- US$ $^2/_3$ bn if elevated
- US$ 2 bn if underground

The biggest factor determining cost is the vertical alignment. At-grade construction is rarely possible in developing cities, but underground construction is 2-2.5 times more costly than elevated construction. By contrast, technology does not have a major impact upon cost within limits.

iii) **Forecasts of Costs and Construction Time -** the forecasts of all costs and construction times were surprisingly poor - 75% of metros had cost and time overruns, often large. Moreover, operating costs were above expectations in all cases, often by orders of magnitude.

TABLE 5.1 - RESULTS OF THE 1990 METRO STUDY

PARAMETER	CRITERIA	PERFORMANCE
Case Studies Cities	21 in total, 13 with metro	
Cost	**Alignment** at-grade elevated underground	**US$mn/route-kilometre** 8 – 27 2 – 60 50 – 165
Capital Cost	**Compared with Forecast** much lower -10% to +10% +10+ to +50% +50% to +500%	**No. Cities** None 3 4 6
Construction Time	**Compared with Forecast** much better as forecast up to +50% +50% to +500%	**No. Cities** None 3 6 4
Operations And Operating Costs	**Compared with forecasts**	• Operations are almost always good • Costs always much worse, or much worse than forecasts
Improvement in Public Transport		Yes, bus passengers benefiting too
Metro Passengers	**Compared with Forecast** much better as forecast up to –50% -50% to –90%	**No. Cities** none 1 3 5
Traffic Congestion		Small reduction, but did not ‘solve congestion’
Environmental Impact		• Often major construction problems • Impact of elevated structures depends upon design
Land Use and City Structure		see text

PARAMETER	CRITERIA	PERFORMANCE
Finances – Farebox Ratio (Fares revenue/ direct operating costs)	**Farebox Ratio:** less than 1.0 1.0 to 1.5 1.5 to 2.0 greater than 2.0	**No. Cities** 5 2 2 1
Economic Rate of Return (against Do Minimum):	**EIRR** less than 8% 8% to 12% 12% to 16 % 16% to 21%	**No. Cities** 2 5 3 3

TABLE 5.2 METRO EXPECTATIONS AND REALITY

Expectation	Reality
Cost will be high	Cost is very high
Metro will improve the quality and quantity of public transport	Yes, they do both
Traffic congestion will be 'solved'	• Initial relief, then not so. It marginally reduces congestion • Longer-term impact on car ownership/use may be important
Metros will promote land use policy	Only with effective land use management (which is rare)
Metros are financially viable[8]	This is not so

[8] defined as previously: with mainly farebox revenues funding all the costs – development costs, land, civl works and equipment, operating, asset replacement, and providing an acceptable return to shareholders if appropraite

iv) **Improvement to Public Transport -** The speed, reliability and comfort of the metro have undoubtedly transformed the image of public transport and the quality of life and business efficiency for travellers. Journeys can be made much more quickly than on buses - and with great reliability: thus in Hong Kong 4/5 face-to-face meetings can be scheduled during the working day, but only 2/3 in Bangkok or Jakarta. Little surprise that metros are uniformly popular with the populace and business community.

On the busiest lines trains do get overcrowded during the peaks, so do the buses; but the loadings have to rise above 40-50,000 pphpd before conditions necessarily become objectionable - figures much beyond the capacity of any bus system. The quantum increase in public transport capacity is self-evident in every metro corridor. The passenger carrying capacity of the corridor typically increases by a factor of 3-4.

Bus passengers usually benefit from a metro too. It is the usual experience that following the introduction of a metro, bus overcrowding reduces and bus operators may be stimulated (by the 'competition') to provide greater variety and quality of service.

v) **Metro Passengers -** varied widely, between 1 million passengers per year per route kilometre in Porto Alegre, to 17 million in Sao Paulo (the equivalent figures for London, New York and Moscow being 2.2, 3.1 and 12.5 million respectively). Peak hour flows varied between a typical 20,000 passengers per hour per direction (pphpd) to more than 80,000 pphpd down Hong Kong's Nathan Road Corridor. Without exception the 'successful' metro lines were radial to the city centre -and lines which were tangential/orbital carried much lower passenger numbers.

Information on modal impact is patchy. The available evidence suggests that typically 95%+ of metro passengers were former bus passengers, or generated trips[9]. In developing cities, metros appear to have little impact upon car use

Forecasts of traffic were almost always optimistic, and often very optimistic. In no case was the forecast an underestimate. The reason for this stems largely from over-optimism in the planning phase. Integration has often not been

[9] although one-quarter of users on the Kuala Lumpur STAR system are former car users, a figure similar to many developed cities

achieved on the scale expected, passengers have not been forced to use the metro as the planners intended, car occupants have not switched to the metro in the numbers expected, there has not been the growth in population or incomes that was predicted, and sometimes the metro alignment was poor, reducing its catchment area.

i) **Traffic Congestion -** Had the metro helped to reduce traffic congestion? This was difficult to investigate. In a few instances a noticeable improvement in traffic conditions had been reported immediately after the metro opened, but the effect had been short-lived. None of the cities offered any evidence of a long-term reduction in traffic congestion.

It seems probable that the roadspace released after the metro opens is quickly taken up. The reason is that although there is a large switch of passengers from bus to metro, the number of buses does not decrease in proportion (bus overcrowding reduces), while very few car trips are diverted to the metro. Most of the roadspace that is released is taken up by generated traffic - particularly car traffic in the short-term.

Thereafter the metro allows public transport demand in the corridor to continue to grow (where previously it could not), and after a period of time the number of bus passengers may be back to the pre-metro figure - in addition to the large number of new metro passengers.

The longer-term impacts on car ownership and use are little known, but could be important. The implementation of complementary measures, part of a comprehensive strategy including car restraint policies are likely to be important in this respect.

vii) **Environmental Impact -** During construction the impact of the construction process could be severe - in terms of road closures/traffic diversions, dust, noise and vibration. Once constructed, elevated structures had a major impact upon the urban environment for all time - for better or worse. This was partly a matter for design, and partly a matter of subjective judgement. Where the corridor was wide, and fronted by high-rise development, it was arguable that a metro enhanced the urban environment (as well giving passengers a welcome view), but in other locations the impact was obviously adverse.

When operational, because the impact of the metro on congestion was very small, then so were the apparent savings in energy and air pollution. However, in the long-term the impact of the metro is likely to increase urban densities, reduce urban sprawl, and reduce reliance on the car. The environmental benefits arising from these changes in the long-term could be substantial.

viii) **Land Use and City Structure -** A city with a metro will likely follow a different development path from a city with no metro - but this may not immediately be apparent from observation.

The cities in which metros were studied included many of the great world cities, whose centres are the focus of economic activity at national and regional levels. Efficient public transport is essential (not just desirable) to the continuing growth of their central areas. All the evidence is that bus systems, however organised, have a practical capacity (of about 20,000 pphpd), which when reached on the main radial corridors frustrates the continuing growth of the centre. At this time there are two possible scenarios: either this natural growth of the centre is forced to other less attractive locations, or a metro is built which overcomes the public transport bottleneck. The role of the metro is permissive - it allows this dynamic growth to continue - allowing the city to continue to function with a strong city centre; but it does not create the underlying growth.

In a few cities - Hong Kong, Singapore and Sao Paulo, the city administrations practice land use/transport planning, and adopt a policy of enlarging the metro's catchment area by concentrating high-density public housing and commercial development close to metro stations. Here the impact of the development is immediately obvious. This has been achieved by a combination of public sector land ownership, housing and infrastructure provision, major development over stations and depots, and in the case of Hong Kong, particularly vigorous private sector development.

In the absence of such positive measures, which require considerable management skills, there was - contrary to expectations, little obvious sign that the metro had resulted in land use/development changes. This is less surprising than it may appear: the metro is always located in the densest part of big cities, where land ownership is both fragmented, and sometimes uncertain. Land assembly in such situations is difficult, and requires government action, but government has its hands full keeping the implementation on track

So the development impact of the metro is complex. The obvious expected high-rise developments along the alignment do not just 'happen'. They require strong government action - either because government is itself the developer (in the case of public housing), or by advance land assembly. But the metro can have a profound impact upon city structure, in allowing the continuing development of a strong city centre. Whether this is desirable - compared for example with a poly-nuclear form, is a matter of vigorous debate.

The long-term impact of a metro network is to create a more concentrated form of city structure, which contracts strongly with the geographical sprawl which characterises many developing cities.

ix) **Economic Viability -** The study developed a strategic pre-feasibility model that could give a quick assessment of the main economic characteristics of a metro project, and was validated against the database assembled from the case study cities. Three metros showed low rates of return (less than 10%), three were marginal (between 10% and 12%), and seven were quite good - and in the case of Singapore, Hong Kong MTR and Cairo (a "missing link" between two busy suburban lines), good rates of return.

The results suggest that, despite the high costs and despite all the problems and poor forecasts that had characterised most of the metro projects, the economic returns of metro projects can be quite high when the conditions are right - and indeed comparable to other sectors of public investment.

But metros can be risky investments too. The experience in most cities has demonstrated that much needs to go right to achieve a good economic performance, and one or two bad decisions can be irreversible, and undermine the project viability for all time. This highlights the importance of proceeding purposefully and with caution, and constantly learning from the experience of others.

Seventy-five per cent of the benefits were time and discomfort savings, dominantly non-working time, and savings in resource costs were not high. Also there were few foreign exchange benefits to offset borrowings. All road users benefited from the metro which, while certainly not solving traffic congestion, reduced the increase in congestion that would otherwise have occurred.

A major conclusion from the economic analysis is that typically half of the metro benefits are received by other road users - who do not pay towards the cost of the metro. It is these major external benefits generated by a metro which provides the rationale for government investment to secure them. Put another way - it is not surprising that metros are not financially viable, when they receive no income for a substantial part of the benefits they create.

x) **Financial viability -** of the 10 metros, 5 required an annual operating subsidy, and 4 produced a cash surplus on day-to-day operations - with the Pusan Metro being at break-even. Fares policy plays a major role in explaining these differences. Only the Hong Kong MTR shows the possibility of making a respectable return on the capital invested - although not one that would attract private investors; and this will only be achieved with substantial ancillary revenues - development profits will have contributed 15% to the capital cost. Seoul, Santiago and Manila all provide cash surpluses on operations that will substantially fund the large asset replacement costs - and may make some small contribution to the construction cost.

Financial Performance has rarely matched expectations: construction delays have been the norm, both capital and operating costs have exceeded estimates - often by a large margin, while patronage and revenues have generally fallen short - also often by a large margin. All the outturn results have therefore been adverse.

The unambiguous conclusion the should be drawn from these results is that no metro in the world was in 1988 financially viable on a stand-alone basis - in the sense of being attractive to the private sector, without Government incentives/ investment/ development opportunities etc - and only the Hong Kong MTR was close.

5.3 USA UMTA Study

5.3.1 Is the developing city experience markedly worse than that in the United States of America? The answer is - interestingly - not; and the evidence is clear (UMTA, 1990).

5.3.2 By 1990 the US Department of Transportation had contributed nearly US$12bn towards new urban transit projects, and this study establishes how forecasts and outturn ridership and costs compare (Table 5.3):

TABLE 5.3 KEY RESULTS OF THE USA UMTA STUDY

City/ Project	Route-Kms	Ridership/ weekday (forecast/ actual)	Operating cost/ year (forecast/actual)	Capital cost (forecast/actual)
Metros				
Washington DC	97	-28%	+202%	+156%
Atlanta	43	not known	+205%	+132%
Baltimore	12	-59%	not known	+95%
Miami	34	-85%	+42%	+31%
LRT				
Buffalo	10	-68%	+12%	+59%
Pittsburgh	17	-66%	Not known	not known
Portland	24	-54%	+45%	+28%
Sacramento	29	-71%	-10%	+17%

Source: UMTA, 1990

5.3.3 The result is by any standards poor - as bad as that for developing cities. The author notes (Pickrell, 1992) that typically 50-67% of costs and 67%+ of the cost overrun of six of the eight projects was paid for by the federal government. It may be conjectured that local cities had everything to gain by getting their projects approved (however) - because they would be a minority payer but receive all the benefits.

5.4 ***TRRL/TTC Bus Priority Systems Study***

5.4.1 A major Study (TTC/ TRRL, 1991) established the operational performance of busways in developing cities. Surveys, mostly in Brazil, demonstrated that well-designed and operated busways did produce very high outputs, routinely carry 15-20,000 passengers per hour per direction (pphpd) at average speeds of 16-22kph. These showed a massive improvement over buses caught up in traffic congestion. It is estimated that their realistic achievable performance in a developing city environment is about 20-25,000 pphpd at similar operating speeds.

5.4.2 Surprisingly, although much studied, few well-designed busways have been implemented outside South America. The problems preventing the widespread, routine development of busways are primarily institutional rather than technical - they have no natural promoters, perhaps because of their lack of image and a lack of knowledge of what is achievable, even though their effectiveness and economic worth are demonstrable. Where they have been implemented widely, in Brazil, they are sometimes seen as a step towards LRT.

5.5 ***TRRL/INRETS LRT Study***

5.5.1 The performance of a mainly at-grade LRT system, designed to perform the line-haul role along the major corridors of a developing city, is not known: because no such system was known to exist. However, a study of the operational performance of tramways/ LRT systems in developing cities (TRRL/ INRETS, 1994) concluded that a rail-based system which is not segregated from road traffic and pedestrians is not capable of carrying high volumes rapidly. This is because a single disruption rapidly affects the whole system, as the LRT cars 'bunch'.

5.6 ***Review of Private Sector BOT Projects***

5.6.1 The consultants (Allport et al, 1998) undertook case studies, which were designed to highlight the major changes taking place during the 1990's in the leading public sector systems, and as a result of private sector participation in MRT projects.

5.6.2 Table 5.4 summarises key facts about the case study cities, focusing on those 'real' projects which are either operational or under construction. The overall conclusion was that there was no evidence that the 1990's BOT 'revolution' as practised in many of Asia's developing cities pushes back the frontiers of MRT achievement. The 'hidden hand' of the private sector as then applied did not produce financially viable projects and widespread public benefits in the absence of informed and strong government and policy.

5.6.3 The 'successful' MRT systems (both public and private sector - e.g. Hong Kong, Singapore, Manchester) were characterised by:

- Extensive planning or the existence of good projects which meet clear objectives,
- Realistic government expectations supported by appropriate policies and frameworks for funding,
- Sensible fare strategies (affecting both the metro and other public transport systems),
- And usually, the implementation of supporting policies for other modes.

TABLE 5.4 MRT SYSTEMS - KEY STATISTICS

City/ Project	Description	Passengers mn/yr/ station	Cost US$mn/ route-km	Farebox Ratio (revenues/ op. costs)
PUBLIC SECTOR				
Hong Kong **MTR**	• **15.6 km Modified Initial System** • **10.5 km Tsuen Wan Extension** • **12.5 km Island Line** • **4.6 km Eastern Harbour Crossing** • 34 km Airport Railway	)) 850 (20)))	? ? 1420 (114) ? 4500 (133) -	2.2
Singapore MRT	• **MRT Phase I and II** • **Woodland Line** • North-East Sector Line	)) 330 (8)	3000 (46) ? 3000	1.5?
PRIVATE SECTOR				
Bangkok				
• Blue Line	20 km underground metro	na	?	na
• Red Line	60 km elevated metro/ expressway	na	?	na
• Green Line	24 km elevated metro	na	?	na
Manila				
• LRT Line 1	**15 km elevated 'appropriate' LRT**	400 (27)	420 (28)	1.7
• LRT Lines 1,2	50% capacity expansion of Line 1 14 km Line 2 mostly elevated metro	na na		
• MRT Line 3	17km mainly at-grade/ elevated metro	na		
Kuala Lumpur				
• STAR	**12km LRT mainly at-grade**	20 (1.5)	500 (42)	1.0-1.5
• STAR Phase 2	15km extension south/ north	na	850 (57)	
• PUTRA	29km automated transit system16km	na	2,350 (81)	
• PRT Monorail	elevated monorail	na	750 (47)	
Manchester				
• Phase 1	**31km LRT, most a former railway**	14 (0.5)	225 (7)	1.9
• Phase 2	7.5 km grade-separated LRT	na	130 (18)	
Sheffield Supertram	**29km tramway, part grade-separated, mostly running in-street**	<10 (0.3)	400 (14)	About 1
West Midlands Metro Line 1	20kms mostly grade-separated	na	225 (11)	

Note: systems in **bold** were operational in 1998, other systems were under construction. Figures were the authors' estimates based on research

5.6.4 Where problems occurred, some or all of the following were noted:

- Little and/or poor planning (by those who little understood metros), or a failure to identify a good project or clear objectives for the metro
- Unrealistic government expectations and no clear framework for funding, also leading to over-designed and expensive systems
- Relatively high fares on the metro and/or low time savings compared with other public transport modes
- The simultaneous implementation of competing infrastructure or unhelpful policies which damage metro patronage.

5.6.5 It was concluded that metros were apparently little understood, by most of the key players: government planners and decision-makers, entrepreneurs or bankers, or their planning and financial advisers. This was a huge problem: for time-and-again projects had been implemented, carried unrealistic burdens of expectation (the metro will solve traffic congestion) and substantially failed to live up to expectations.

5.6.6 Sometimes the problem appeared to have arisen from early successes with BOT expressways, and a mistaken belief that metros were similar. They were found to be very different, with much higher capital and operating risks for metros, and hugely greater risks associated with securing benefits (ridership, congestion relief and development/ regeneration impacts).

B DIAGNOSIS

6 Scale of Challenge

6.1 *A Major Challenge*

6.1.1 All MRT systems are demanding to implement. For example busway development involves some institutional complexity, a possible need to restructure the existing public transport system, maybe the challenge of procuring from the private sector. But metros are particularly demanding, facing all these and many more challenges.

6.1.2 Yet this is not always appreciated, because few people understand the totality of the subject matter: how to develop from concept to detailed plan, implement and then operate efficiently a metro system. Rather, most people have misperceptions about the subject – which are optimistic, and almost always result in disappointment and worse.

6.2 *Metros as Projects*

6.2.1 Why are metros different from other projects? The reason stems from their size and multi-dimensional impacts. These may be summarised as follows:

1) They are hugely costly – usually the largest cost project a city has contemplated. They are thus political from the outset. Despite the hopes that they will be financially viable, they require *huge levels of public sector* investment (see below), funds which could be spent in the city in other sectors, or in other provinces in the country. Thus central government is always involved, and support from both central and state / city government is necessary

2) While much can be learned from experience, every project is different, and there is no 'template' for developing a successful metro. This poses major questions in developing an approach which can be effective in the particular environment in question

3) Most projects require the use of roadspace at some time, which requires the active support of the highways agency, while the project is usually implemented under the leadership of the transportation agency. These must

be strongly supported by the economics and finance agencies. The environmental agency must be involved and often other agencies too. This raft of agencies poses demanding requirements for institutional coordination

4) They require land to implement, and in particular a large land area for the depot site. There have been attempts to avoid this (notably the Bangkok Green Line), but the reality is that land is always required: for stations, working sites during construction, and the depot (without which there can be no metro). Land can realistically only be secured by government. The problem of identifying land in the right place is reinforced by the frequent need to rehouse squatters and compensate them, before construction can happen. A metro project thus often begins as a housing project. If redevelopment around stations is an objective (also providing a possible contribution to funding the metro), then large land holdings need to be assembled in advance. When land is in the ownership of more than a few people, advance government action is necessary, and without this such redevelopment and densification does not happen.

5) They are complex to design. The prospect of transporting 60,000 passengers per hour/ direction underground, maybe in difficult terrain, maybe in the tropics is a major challenge to safety. Those familiar with rail technology are aware of the complexities which are always faced. Indeed it is this complexity, and the need for strong technical leadership that is a cause of metro problems: such people often take *the* leadership in project development, when they may be unaware of the (many) other dimensions to successful project delivery.

6) They are disruptive to implement. They pass through the centre of the world's most congested dynamic cities – often the country's capital. Whether elevated or underground disruption is a problem. Over several years (typically 4-6) traffic will be massively disrupted, and the prosperity of affected businesses potentially harmed. Most of the articulate car-owning class will be affected, including most senior politicians and government officials. Sometimes the problems continue, if viaduct columns permanently reduce the space remaining for road traffic.

7) Once constructed, the environmental impact can be large. Many projects are entirely elevated, and problems are frequently perceived to have been created: of visual intrusion, severance etc..

8) They often require a restructuring of the public transport system, on which most of the people travel. These changes are necessary to 'feed' the metro stations, and to encourage transfer to and from the MRT. Often the bus and paratransit operators oppose change, and can frustrate attempts to bring about integration, leading to under-utilisation. Yet when they are implemented, the changes also threaten to disrupt travel for those remaining on the buses, who cannot use the metro.

9) They are demanding to operate efficiently. While the front-line staff are on view, the maintenance task is substantial and challenging, and there needs to be strong support in the marketing, administrative and finance functions. Service levels and fares/ticketing strategy needs to be devised, based on sound market information.

10) Once embarked upon, it is necessary that government actions support, and do not conflict with the metro. This places a requirement on the government planning system to take coordinated actions, something that is not always present.

6.2.2 The overall result of these characteristics is that metros are particularly demanding to develop, fund, implement and operate successfully. This poses a challenge for any government, however skilled, and for those cities where institutional capacity is not yet well developed, there should be questions whether the challenge can realistically be met.

6.3 ***Required Approach***

6.3.1 Political commitment is the basic requirement, something that needs to extend for a substantial period of time during the project development process. Then, experience demonstrates that there are five essential components to any approach (Ridley, 1999). All are necessary to successful project delivery, and the failure of any one may well cripple a metro project. These are :

- 'Software' – the right staff, and training
- 'Hardware' – quality and robust technical work
- 'Finware' - developing funding to plug the gap in the project financial structure, and adopting realistic financing modalities

- Ecoware – building in planning and environmental objectives and constraints from the outset

- 'Orgware' – having the organisation and administration to manage and control the overall process

6.3.2 Success is likely to follow from a well-conceived process. This is the sequence of activities that start with clarity as to government objectives, proceed through strategy planning, to project identification, funding, design and implementation and ends with preparation for operations, then the delivery of services to the public. Where this process has been developed and applied well, successful projects are likely to result. But this tends to be the exception in many developing cities. Here, there is often the view that there is no time for a substantive programme of studies and decisions. Often the prospect of private funding and BOT projects appear to make such a process unnecessary. Yet nothing could be further from the truth.

6.3.3 For a process to be effective, there must be efficient decision-making. This is both necessary when major decisions need to be taken, but also on an ad-hoc basis when things go wrong. Effective decisions require as a minimum inputs from the key stakeholders who may affect the implementation and operations of the project. We have seen that the impacts of the metro are multi-dimensional, and it follows that there are a large number of stakeholders. The process to which we refer needs to generate a consensus behind the project. This is partly a matter of process, and partly of technical approach (see below).

6.3.4 Unlike most 'projects', there is no defined model for the development of metro projects. We can however, through understanding the problems and successes provided by recent history, provide some pointers to the overall approach.

6.3.5 The required activities are:

- Determining government objectives and constraints – with clarity as to the required role of MRT, and in respect to public funding
- Strategy development: a robust strategy is the 'rock' which will keep focus *when* things go wrong. It must be founded on reality, and be robust across the range of likely futures. This requires to be developed by a small high-calibre planning team

- Project identification – we have seen that forecasts of the key parameters are more optimistic than outturn reality. The key requirement to guard against misleading forecasts is that they are benchmarked against reality.
- Funding - almost certainly there will be a large call on public funds. It is necessary to secure agreement to this being met. Innovative financing might help – in the sense of putting off the evil day when it has to be met, but it will not solve the underlying funding problem.
- Organisation for implementation and operations – once the decision is taken, a single-minded implementation team is essential, using project management disciplines
- Procurement and implementation
- Training and operations

6.4 ***Role for the Private Sector***

6.4.1 There has been much confusion about the ability of the private sector to develop new, innovative and profitable projects. Experience has demonstrated much of this to be erroneous, despite the strenuous efforts of the private sector participants. The reason is not a failure of the private sector, but a failure by the public sector to recognise its necessary role. Government needs to set strategy, and identify projects in some detail. Without this, the private sector in practice can do little.

6.4.2 Given this, the role the private sector should play will depend upon local circumstances, in terms of international sentiment towards the country, the effectiveness of the private sector participation process, sentiment in the industry towards the project, and the interests of the private sector players. Such interest will be maximised when government performs its necessary functions well, has demonstrated transparency in executing the procurement process, and has demonstrated its ability to regulate according to the negotiated concession contract.

6.4.3 The role of the private sector, and private sector funding are therefore important issues, but they are only relevant issues after government has undertaken the necessary strategy planning and project identification work, and decided it should commit to the project in the knowledge of all its important consequences.

6.5 ***Conclusion***

6.5.1 The above provides a challenging agenda of requirements for success. The reality is that metro projects in particular are inherently risky, and that one significant failure can undermine hoped-for viability. The core messages are that:

1) Planning is essential. This needs to comprise a substantive series of studies, and takes considerable time. There are no short-cuts to success

2) Metros place substantial demands on government's administrative and professional capacity. Where these are not yet developed, success is unlikely.

3) Metros require a high level of public funding support. They should be developed only when this is shown to be a rational use of available funds, given competing needs

4) The private sector alone is *not* the answer to profitable metro projects. In cities where the institutional capacity and public funding exist, the private sector may be effective, but without these it can do little.

7 Attitudes to MRT

7.1 *Introduction*

7.1.1 There often appears to be a gulf between the results of apparently rational technical analysis and what is actually implemented. This particularly concerns the attraction of rail systems and the frequent lack of interest in bus systems, by politicians and car users.. We have also seen that the choice is often for an underground alignment, something that increases the capital cost by a factor of 2-3. The issue we consider here is why these strategic choices are made, often contrary to the findings of so-called 'rational analysis'.

7.1.2 The following have all occurred in our experience:

- Most of Singapore's initial MRT system is elevated but it is underground in the city centre

- Manila built LRT Line 1 as an elevated massive concrete structure right through the centre, and along one radial road which was narrow. Yet Filipinos have liked the system, with few adverse comments on its visual impact

- Bangkok has just opened a visually attractive fully elevated metro, one section being down a major shopping/commercial thoroughfare, creating 'tunnel' conditions. The public outcry has been of pollution trapped under the stations, not its visual appearance

- The Thai Cabinet, faced with massive elevated 'spaghetti' from elevated transport infrastructure decided in the mid 1990's that all new infrastructure in the central 25 km^2 of the city should be underground. The southern section of the Blue Line, within this area is underground; and so is the northern section, although outside the area, due to environmental lobbying

- China builds its metros underground in the large inner city area, while outside the ring-road, it is usually termed LRT and is elevated

- Taiwan's CBD is characterised by buildings which are more attractive in design today, than yesterday. Its metro is largely underground, but its medium-capacity system is elevated

- There has been great pressure for Jakarta's promised first metro line to be underground for much of its route, although the route is broad and largely unencumbered

- Many cities seem to want rail systems - preferably a metro, and outside Latin America there is little interest in busways

- In many Central/Eastern European cities there is a deep-seated view that trams are better than buses, and metros better than trams. It is difficult to know why this is, other than that is the case – they already have the technology, and they like it. (This is in spite of the fact that many cities have renewed their bus fleets and that the trams may be slower than the buses).

7.2 ***Causal Factors***

7.2.1 Two possible reasons for the divergence between the results of apparently rational analysis and the decisions actually taken are put forward. The first follows from research carried out into a range of bus and rail transit systems (ETP, 2000).

7.2.2 It has been suggested that a core reason may be that what are often considered to be the disadvantages of rail – its high cost and inflexibility, translate in political terms to a visible sign of *commitment* (making a confident, futuristic symbol for the city) and *security* (the population is confident that the new system being taken away, and they can make decisions knowing that the system will be there for the future).

7.2.3 By the same argument, the main disadvantages of relying on conventional buses may be perceived as what are usually assumed to be their advantages – their low cost and flexibility. This usually results in implementation which is too cautious, so that the service improvements, while overwhelmingly positive in terms of value for money, are simply too small to make a great impact. Maybe it requires much bolder political will to make success of (low cost) bus systems than (high cost) rail systems.

7.2.4 It was also noted that political and professional careers have been built around constructing a rail system. Rail systems appear to have many friends – commercial, civic, political and environmental – and few enemies.

7.2.5 The second possible explanation concerns the observation that some developing countries benchmark themselves against a 'developed' model to which they may aspire. Sometimes countries aspire to 'be like' somewhere else, that is perceived to have parallels and be successful. Thus Singapore has often benchmarked itself on Switzerland, Mauritius tends to do so on Singapore etc.. More generally, it seems that developing countries in some respects may benchmark themselves against the major economies. Metros are considered part of this 'developed city' package, and there is reason to expect that this transition to a more developed status needs to be visually obvious.

7.2.6 It is interesting to consider the attitudes to busways. In Latin America, busways have been a success. Maybe the answer here is that having been relatively affluent, and then suffered from mis-government, they were faced with large problems – a road infrastructure that was breaking up, and large, restless urban poor neighbourhoods. Busways were the obvious answer to delivering acceptable service within the constrained means available. There is a marked contrast in Asia, where the perception (with some notable exceptions) is that most governments want – and seems to think they can have a metro system.

7.2.7 If this analysis has some force, then developing city perceptions will likely be coloured by those of the developed cities against which they benchmark themselves, and their perceptions will likely change over time, and become more aligned with those of the developed country. Cultural attitudes overlay this, resulting in a wide range of attitudes which impact upon local perceptions.

7.2.8 A survey of environmental perceptions in Bangkok in the mid 1990's concluded that air pollution was clearly the No.1 problem. This was perceived as affecting the respondents' health adversely, and was something they individually could do little about. Then, dirty water was a problem in those neighbourhoods where there was a problem, but this was not widespread. Then, there were other problems – for example visual intrusion, noise, vibration etc – but these were distinctly minor problems.

7.2.9 It seems that many developing city residents may have similar priorities. In particular visual intrusion is either not (yet) a problem, or is distinctly secondary. It may also be the case that there are 'thresholds' which affect this. Thus in Bangkok, the existence of a large amount of elevated 'spaghetti' created by existing and proposed expressways and metros became a visual problem.

7.2.10 In some more autocratic societies, people have yet to fully develop individual perceptions; rather they are accustomed to conforming with government advice which has been the way for many years. For example, when we inquire why metros in Chinese cities have to be underground, we find the reason is that this is the central view of the way that things should be.

7.3 *Implications for MRT Development*

7.3.1 The implications of this understanding are the following:

1) Political attitudes towards 'high-cost, inflexible' rail systems may be positive precisely because high-cost is interpreted as commitment and projecting a positive city image, and inflexibility is interpreted as security – that the system will be there and medium-term decisions can be based on this being the case

2) The combination of developing aspirations, cultural attitudes and sometimes centralised dogma shape environment attitudes. Understanding these is essential to appropriate project identification.

3) In some societies, elevated structures may be acceptable on visual grounds, maybe even in confined corridors. But this depends in part on the other elevated transport infrastructure planned and in place.

4) There is often a deep-seated view that 'making it' in developed terms requires a metro. This is part of the 'developed city' package, together with high-rise buildings and a CBD. Making the case for busways as an alternative is often just not on the agenda. In Central/Eastern Europe trams are an acceptable alternative to the metro. Otherwise, politicians may prefer to wait until they can afford a metro.

5) Good rather than basic design from the outset is likely to be a sound investment, as environmental perceptions are likely to rise with incomes, and it is not possible to retrofit an ugly structure to make it attractive.

6) There may be limited value in forcing comparisons with MRT options when local perceptions do not perceive them as acceptable options. Instead the focus should be on the affordability of rail-based options, something which cannot be escaped.

8 Forecasting MRT Impacts

8.1 *Accuracy of Forecasts*

8.1.1 The review of available research has highlighted unambiguously the poor record of forecasting the main financial parameters – capital cost, construction time, operating costs and ridership/revenues. It has also demonstrated that this is not confined to developing cities – the US experience mirrors that in developing experience, and is reinforced by much other developed country evidence.

8.1.2 This record is not confined to MRT projects. The record of traffic forecasting for large BOT expressways is often poor, and in some cases the cost estimates are poor too (World Bank, 1996 and ADB, 2000). Many megaprojects have large cost over-runs, and overall experience is that poor forecasting is endemic on large public works projects.

8.1.3 This of course does not excuse bad forecasting, but it puts the MRT experience in context. The required approach needs to understand the cause of the problems, then to devise approaches which will lead to better forecasts, on which decisions can be more soundly based. The remainder of this section addresses these issues.

8.2 *Cause of Poor Forecasts*

8.2.1 There have been several reviews of forecasting (for example, Mackett et al, 1998). The reasons for poor forecasts may be classified as involving political, financial or technical factors:

8.2.2 ***Political Factors*** – new MRT systems, particularly a rail system, are popular with politicians and the public alike. The new system is usually a discrete project which can be clearly identified, so that those with an interest in doing so can claim to have produced a significant achievement. It can be argued that planners are under pressure from politicians to produce such an attractive scheme – particularly (the next point) if it is paid for by the national government or by a local tax that has popular support. In other words the ratio of local benefits (including those to politicians) to local taxation is very high'.

8.2.3 In many cases the activities of donor governments and their equipment suppliers/contractors reinforce this trend, promising attractive projects at costs that are found to be misleading. So-called 'free' studies sometimes contribute to their development

8.2.4 ***Financial Factors*** – Pickrell analysed the reason for the poor forecasting of the federally-funded US systems, and concluded that one reason planners were keen to develop such projects was that most funding came from the federal government. Moreover, high ridership forecasts led to a costly system, which brought in more federal funding. The federal government also funded most of any financial over-runs.

8.2.5 In the UK, the method of obtaining central government funding is in respect of non-user benefits, including congestion relief, development impacts, reduced accidents and reduced pollution. Several of the UK transit projects funded under this regime are performing poorly: ridership has failed to match expectations, and the estimated non-user benefits are unlikely to have been achieved. Manchester Metrolink is a notable success story by comparison.

8.2.6 ***Technical Factors*** – we consider demand forecasting and cost estimation separately:

Demand Forecasting

8.2.7 ***The Issues*** - Appraisal of rail systems requires forecasts to be prepared over many years (at least 25), and because of the complexity of the issues it is necessary to use transport 'models'. A simple review of the performance of such models in forecasting metro ridership should be warning enough that the models are by no means guarantors of accuracy.

8.2.8 The first issue concerns the objective of transport planning in developing cities. The environment and the transport planning process is characterised by all the following, which should be a warning that standard approaches which may be appropriate elsewhere may be unsuited to these environments:

- A poor database
- A complex transport situation
- Few resources available for the transport planning task, and
- An uncertain environment

8.2.9 Faced with these conditions, the objective should be to develop a 'good' strategy or project, which is robust against the uncertainties that exist. This contrasts with common practice, which is to plan on the basis of a 'best' or 'central' assumption, and then to conduct sensitivity tests. The approaches are likely to deliver different results.

8.2.10 Setting aside this fundamental issue of approach, analytical errors may arise for any/ all of the following reasons

- base year data against which the models are validated. Often data collection is poor or not undertaken for reasons of a lack of funds and time
- model specification: the ability of models to reproduce travel behaviour in the centre of large, complex cities is always demanding
- input assumptions which prove to be incorrect. These include macroeconomic/land use forecasts, assumptions about the transport system, assumptions about the MRT system and its integration with the public transport system. These are probably the greatest area of uncertainty
- practitioner error in developing and applying the models

8.2.11 ***Transport Models*** - There are different generic types of model, and some studies adopt 2-tier modelling approaches, combining 'strategic' and detailed' models at progressive stages. For example:

- The 1990 research developed a strategic MRT corridor model, designed specifically for the pre-feasibility analysis of metro systems, and validated against extensive case study data collected
- Sometimes city-wide strategy models are used to test a range of transport strategies, and narrow-down the area of search, so that:
- Corridor or modal models are used to produce detailed forecasts.
- These are supplemented by simulation models for specific tasks and events

8.2.12 The requirement of any models should be to test a *large* number of alternatives. This is usually necessary, given the multiple factors impacting upon the forecasts, and the imperative of understanding the risk characteristics of the forecasts. This requires a compromise given the complexity/detail of many models.

8.2.13 Many factors combine in the development of models whose complexity and detail is clearly not reflected in their forecasting ability. Part of the problem is the analysts desire to constantly refine. Part is the wish (which should not exist) for consultants to 'impress' clients who do not understand the subject with the apparent sophistication of their models. And part is a lack of knowledge about how poor forecasts routinely are.

8.2.14 Finally, it is important to recognise that models cannot realistically measure all impacts. For example, a metro may require the substantial restructuring of existing public transport to secure integration, upon which its viability depends. The existing paratransit and bus services may materially change, with new operators, larger operations, buses replacing paratransit etc. The impact of these changes on the service provided and costs may be large, and affect much of the city, yet they are not something the model can tell us much about, even if it is 'detailed'.

Cost Estimation

8.2.15 The approach in respect to both capital and operating costs is often 'bottom-upwards' - to build up costs from the bottom.

8.2.16 ***Capital Costs*** – we have noted that there is no 'template' for developing a successful rail transit project. The approach to project development needs to be tailored to each situation, and while there are broadly standard approaches to project management, the outturn depends critically on institutional, political, environmental etc factors, which are often difficult to foresee, without substantive and sustained technical effort over a considerable period of time. In developing city environment, it seems this is rarely possible.

8.2.17 Table 3.2 summarises the factors that influence capital costs and which are most important.

8.2.18 ***Operating Costs*** – poor forecasts often result from a genuine lack of understanding of the complexities of urban rail systems, the functions which need to be carried out and the scale of effort required. The maintenance of track and equipment is particularly demanding in terms of manpower and cost.

8.3 *Recommended Approach*

8.3.1 Following from the previous analysis, progress apparently requires: accountability by decision-makers, a funding mechanism that does not distort funding in the sector, and forecasts that are validated in some way, to demonstrate their plausibility. How is this latter objective to be achieved?

8.3.2 The central conclusion the authors have reached based on the available evidence is that forecasts cannot be trusted unless they are shown to be reasonable by comparison with actual systems which are operational. 'Benchmarking' is the term given to this approach. It amounts to a top-downwards check on the 'bottom-upwards' estimates, and the requirement that these should broadly agree.

8.3.3 This approach is used by some transit companies at present to analyse their performance in detail, and strive to improve it. The COMET project run by Imperial College, London is such a system. The problem is that the data are confidential, as the transit companies pay for membership of their metro 'club'. Nevertheless it is straightforward for others to develop benchmarking criteria, for example ridership per station, capital cost per route/km and type of construction, operating cost per passenger, revenue per $ operating costs etc. Then, when developing a new system, it is possible to check it against broadly comparable systems.

8.3.4 Thus for example, however much effort is put into data collection, modelling, and the preparation of models inputs, little confidence can be attached to the forecasts *unless they are benchmarked against existing metro performance.* The difference in the passengers/station or per route kilometre for the system being studied against other comparable systems must be explicable – if it is not, the assumption must be that the forecasts are erroneous.

8.3.5 Even better the farebox ratio (the ratio of farebox revenues over direct operating costs) of the studied system should be compared against comparable systems. When forecasts are benchmarked against other systems in the knowledge of their differences, then genuine confidence can increasingly replace the blind hope that sometimes characterises existing practice.

8.3.6 Turning to the model form that is best suited to perform such appraisals, the evidence is that:

- Strategic modelling is likely to be cost-effective. For example the 1990 research model MRTAP (Bamford et al, 1992) was specified to include many features of behaviour in the centre of major developing cities, not included in so-called 'detailed' models, yet it was applied strategically. The evidence in this report suggests that its forecasts compare well with the results of all the detailed models

- The use of parts of the overall transport model (this is usually a 4-stage model) can be effective in particular circumstances. For example public transport assignment models can provide good indications of the balance of advantage between different routes, alternative integration proposals etc. and produce a large number of tests quickly.

- Where government recognises the central role of good forecasts to its transport planning process, the resources should be invested into data collection and model development, together with the model inputs, and the forecasts monitored against actual change. Then the model can be progressively updated, and 'detailed' models are likely to be cost-effective. The experience is that this tends to be the exception, instead detailed models are often developed without the commitment of resources, or without the institutional environment to ensure they can be sustained.

8.3.7 The evidence is that large errors occur through an absence of understanding or misplaced optimism in respect to the input assumptions. This report has identified some of the key issues, which should allow more realistic assumptions to be made. Assumptions concerning the integration of the metro with the existing public transport system is an area where particularly poor assumptions are not infrequently made. The formal incorporation of uncertainty in the appraisal approach is another such critical area.

9 Planning for Tomorrow

9.1 *The Issues*

9.1.1 There is an urgent need in many cities to make improvements in public transport. It is well known that the gestation period for rail-based systems can be lengthy. Busway transit should be capable of rapid implementation – technology is relatively simple and busways may be introduced incrementally, but while busway transit can have an immediate impact on existing public transport problems, can a busway based system be regarded as the long term solution in terms of capacity and quality in large cities?. As with any transport system, Brazil's busways were considered appropriate when they were first opened, but some have suffered from adverse environmental, related land use and sometimes safety problems. Today there are pressures for upgrading to mitigate these problems, or their replacement by rail systems (we have seen, that this is happening in Salvador and Belo Horizante).

9.1.2 Manila's LRT Line 1 was 'appropriate' when it opened in 1984. A medium-capacity system, non-air-conditioned, fully-elevated mass concrete viaduct, with no escalators or lifts, and a simple token-in-the slot ticketing system with fixed fares. Planning for the future comprised building the stations 50% longer than warranted at opening, and planning for new lines.

9.1.3 In developing cities, where demand, incomes and perceptions are all typically expected to increase rapidly, how should MRT systems be developed? Should they be appropriate to the time (like Manila Line 1), or built for the future, building in everything from the start? Or should projects be planned for future upgrades, but built only with those features necessary now? These represent three quite different strategies.

9.1.4 The main parameters that may change over time, where decisions are required at the design stage are:

- System capacity, which is based upon traffic forecasts, which in turn depend upon the future network which is assumed
- Comfort standards accessing the trains – escalators rather than stairs may be required

- Comfort standards on the trains – tunnel dimensions are critical to comfort as well as capacity standards. Also air-conditioning is important
- Access by the travel-impaired. These include any/all of: encumbered travellers (women with children, people with shopping etc), frail and infirm travellers and the disabled who are unable to use stairs/escalators.
- Ticketing equipment – over time operators may wish to introduce sophisticated ticketing, allowing market differentiation, providing marketing information, and increasing revenue capture.
- Aesthetics – the environmental impact of busways and the visual impact of metro viaducts and stations in the case of elevated systems, and the internal environment within stations

9.1.5 These issues have all arisen, for example:

- Capacity – The 1990 research into metros provided examples of over-provision. Of 9 developing city systems for which information existed, 5 had traffic which was between –50%/-90% of the forecast, another 3 had forecasts in the range 0 up to –50%, 1 was as forecast and none achieved traffic higher than forecast. Capacity constraints have developed on the most successful metros – for example Hong Kong's MTR in the Nathan Road corridor, and Mexico City's Lines 1-3
- Comfort standards accessing the system – escalators rather than stairs may be required for metros. The Bangkok BTS and Manila MRT3 private sector projects did not originally provide escalators from street-level, but these are being progressively added.
- Comfort standards on-vehicle – air-conditioning, and reduced levels of over-crowding may be sought. The Manila LRT Line 1 has recently been upgraded comprehensively, and air-conditioned cars introduced. Most rail systems however do have air-conditioning, because passengers are willing to pay more for the comfort provided. A notable advantage of bus systems is that they can combine different tariff/ quality standards
- Access by the travel-impaired. Except in the most advanced cities, many of the travel-impaired cannot access buses on busways. Many metros have been required by government to add lifts at the last moment, or after opening. Singapore has just announced that all stations will be provided with such access shortly.

- Ticketing equipment – once modern ticketing equipment is provided, incorporating ticket barriers and automated ticket readers, new technologies have increasingly become 'bolt-on extras', incorporated relatively easily. The problem has been in converting old technologies to this modern form – examples of this being done are provided in London and Manila LRT Line 1. This is feasible, albeit difficult to accomplish. As occasional busways are developed to become busway *systems*, off-vehicle ticketing should become possible; but at present this is the exception.
- Aesthetics – we have noted the environmental degradation created by large numbers of diesel buses using busways day-in and day-out, and the adverse impact on the busway corridor; Avenida Caracas in Bogota is an example. The visual impact of the metro viaducts and stations are the issues in the case of elevated systems.

9.2 ***Cost-Effectiveness of Modifying MRT after Implementation***

9.2.1 It is useful to distinguish between:

- Active and passive provision. For example should the station shell be built at the outset, or should space be safeguarded for future development? How should access to underground utilities be provided for in the case of busway or LRT systems?
- Hard and soft features. The tunnel dimensions are an example of the former, lighting or a public address system the latter
- Core and non-core facilities. Station dimensions, access capacity and air-conditioning are examples of core facilities.

9.2.2 ***Capacity -*** We have seen that demand forecasts have in practice often been too high. This sometimes results in infrastructure being under-utilised. But this is a less serious problem than capacity constraints developing. To guard against this, in principle it would be possible for extensions to stations to be planned but not built initially, but to our knowledge this has not happened.

9.2.3 ***Comfort standards accessing the trains –*** the need for escalators depends upon the vertical height to be accessed. For example, the KL PUTRA project provides for escalator provision when this exceeds 5 metres in the up-direction, and more than 7.5 metres in the down direction when this is also a major flow. Upgrading stairs to escalators in an operating railway can be designed for, and is then not so troublesome. It is probable that in most situations the benefits in terms of increased ridership will outweigh the extra initial and operating costs of escalators. Otherwise provision should be made for escalator installation subsequently

9.2.4 ***Access by the travel-impaired*** – when lifts have been provided, justified on the basis that they will be used by the disabled, the result is that they have been used extensively by the encumbered and mobility impaired, but not so much by the disabled. In many cases the extra patronage generated, and the social benefits created in having most of the community able to access the system will justify the extra costs of provision; in others (e.g. tunnel walkways to accommodate wheelchairs) this is unlikely to be the case.

9.2.5 In the case of elevated metros, lifts can be 'bolted on' after the event, but this can be difficult and unsatisfactory (lift passengers need to be able to access the ticketing concourse and platforms). In the case of underground systems the problems become large and costly..

9.2.6 ***Ticketing equipment*** – all modern metros are likely to require modern ticketing equipment, which will be capable of accommodating technology upgrades relatively easily (e.g. from magnetic stored value tickets to smart cards). This will be justified on commercial/marketing grounds

9.2.7 ***Aesthetics*** – an ugly viaduct, and ugly stations cannot be made beautiful from the street after the event. In practice, there is not a significant cost difference between the two extremes, rather the difference is the investment of effort at the design and construction process stage. Bangkok is a good example of a city which has mastered the art of creating attractive viaduct, and Singapore is an example of overall good design. Where architects seek to make stations attractive *internally*, by creating internal space, then costs can increase by orders of magnitude.

9.3 ***Conclusion***

9.3.1 It is likely that the sum total of most of the above measures, if designed into the system from the beginning, would be small (perhaps 2% of the initial cost at a guestimate). Most would be justified on commercial terms, that is they would increase revenues more than costs. The exception concerns station design. Large stations, designed for aesthetics reasons can be very costly, especially when underground.

9.3.2 The required approach therefore is :

- Design the system capacity on the basis of traffic forecasts, which are benchmarked against reality. Incorporate a ‘factor of safety’ to guard against future capacity constraints
- Provide escalators when the vertical separation demands it, from the outset in most situations; otherwise plan stations for future escalator installation
- Provide lifts from the outset
- Provide modern ticketing equipment from the outset
- Put effort into the design/construction process, producing visually attractive viaducts and stations in those cities where this is a matter of concern
- Design for the need to control air pollution in the event of ‘tunnel’ effects’ being planned

10 The Private Sector Approach

10.1 ***Objectives***

10.1.1 We consider the experience, first of new-build systems, and then of the concessioning and privatisation of existing systems

10.1.2 The sustainability agenda (World Bank, 1996) defines an increasing role for private sector *participation*, and in due course *funding* for the transport sector. This is a new approach, which is expected to endure. The so-called BOT[10] experience described here is the first step along this road in the MRT sector for developing cities. It describes some success, but many problems. The section points to changes of approach and a re-thinking of policy which are necessary. In some cities these changes are already beginning.

10.1.3 There are two broad reasons for embarking on private sector participation (PSP) in infrastructure:

- Because government's imperative to 'do something' is not matched by the public finances, and private funding is considered to be the 'only option'. Sometimes it is also seen as the 'easy option', and therefore the obvious course to follow

- Because this is regarded as a 'better way' leading to improved efficiency in the sector, with additional funding its consequence, but not necessarily its principal objective. Specifically, BOT projects can use the private sector to implement and manage projects, reveal project risks and transfer some to the private sector, and also overcome cash constraints

10.1.4 Today most countries probably fall into the first category in terms of their approach to BOT projects, with a small and increasing number, supported by the development banks recognising that this approach should provide the 'better way'. The appropriate approach in any city/country of course needs to be tailored to local conditions.

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[10] Build Operate Transfer – a concession granted to a private project company to fund, implement, operate and maintain a system for a concession period (typically 25-30 years), and then hand it back to government

10.2 ***Implementation Experience***

10.2.1 ***Busways*** – despite considerable efforts, no busway concessions have yet been implemented. There have been attempts to seek innovative financing of busways through various versions of BOT (Sao Paulo and Bogota). These were not successful due to the failure to resolve the existing bus system issue (Bogota), and the perceived levels of financial risk to be incurred by bidders and uncertainties arising from the unknown concept of busway transit in the bus service industry (Sao Paulo[11]).

10.2.2 ***Rail Systems* -** After a decade of strenuous efforts by developing city governments and the private sector to implement BOT projects, we have learned that this approach is problematic. First, little has been implemented: **Table 11.1** refers to Asia, which is where this approach has been pursued with most vigour. It is notable that, despite vigorous efforts, this approach has been implemented in only a few countries.

TABLE 10.1 MRT INFRASTRUCTURE CONCESSIONS IN ASIA

Country	Operational	Construction	Planning
Malaysia	2	1	
Thailand	1	1	1
Hong Kong	(1[12])		
Indonesia			
Philippines	1		4
Other (7 countries)			
Total	**4**	**2**	**5**

Source: authors 'research

10.2.3 The 4 operational concessions are evaluated below. Additionally, the Bangkok Blue Line is currently under construction. This uses a different approach to the Green Line, also in Bangkok: instead of a full BOT concession, the basic infrastructure is being procured by government under an OECF loan, and the equipment supply,

[11] The World Bank offered partial risk guarantees for Berazilian busways, tpo overcome this problem, but they have to be counter-guaranteed by the federal government, which was not porepared to do so

[12] The Eastern Harbour Crossing was implemented as an expressway, with MTR link incorporated, under a BOT concession

operations and maintenance are being let as a BOT concession. In Kuala Lumpur, the Monorail project has recommenced construction. There are five projects at substantive stages of planning: The Hopewell replacement project in Bangkok (this follows the collapse of the Hopewell BOT concession), and Manila LRT Line 1 Extension, Line 4, Northrail and MCX/Southrail concessions.

10.2.4 The characteristics of the 4 new build concessions are shown in **Table 10.2**. These, together with evidence from the developed world provide the evidence for the approach as practised to date:

TABLE 10.2 KEY CHARACTERISTICS OF METRO CONCESSIONS

Characteristic	**KL STAR**	**KL PUTRA**	**Bangkok BTS**	**Manila MRT3**
Concession	BOT 30+30 year concession	BOT 30 + 30year concession	BOT	BLT 25 year concession
Competitive award?		Competition for different specification systems	6-week competition for a project which changed completely	Negotiated contract, 1 bidder qualified
Project (all fully segregated)	12+15 kms in 2 phases	29 kms automated technology	24 kms in 2 lines	17kms
Opened	1996, 1998	1998-99	December 1999	December 1999
Capital Cost	$1.3bn	$ 2.3bn	$ 1.3bn	$0.7bn
Traffic 000's per weekday	60 (Oct 1999)	110 (March 2000)	160 (March 2000)	40 (line not yet complete)
Revenues/operating costs	1.0	0.5	Not known	Not known (<1)
Environmental impact	Minimal – mostly at-grade along existing corridors	Not large, mostly elevated, tunnel in centre, no catenary	Elevated, viaduct impressive, Silom section of route intrusive, leading to concern about air pollution	Mostly at-grade/elevated, in the middle of wide highway, so little impact
Identified impact upon the poor **Construction**	-	Some squatter relocation near Bangsa	Construction work	Construction work. 3300 squatter families

As riders	Poor don't ride it	Poor don't ride it	Poor don't ride it	relocated at depot Poor don't ride it
Other direct impact	-	-	Little impact	Little impact

10.2.5 The remainder of this section considers their successes, problems and draws conclusions on experience to date of the BOT process.

10.3 *Project Development Process*

10.3.1 One unexpected result of the private sector approach as applied has been to intensify institutional conflicts. In Bangkok all government agencies were encouraged to promote BOT projects, and once secured these are jealously protected. The 3 MRT projects are promoted by different government agencies, each of which has sought private sector concessionaires. The result is that institutional conflicts, always problematic, have intensified.. In Manila MRT3 is aligned down the middle of the major highway in the city, which is being up-graded towards expressway standard. The transportation ministry promoted the private sector project, and the concessionaire sought to minimise cost. Initially this created a technical 'solution' which would have seriously disrupted crossing traffic. Eventually government agreed to fund the substantial grade-separation of the MRT, and an acceptable technical solution was achieved.

10.3.2 None of the projects were identified by government as a result of study. Indeed none have been subject to feasibility study, and only two were subject to traffic studies. The factors behind their development are as follows:

- The first was STAR in KL. This was a private sector project identified and promoted by foreign interests, seeking to minimise cost by using a disused railway line. Subsequently the company agreed to construct Phase 2, which was to be operational in time for the Commonwealth Games, and whose impact on the project finances has proved to be negative

- The PUTRA project, also in KL was promoted by a local conglomerate, supported by government. It was designed to provide a shop window for Malaysian technology, and was required to be operational in time for the Commonwealth Games

- The Bangkok BTS project started as a downtown people-mover, promoted by the city administration, and designed to require no land other than that owned by the administration. This was a reaction to the perceived failure of national government to implement a number of promised MRT projects. After contract award it has transformed in almost all respects to become the city's first metro

- The Manila MRT3 project was promoted by an individual entrepreneur, down the centre of the city's main thoroughfare. It was designed to minimise cost and target major property development along and over the thoroughfare. It was designed to extend the MRT system, Line 1 of which was opened in 1984, and Line 2 of which is also under construction (after a failed BOT bidding, this is being procured by government under an OECF loan)

10.3.3 The systems show marked differences in the form of concessions, the allocation of risk and the concessionaires:

- The two KL systems have the same concession form (30 year BOT renewable for 30 years) but are otherwise quite different. STAR was a foreign-promoted project, with contractors and equipment suppliers significant players, but Malaysian companies the majority equity holders. Substantial risk was carried by the project company. PUTRA was concessioned to a local conglomerate, with property and construction interests. Following tenders for the equipment supply contract, the highest specification and highest cost tender was selected, with a foreign equipment supplier. The main risk falls to government and the state pension scheme (bank debt is guaranteed by government)

- The Bangkok Metropolitan Administration initially invited BOT bids for a (technology unspecified) downtown people-mover system. Following contract award the project changed out of all recognition in terms of route, technology, and depot location, and the contract was the subject of constant re-negotiation. What has emerged is an example of a classical BOT project, which was structured with the participation of the IFC. The concessionaire is led by a Thai property company, and a Thai construction company and overseas equipment supplier were active promoters.

- Manila MRT3 is not a BOT project, but Build-Lease-Transfer (BLT). The concessionaire raises the funding, implements the project and transfers it to government who assume the commercial risk. This is akin to obtaining the project on hire-purchase. The main risk is borne by government, and the project company is guaranteed a 15% IRR on its equity invested, with the potential for additional returns from property gain which is shared with government. An initial tender produced only one qualified bidder. The original Manila project company has substantially changed ownership during the project gestation, in which large changes have been made, and re-negotiation has been frequent. The final company structure is dominantly Filipino, led by property interests.

10.3.4 ***Project Funding*** – the funding characteristics of the projects is as follows:

- STAR had a debt: equity ratio of 3:1, and included some government soft loans. No significant property profits were targeted or secured.

- PUTRA was expected to realise large property development profits, but to date it is understood these have not been realised

- Bangkok BTS financing was structured with the assistance of IFC, who are project equity holders. The full equity was to be used, before any debt was drawn down. Apart from the depot, it is understood that little development gain has yet been realised, but some development gain from adjacent shopping centres in the ownership of the concessionaire is targeted

- Manila MRT 3 has a 2:1 debt:equity structure, with most of the debt being foreign. The full equity was to be used, before any debt was drawn down. Property development above stations is targeted (some is under construction) and some development gain from adjacent shopping centres in the ownership of the concessionaire should be realised

10.4 ***Project Development and Implementation***

10.4.1 The Manila and Bangkok projects took 8 and 9 years respectively between project concept and operations. This is impressive given the record of the industry. There have been many problems, as always occur, but the implementation performance is impressive. No doubt this is in substantial measure because the cash-flow profile is a real issue for the private sector companies involved, especially the bankers who spur progress.

10.4.2 ***Cost -*** Reliable cost information is not available. The costs shown above are publicised, but exclude much of the government support, together with part of cost escalation. The costs per route-km are as follows (**Table 10.3**);

TABLE 10.3 MRT CONCESSIONS - COSTS

Project	% At-grade	Cost US$ bn	Cost US$/km
STAR Phases1,2	62	1.3	50
PUTRA	7	2.3	81
Bangkok BTS	0	1.3	54
Manila MRT3	43	0.7	>40

10.4.3 It is not possible to conclude how these costs compare with public sector benchmarks. It seems likely that the costs are lower, and that this is an area where the private sector has applied its skills effectively.

10.4.4 ***Technology and Operations*** – The systems differ markedly in technology:

- Cost was the determining factor with STAR. Procurement was from many sources. This is one reason for the problems with the resulting *system*, which have been, and are many. These have not affected passengers, but have increased maintenance costs and reduced car availability

- PUTRA is the 'Rolls Royce' of transit. It is the one of, if not *the* world's largest automated transit system. It uses linear induction motor technology and driver-less trains, and offers 90 second peak headways. The problems with moving-block signalling encountered elsewhere have not been encountered here.

- Bangkok BTS is modelled on the Hong Kong MTR, and uses state-of-the-art conventional metro technology

- Manila MRT3, like STAR, was determined by the need to minimise cost. But procurement was packaged, the cars being from TATRA of the Czech Republic for example. Initially these were not specified to be air-conditioned, but the delivered cars provide for this

10.4.5 In terms of operational performance, all systems provide a good service to passengers, and PUTRA an excellent service. Operating costs have probably been controlled well by the private concessionaires (although data is not available to confirm this).

10.4.6 ***Capacity/Flexibility*** – STAR Phases 1 and 2 have line capacities of 16/33,000 pphpd, PUTRA 30,000 pphpd, Bangkok BTS 40,000 and Manila MRT3 30,000. Given the nature of the alignment, the capacity could be considered low in the case of Manila MRT3.

10.4.7 STAR operates with single articulated 2-section cars, expandable to 3-car trains. PUTRA operates with a married pair of cars, and can be expanded to 2 married pairs. Its technology enables it to tailor capacity closely to demand, and to recover from service interruptions quickly. Bangkok BTS and Manila MRT3 operate with cars at modest headways, and can be expanded by increasing train length and frequency.

10.4.8 ***Network Integration*** – Little integration has been implemented:

- In Kuala Lumpur, the two projects are not integrated, even though they do not compete. To interchange where they have apparently common stations, passengers first need to exit to the street, then enter the second station. No tariff integration yet exists

- For STAR, bus integration is not good: the concessionaire has no control over frequency or bus quality, both of which are unsatisfactory. However, substantial park-and-ride provision has been provided (1100 spaces in Phase 1), and this is well used. The story is similar with PUTRA. In effect the two MRT systems together with the suburban commuter system (KTM) and the two main bus operators operate independently of each other

- In Bangkok, the two committed projects will not be well integrated. Passengers are faced with difficult interchange. No tariff integration yet exists (the Blue Line is well under construction), and given the tariffs proposed, little appears likely to take place.

- For the BTS, bus integration is mixed. No new feeder bus routes have been provided by the dominant government operator (BMTA), but the concessionaire is about to introduce his own. On the other hand many buses pass the BTS stations. Flat fares on the 'basic' buses hinders transfer at the lower end of the market, and no tariff integration yet exists.

- In Manila, the three committed projects are not well integrated. The MRT3 concessionaire was given the freedom to locate stations, and many were fixed late, without recognition of the necessity for interchange. The result is that passengers have to exit to the street, and sometimes interchange is problematic.

- In Manila bus and jeepney[13] integration has not been planned. As with Bangkok, the flat fares on the basic buses hinders transfer at the lower end of the market, but this is compensated for by the large number of jeepneys which have graduated fares that start low. No tariff integration exists

10.4.9 ***Access to Stations*** – once at the stations, access on STAR is good. Escalators are provided when the vertical separation and passenger flow are deemed to warrant it; and on PUTRA access is excellent.

10.4.10 BTS has had access problems, forced by financial imperatives to complete the project within a fixed budget. Escalators were originally provided from street level at just 1 station on the system, leaving passengers with about 50 steps to reach concourse level; escalators were provided from concourse to the platforms. After operations began, the concessionaire has been required to add street-level escalators at a further 10 stations by government, and more are planned, following market research.

10.4.11 Manila MRT3 is aligned down the centre of Manila's broadest corridor. Most stations are located mid-block, often quite far (100-400m) from the cross streets after which they are named. As a consequence, transferring bus and jeepney passengers have to walk considerable distances. The same is true for transfer with other LRT lines. No escalators were provided initially, but after opening the concessionaire was required by government to add them at the busiest stations.

10.4.12 ***Access for the Travel-Impaired*** – these include the disabled together with the encumbered (travellers with shopping / market produce / children) and the frail (elderly and infirm). STAR made no special provision for them, other than the above escalator provision, while PUTRA made total provision (including special toilets). In Bangkok no provision was made, until 2 months before opening, when the concessionaire was required to add lifts at defined stations. In Manila, there is a

[13] jeepneys are a form of paratransit with typically 12-20 seats

similar story, with the concessionaire being required to add lifts at defined stations after operations commenced.

10.5 ***Operational Performance***

10.5.1 Traffic is the core indicator of project benefits. All 4 systems seriously fail on this basis. Traffic is much lower than expected. In two cases expectations were based upon ridership studies, and in two cases no meaningful forecasts were undertaken (hence expectation was more an aspiration). The latest (May 2000) figures are:

- STAR carries 60,000passengers per day (ppd), a figure that is changing little. It is highly peaked during weekdays, with half the traffic carried at weekends. Fares are quite high relative to the buses. This is 20% of the forecast

- PUTRA carries 110,000 ppd following a large fares reduction

- Bangkok BTS carries 160,000 ppd, 27% of the forecast 600,000 ppd. Much of this is off-peak and weekend traffic, and the system has not yet captured substantial commuter traffic. Its fares are high relative to the buses.

- Manila MRT3 has not yet been fully opened, and its final section links to the main commercial district of Makati, which will undoubtedly increase traffic. Its traffic is 60,000 ppd, 13% of the expected 450,000 ppd on opening. Its fares are high relative to the buses and jeepneys

10.5.2 Only the Malaysian systems have been operational for more than a few months, and it may be expected that vigorous marketing campaigns will be undertaken to increase ridership (this is the case with the Bangkok BTS and KL STAR systems).

10.5.3 Government support has not been active: new projects have been implemented that compete with, or do not complement the MRT projects, the STAR concessionaire's ability to introduce improved service has been constrained, promised city centre car parking restraints have not been implemented.

10.5.4 In Bangkok experience with expressway BOT projects and the development of the MRT Blue Line give cause for concern as to how effectively contracts will be regulated e.g. in respect to price and competition. In Manila there are similar concerns, based on experience with expressways.

10.6 ***System Impacts***

10.6.1 ***Impact upon the Poor*** **-** Metro projects are often promoted for reasons of city efficiency, with the expectation that there will be 'trickle-down' benefits which will reach the poor. They should therefore always be justified in conventional economic terms, and if they achieve their expected impacts, there may be a reasonable prospect that the poor will benefit. This review raises questions about the economic efficiency of these BOT projects, owing to their poor traffic performance. To the extent that this is so, then the availability of benefits to 'trickle down' to the poor must be questionable.

10.6.2 To the extent that the projects reduce traffic congestion, then the poor in particular may benefit, because they typically spend long hours living, working or travelling in the street environment. Here the picture is unclear: the STAR and PUTRA projects are clearly attracting considerable car occupants, but overall ridership on the projects is as yet not large. Looking ahead it may be possible to build on these projects to develop strategies, which will indeed bring about health benefits from reduced congestion.

10.6.3 There is little recorded evidence about the *direct* impact of these projects on the poor but it is possible to put forward hypotheses, and to test these against experience with these projects. This is reported in section 14 of the report (Table 14.1). The available evidence supports the propositions, almost all of which are likely to be adverse for the urban poor. It seems clear that such projects do not specifically benefit them.

10.6.4 Turning to the *indirect* impact upon the poor, it is clear that this may be large. The argument is as follows:

- The public sector 'unexpectedly' requires to provide large funding for these projects[14]. Typically we estimate (see section 12) that the public sector support/funding needs to be US$ 0.6-2.0bn for typical elevated and underground projects respectively

[14] This is not strictly true for these particular projects, where the project investment company and banks may have taken a hit, but it is most certainly true for future projects, as investors will not repeat the mistakes of the first round of projects. Even for these projects there is no doubt that the Malaysian and Philippine governments are having to make very large, unexpected provisions for these projects

- The scale of this funding is large relative to the size of government's budget. The current Philippines transport budget is just $1bn for all road, rail, maritime and aviation projects for the whole country. In Colombia, the national government estimated that its 70% share of the construction cost of Bogota's first metro (a 30 kilometre line) would require a commitment of 30% of the total investment component of the national budget for the next decade

- The opportunity cost of one BOT metro can be seen to be large. The possibility of the needed funds being diverted from pro-poor programmes (among others) is not difficult to foresee

10.6.5 The overall conclusion is that these projects, as currently developed, are likely to have negative impacts upon the poor.

10.6.6 ***Environmental Impacts*** - STAR fits in well with the city form using an existing right-of-way or elevating over existing roads. Its standard of design is good, with no obvious problems. PUTRA too is aligned to fit into the urban form, and in the case of the city centre is tunnelled. Its quality of design is high, and it projects a high-tech image. There was a need for some squatter relocation, but there were no particular problems.

10.6.7 Bangkok BTS encountered depot problems. The ownership of the original site was unclear, and when it became clear required a need to extend the project substantially to find a new site. The project is entirely elevated, and the quality of its viaduct and station design is high. Problems occur along one road when a 'tunnel effect' is created and vehicle fumes are trapped under the stations, causing unpleasant conditions for pedestrians.

10.6.8 Manila MRT3 also encountered depot problems, in this case relocating 3,300 squatter families. It is located in the centre of Manila's largest traffic corridor, and adds no significant additional environmental problems.

10.6.9 ***Development Impacts*** - It is early days to evaluate the physical land use impact of these projects. There is no known impact of STAR, neither was this expected. In the case of PUTRA, major land developments associated with key stations were planned, but none have so far materialised. The recent Asian economic downturn may explain this.

10.6.10 Bangkok BTS was promoted by a property developer, and property benefits were planned from the outset. The depot site has been re-developed, but otherwise the property benefits are not obvious (having said this the project has only recently opened).

10.6.11 Manila MRT3 is also promoted by property companies, and development is more apparent here. The large depot site is being re-developed on a massive scale. The stations have been designed for development above and over the width of the broad corridor along which it runs, and already there is some evidence of such construction.

10.6.12 ***Impact upon City Development and Transport Strategy*** - This has been an objective of all the systems, in keeping with conventional wisdom on the appropriate role of mass transit. KL although a small, still green city, with high incomes has severe problems of congestion with its attendant air pollution. The MRT projects, together with the KTM commuter services (and the proposed Express Rail Link) should provide a quality public transport backbone that will serve KL well into the future.

10.6.13 That their impact has to date been limited, and that performance has so far fallen short of expectations is partly the failure to create an integrated network, and partly expectations of the BOT process that were unrealistic. Currently the public transport system is being comprehensively reviewed, with the objective of restructuring debt and creating an integrated system. Much can be recouped, with the right policies.

10.6.14 Bangkok has been trying to develop MRT systems since the mid 1980's, when busways and a single metro were recommended. Busways have never had a resonance, but there have been continuous efforts to develop metro and expressway networks. This has been done in a difficult institutional environment, which was compounded by the decision in 1990 to encourage government agencies to promote BOT projects individually. The result was a large number of concessions signed, many mutually exclusive, many competing directly with each other. Quickly the city became 'locked up' by these paper concessions, few of which made physical progress, but which pre-empted any other action by the government. It has taken 10 years to resolve the worst of these conflicts, and untold effort, during which Bangkok has developed a low-density car-oriented form of suburban development, dependent on the private car.

10.6.15 All these concessions were aligned down and reinforced existing major road and rail corridors. They have reinforced one of Bangkok's underlying problems – huge megablocks of land often in the inner city, which are inaccessible and therefore undeveloped or under-developed. By contrast development sprawls 50 kilometres and more down the main radial highways.

10.6.16 In December 1999, the first metro opened, the BTS or Green Line. The second is scheduled to open in about 2 years. There are already advanced plans to extend the Green Line. No other metros are at an advanced stage, the Hopewell project having been abandoned part-constructed, but there are plans for a large network. The Green Line has so far disappointed, but when it is extended it will do better. The real problem is that the system operates without effective integration, and the overall metro network is developing similarly. Eventually the projects will no doubt carry useful traffic. It is less clear what the strategic impact of the small network will have. In some ways it is too late to reap the advantages in terms of changing the structure of the city towards a more sustainable form.

10.6.17 Manila is a complex story. Government understood the need for MRT in the late 1970's and implemented LRT Line 1 purposefully. It extended down 2 of the main radials and was expected to breathe new life into the CBD, which had declined as the premier centre, due it was thought to congestion. LRT Line 1 was immediately successful – in traffic and financial terms (it is one of the better performing systems in the developing world, albeit not 'profitable' as many expected), but the old CBD has never reasserted its premier role. Meanwhile Makati, which is located adjacent to what used to be the main bypass of the city, has grown rapidly and is today a modern high-rise centre; and the bypass has been progressively upgraded, and is one of the largest corridors in the world, carrying very large bus passenger flows.

10.6.18 Political change and unrealised BOT hopes derailed future development of the MRT system. It was another 15 years before the private sector promoted MRT3 line opened (in late 1999) aligned down the 'bypass', and feeding the new centre of Makati; this is almost complete. It has become a radial to the new centre, after its development.

10.6.19 Manila's MRT network has undoubtedly contributed to its overall development. Its first Line was successful, but the improved accessibility to the old CBD was not matched by improved road accessibility (there was little reduction in congestion), and its regeneration never took off. Today a third line is at an advanced stage of construction, and there are plans, for new lines and extensions to existing lines, all private sector BOT schemes. It is probable that the network will be extended gradually, as the public sector support/ guarantees become understood and affordable. Meanwhile Makati has been developed purposefully throughout the post-war period. The new MRT lines are reinforcing the land uses that are there.

10.6.20 ***Profitability*** **-** BOT projects were expected to create 'profitable' projects in terms of the project companies at least. The evidence is that they have controlled the costs and construction times well. It is however the revenue side that has failed to live up to expectations, with farebox revenues much lower than forecast, and property profits non-existent or smaller than expected. The latter was no doubt exacerbated by the Asian economic crisis, which also adversely affected financing costs.

10.6.21 The result is that at least 2 of the project companies are technically bankrupt, with the others hurting badly. The evidence is that BOT projects do not by any means create profitable projects, even in their own narrow terms for the project company. And certainly when all the costs and risks borne by government are included the projects are not financially profitable.

10.6.22 In summary the BOT concessions have to date shown no evidence of changing the conclusions on viability reached for public sector metros. The firm conclusion should be that, except for possibly exceptional circumstances, these projects require large public funding and support – whatever the procurement form.

10.7 ***New Build MRT - Conclusions***

10.7.1 The test of this private sector approach is the efficiency achieved in implementation and operations and critically, the traffic attracted and benefits secured. The evidence is that overall construction has been well-managed, and that the systems operate well.. Without exception however ridership is low – much lower than expectations (typically one-third). The highest traffic on any of the systems is 160,000 passengers per day (ppd), approximately one-third of the Manila Line LRT Line 1 ridership.

10.7.2 Experience to date is that these projects are unlikely to be justified economically. To the extent this is true, the trickle-down benefits to the urban poor will be correspondingly small. It follows that the potential *strategic role* of MRT in development and transport strategy is not yet being realised. But strenuous action is underway to try and increase ridership, and the potential exists for much more to be achieved.

10.7.3 What then has been the impact of private sector concessioning? It is likely that this has been to control cost, and probably reduce it, while reducing implementation time relative to the public sector alternative. The qualifications to this are that:

- Cost reduction *per se* is not always desirable. In the case of MRT projects it has sometimes been achieved by purchasing low-cost – and low-specification equipment, which may be ill-suited to the task in hand

- Construction has sometimes been planned for the medium and long-term, creating problems for future upgrading of the systems as incomes and aspirations rise

- The major problem is that ridership/ revenues, congestion relief and economic benefits are too low. The failure to develop the concession as part of a *network* is probably the most serious problem.

10.7.4 All cities are active in promoting new projects, and in the case of Bangkok BTS and Manila MRT3, extensions to the existing projects. Many other cities are proceeding down this path. We started by noting that these experiences are early days in a new form of public-private sector partnership. Much has been learned from these experiences. Subsequent sections of the report analyse this, and draw conclusions for the potential of private sector participation in the future. There is little doubt that over time, and with the right government policies, these BOT projects will play useful roles in terms of development and transport strategy. The real message is that, with the benefit of hindsight, more should have been achieved.

10.8 ***Concessioning/ Privatisation of Existing Systems***

10.8.1 Extensive experience in Argentina, Brazil, the UK etc has allowed much to be learned about the potential for concessioning existing operations, both suburban rail and metros. This has provided the basis for the expansion of the approach, to Sao Paulo, Mexico City, South Africa and elsewhere. To date no such busways systems have yet been concessioned. We now review the Argentinean and Brazilian experience .

10.8.2 ***Buenos Aires –*** the Argentinean railways as a whole had declined between 1965-89, as a result of a lack of commercial orientation and a commercial pricing/

investment policy, inefficiency and lack of investment funds (Estache et al, 1999). Between 1989-1992 a new policy was established, with the Buenos Aires suburban rail and metro services unbundled and concessioned to the private sector. The State remained owner of all assets, and the concessionaire paid a fee to use the infrastructure for 10 years (suburban rail) or 20 years (metro), and to implement a programme of investments to rehabilitate and improve the line, as specified by government. Thus it was accepted from the start that government would need to provide funding to operate the services and improve the infrastructure. Contract award was on the basis of the lowest subsidy requested.

10.8.3 The impacts of the concessioning have been substantial:

- Suburban rail passengers have increased from about 200mn in 1992-4 to almost 500mn by 1999, with a far higher proportion paying, as fare fraud has been reduced. Its share of the Buenos Aires travel market increased from 5.8% in 1991 to 9.1% in 1997. The equivalent figures for the metro are a 53% passenger increase 1993-97, and a mode share increase from 2.8% to 5.5%.

- Service as measured by car-kilometres increased by over 50% between 1993-97 for both suburban rail and the metro. Over 85% of passengers surveyed confirmed that service level had improved post-concessioning

- There was a huge retrenchment of workers, who had reduced from 92,000 to 17,000 in 1998

- The scale of government funding is still high, about $400mn/yr, but much lower than the $1bn/yr before the reforms

- The overall results are not clear. In 1998-99 most contracts have had to be renegotiated to accommodate the unexpectedly high traffic levels. Most operators have secured 17-30 year extensions of their concessions, and a large 80% tariff increase spread over 4 years to carry out the agreed investment plan, pay for service improvements and/or reduce the level of public funding.

- Overall it is clear that the concessioning programme has improved service level resulting in large passenger increases, while increasing investment and reducing public funding.

10.8.4 ***Rio de Janeiro*** – to help deal with a budgetary crisis in 1995, the State government embarked on a major privatisation and concessioning programme for the metro and suburban rail system. The result was expected to eliminate subsidies for the metro, and reduce the suburban subsidies by two-thirds, while improving service, and clearing the backlog of maintenance and investment (Rebelo, 1999. The suburban rail concession was for a 25 year period, and the metro 20 years, each renewable. Tariffs were defined by government to be affordable to the poor.

10.8.5 For the *metro* in Rio de Janeiro, unlike the Buenos Aires model, the state undertook to carry out new investment works, which spanned the contract award. The metro was concessioned in December 1997 after strong competition, and surprisingly attracted a positive bid – surprising because the metro assets and operations were in bad shape. The NPV of the concession fee was ten times the expected minimum defined in the bidding documents, considered a considerable success, and a $100mn pa deficit has been converted to a $100mn pa surplus. Patronage has increased slightly, but is constrained at the peak due to difficulties in expanding capacity (the track gauge at 1.6 metres is non-standard, which causes extra rolling stock acquisition difficult[15]). To the public there has not been a great change, as it has not yet been possible to secure agreement to integrate the metro with the buses.

10.8.6 The *suburban rail* concession had been preceded by transfer of the operation to the State. The system was concessioned in January 1998, after strong competition. The highest price was six times the minimum defined in the bidding documents. It is early days, but the indications are positive. Integration with the buses remains a challenge in Rio de Janeiro.

10.8.7 ***Conclusion*** – Experience suggests that there are essential prerequisites to maximising the potential of suburban railway systems, and they may benefit metro operations too. In particular, suburban rail operations that are to contribute effectively to urban transport requirements are likely to require an institution which is separate from the national railway system, whose geographical coverage is coterminous with the main commuter catchment area, and which has some financial independence. This may involve corporatisation or, usually better, concessioning of the railway to the private sector.

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[15] This points to the problems of proprietary or non-standard rail systems

10.8.8 Railways are often reluctant in practice to give up their suburban operations, yet without this, apparently 'obvious' physical opportunities which should be attractive for rail operations cannot be effectively exploited.

10.8.9 Given this autonomy, and management focus to establish and control its costs, and decide marketing strategy, the suburban railway can be considered in its urban context, and decisions taken on service level, tariffs, subsidies and investment. Too often the role of suburban rail is confined (only) to that of carrying the peripheral urban poor, at very low tariffs (or often without any payment). In contrast in Europe suburban rail is used by middle and upper income groups, who pay a premium fare for a quality service (albeit a fare that is often subsidised to attract potential car users).

10.8.10 The Latin American experience has comprised a three-prong approach, which appears to be successful: decentralisation of responsibility, concessioning to the private sector, and negative concessions in which tariffs are defined by government to be affordable to the poor. In effect this creates 'surface metros' at low cost, which can benefit the poor. In Brazil implementation has been by means of 4 'pillars': creation of a Regional Transport Coordination Commission, which includes all public transport operators at national, state and municipal level; development of an integrated land use/transport/ air quality plan, which provides the catalyst for coordination and shared analyses; development of additional funding sources by advertising, use of the right-of-way by cable companies etc; and concessioning to the private sector.

10.8.11 Elsewhere there are proposals for various forms for private sector involvement in metros. In Sheffield UK, an operating concession has been let for the Supertram system, whose patronage and financial performance have been problematic. This led to rapid increases in patronage. In Hong Kong the MTRC is to be part-privatised later this year, by selling shares rather than re-management. In Manila there are proposals to privatise LRT Line 1, which has a healthy surplus of revenue over operating costs.

11 Affordability and the Private Sector

11.1 *Financial Forecasts, Outturn and Risk*

11.1.1 This section establishes that metros (in particular) are unlikely to cover all their costs from project revenues, and that they are risky investments. Together these factors make their funding and implementation as BOT concessions problematic for the private sector. It then establishes that there may well be a rationale for public sector support, that this may need to be large, and that it needs to be put in the context of competing demands for scarce available public investment resources. These issues are at the heart of the metro debate.

11.1.2 We start by noting that busway costs are low in relation to other mass raid transit modes; but even here, there are examples of the initial cost being problematic for hard-stretched city governments. The answer should be that they can be implemented incrementally, as funds allow, preferably into systems. For, although there are few integrated *systems*, where they do exist (in Curitiba and Quito), it is reported that they cover their full operating costs (including depreciation, debt service etc).

11.1.3 However, the core sector problems concern the development of metros, and we examine their record of profitability, first by considering the public sector evidence, and then recent BOT concessions.

11.1.4 ***Public Sector Evidence*** **-** the financial structure of a metro project is determined by:

- The capital cost (which depends upon construction time)
- Operating costs
- Traffic and tariffs, hence revenues
- Other commercial opportunities
- And the terms of finance, including tax allowances

11.1.5 **Table 11.1** summarises what we know of the forecasts of the first three parameters (Allport et al, 1990). It is apparent that the outturn results differ markedly from the forecasts, and almost always to the detriment of the project finances.

TABLE 11.1 METRO PROJECTS: FORECASTS AND OUTTURN

PARAMETER	CRITERIA	PERFORMANCE
Case Studies Cities	• 21 in total • 13 with metro	
Capital Cost	**Compared with Forecast** much lower -10% to +10% +10+ to +50% +50% to +500%	**No. Cities** None 3 4 6
Construction Time	**Compared with Forecast** much better as forecast up to +50% +50% to +500%	**No. Cities** None 3 6 4
Operations And Operating Costs		**Compared with forecasts** • operations are almost always good • costs always much worse, or very much worse than forecasts
Metro Passengers	**Compared with Forecast** much better as forecast up to -50% -50% to -90%	**No. Cities** None 1 3 5

11.1.6 ***Private Sector Evidence*** – Section 10 of the report has reviewed the private sector experience, where costs have probably been controlled better than the public sector equivalent. But traffic and revenues are if anything worse than their public sector equivalent. Also, expected funds from development profits (which were expected to contribute to the project financing) have disappointed. If there was not government support (outside the concession contract) at least 2 of the 4 project companies would be bankrupt.

11.1.7 ***Project Risk*** **-** Metro finances are inherently risky. The surplus of (dominantly farebox) revenues over operating costs needs to finance the capital cost, asset replacement (this is large, particularly when the rolling stock requires replacement), and, in the case of private sector concessions, dividends acceptable to share-holders. Both these critical parameters **-** the revenues and operating costs are each numerically large, and their difference is inherently uncertain. It is inevitable that the project finances are themselves uncertain.

11.1.8 The problems with MRT projects follow some early successes with BOT expressways, and sometimes a mistaken belief that metros are similar. But **Table 11.2** shows that they are quite different.

TABLE 11.2
CHARACTERISTICS OF EXPRESSWAY AND METRO PROJECTS

Project	**Cost Risk**		**Benefit Risk**		
	Capital cost over-run	Operating cost over-run	Traffic low	Congestion relief low	Development/ regeh benefits low
Expressway	Low/medium	Negligible	Medium	Low/medium	Varies
Metro	Very high	Very high	Very high	Very high	Very high

11.1.9 It is clear that the private sector cannot be expected to entirely fund and/or take the risk associated with metro projects. Instead a public-private partnership is required, and we now consider the rationale for public sector involvement.

11.2 *Level of Government Support*

11.2.1 The conventional wisdom, which we support, is that metro projects should be shown to be viable in economic terms, even though we have shown that, with the exception of the Hong Kong MTR, none is likely to be in financial terms (when all the costs are included). The difference between these evaluation criteria provides the rationale for government investment in ‘good’ metro projects.

11.2.2 We have seen that metros can have major effects on cities, as reported subsequently in this report. A full socio-economic analysis is required to establish the overall worth of a project. This includes economic together with social, developmental, environmental and financial evaluations. The economic evaluation for a metro typically includes the following benefits:

- Time savings for metro users, bus passengers and car/motor cycle etc users
- Benefits resulting from new 'generated' trips
- Comfort-and-convenience benefits which metro passengers perceive
- Cost savings to private traffic and road freight
- Cost savings to bus operators
- Operating costs of the metro,
- Savings from reduced traffic accidents, and
- Savings to other sectors of the economy, through changed government tax receipts

11.2.3 It will be apparent that *financial viability* is concerned with only some of the above parameters, specifically those costs and revenues directly associated with the metro project. We thus typically find a large difference between the economic and financial viability of a metro. Based on the 1990 research, about half these benefits may be received by metro passengers, and the other half by road users and the wider community, who do use and do not contribute funds towards the metro. The rationale for public investment is to secure these non-financial benefits.

11.2.4 For 'good' projects government should be prepared to invest to capture the external benefits received by these other road users and the wider community; if they do not it could be argued they would need to incur added expenditure to secure the benefits. The maximum level of public investment should in principle be the difference between the economic and financial evaluations, modified for other environmental, social and development benefits created.

11.2.5 It should not be surprising that few, if any, metros in the world are in narrow terms financially viable. There is no reason why they should be. Rather they should be evaluated within this broader framework, and if appropriate government should invest to secure the wider benefits.

11.2.6 It is therefore perplexing that the private sector BOT approach usually assumes that projects should be financially viable, and to support this many contortions take place to create apparent viability.

11.2.7 An alternative approach would recognise the characteristics of the projects, and determine by analysis the rationale, and if appropriate the scale of public investment which may be justified. This could provide the basis for bidding under 'reverse-tender' or 'negative' tenders, in which the government seeks to minimise the public funding required within this cap, by a process of transparent bidding. But first, it needs to ensure this is a rational allocation of public funds. The next section considers this.

11.3 *Affordability*

11.3.1 Many large cities seem to want metros, and those who can rationally afford them should be developing such projects. Unfortunately the link between the desire and the means to afford them is not always made. The 'good news' is that as economies grow and incomes rise, then metros become more affordable, because their costs increase at a slower rate than their benefits (equipment and construction costs often increase little in real terms, while most of the benefits increase proportionately with incomes).

11.3.2 The importance to decision-makers of understanding the scale of public investment funds required to implement metro projects, either as public sector projects, or as so-called 'private sector' BOT projects, follows from the scale of the funding involved..

11.3.3 Based on the available evidence of outturn costs, and including often 'hidden' public sector costs, we have estimated that the all-in cost of metros in Asia today is about:

- At-grade US$ 15-30mn/km
- Elevated US$ 30-75mn/km
- Underground US$ 60-180mn/km

11.3.4 These costs are high by any standards, and result from:

- The project development process
- The procurement approach
- The high start-up costs when constructing for the first time (compared with extending an existing system)
- The actual high costs of equipment in an industry where economies of scale are as yet not large

- The high technical specification which has become the norm
- And the sheer scale of engineering work, which can overwhelm administrations without previous recent experience

11.3.5 **Table 11.3** estimates the public sector cost implied by such projects, based on Asian experience (Allport et al, 1998):

- The cost of typical 15-kilometre projects is the starting point – for the main construction types, elevated and underground

- The public sector component is estimated, based upon research and experience of working on BOT projects for the private and public sector. The central conclusion is that these are large costs

- Their significance is seen when the current Philippines public sector transport budget is defined – this is $1bn for all road, rail, maritime and aviation projects for the whole country. Another example is provided in Colombia. The national government there estimated that its 70% share of the construction cost of Bogota's first metro (a 30 kilometre line), would require a commitment of 30% of the total investment of the national budget for the next decade

- The opportunity cost of one BOT metro can be seen to be very large, and incur a public sector cost equal to twice the Philippines' annual transport budget

- Such BOT projects do attract substantial private funding, which is often their central rationale. But this only comes when there is a large public sector investment too, as the table shows. Each private sector $1 requires a matching public sector $0.6 in the case of an elevated metro, and $2 in the case of underground construction.

11.3.6 The conclusion of this simple analysis is that so-called 'private' sector projects will require a large level of public funding, and that this has potential macro-economic impacts, which require to be addressed, before assuming that such funding represents a rational use of public funds.

TABLE 11.3 METRO AFFORDABILITY

Cost (US$)	Metro	
	Elevated	**Underg d**
Cost per route-km $mn	75	180
Cost for a typical 15 kms project $bn	1.1	2.7
Cost to the *Public Sector* $bn	0.6	2.0
Public sector Transport Budget p.a.	US$ 1bn all sectors, whole country - Philippines	
$1 Private sector requires *Public Sector*	$1.2	$2.9

11.4 ***Necessary Role for the Public Sector***

11.4.1 We have highlighted the problems encountered with the BOT process for new-build MRT systems, and it is clear that the mechanism for effective private sector participation needs substantial change. To date the private sector has been successful in implementing some MRT projects[16] and shown skill in securing construction/ supply profits, but not in handing over to government a transit system with good commercial prospects, or one which necessarily meets public policy objectives.

11.4.2 If there is any 'fault', it does not principally lie with the private sector, but with governments who have not always understood the potential of BOT projects in this sector, or who have embarked upon the projects without the resources to protect the public interest **(Table 11.4).**

11.4.3 So the starting point to defining the role of the private sector is to define the necessary role of government.

[16] whether more successful than government is difficult to say: in Manila for example Government implemented the first LRT line, and is implementing Line 2 in parallel with 'private' MRT Line 3 . It is often true however that 'private' projects have allowed fares to be higher than would otherwise be the case

TABLE 11.4
PERCEPTIONS OF BOT MRT PROJECTS

Perception	**Reality**
Metros make money - the private sector will fund them	They do not... ..most of the capital cost will need to be funded by government
The private sector will cross-subsidise the metro from property profits.	Not so – usually there are minimal property profits for many years. Property is no solution to the funding problem, and exacerbates the total risk
The private sector can identify a project and 'make it happen'	Only gov't can acquire land., and gov't action is essential to implement a metro
The private sector knows about metros... and can implement 'good' projects	The private sector undertakes minimal planning and focuses on low initial cost rather than serving traffic requirements and whole-life costs. Its interests are not necessarily those of passengers.
The private sector understands the critical importance of integrating the metro into the transport system	If it understands this, it is unable to do so, without government action
The private sector will be commercial and effective managers of the metro operation	The private sector will not usually be interested in operations. The evidence is that both public and private sector operators can be effective.

11.4.4 The evidence allows us to conclude with confidence that Government needs to be proactive in determining strategy, and identifying the projects it wants implemented, and will support. All the evidence suggests that the private sector cannot identify and implement projects, without strong government support. Project revenues and risks will depend upon the effectiveness of this government action e.g. in allowing competing projects, or in integrating projects into the public transport network. We now consider the core tasks of government.

11.4.5 ***Defining Transport Strategy -*** government needs to define an implementable, affordable strategy, which builds in realistic assumptions about private sector participation. The strategy should result from substantive investigations of the options in the context of the City Development Plan.

11.4.6 ***Identifying Projects* -** Attempts by the private sector to ‘make BOT projects happen quickly’ have time and again failed. Government must take the lead in this process, by identifying the projects it determines are important. Only then can there be confidence that anything will be implemented, and that what is implemented will likely be beneficial.

11.4.7 Government must therefore prepare projects, and face up to the realities decisions which will be required. These are:

- Public funding
- Risks - most private proponents want government to shoulder risk, and provide guarantees (often another form of funding)
- Land is always needed and must be acquired
- Permissions are required, which requires government action
- Tariffs may be high to reduce the need for public funding (even if they are not revenue-maximising), and they must be acceptable to government
- The environmental consequences of new infrastructure must be acceptable
- The consequences for traffic during construction and operations must be acceptable

11.4.8 ***Implementing a Transparent BOT Bidding Process* -** Government needs to develop the existing BOT bidding process so that it better serves the public interest. A problem in these ‘early days’ has been that private groups have sometimes been awarded contracts which freeze out any opposition and yet carry substantial risks for government, without purposeful feasibility study, and sometimes without transparent competitive bidding.

11.4.9 Change is required, based upon the following principles:

- Government should confirm that such privately funded projects conform to its stated policy and strategy.
- Projects should be the subject of rigorous feasibility study, which should identify risks – thorough risk assessments are needed.

- The procedure for bidding of Unsolicited Projects should be critically examined. As a minimum, government should accept no risks on such projects, and the time available for competitors to prepare matching bids should be adequate
- Risks should be allocated between government and the private sector on the basis of which party is in the position to control, or insure against the risk.
- Government should establish whether the terms of a bid result in value for money for the public sector.

11.5 ***Interests of the Private Sector***

11.5.1 Unlike the water or power sectors, where there are privatised companies with sector experience in operations and management, there are not as yet 'transportation companies' who have an interest in bidding for and operating metro projects over the long-term in developing cities. The transportation companies that do exist (in France, the UK, USA, Australia etc) tend to focus on markets which have predictable processes and regulatory environments, and show little interest in most developing city concession projects.

11.5.2 Instead, interested bidders are mainly those with short-term interests expecting to profit from creating the project (and selling on), construction/supply contracts, and development gain from associated property. Where the private sector participation process is not fully competitive, short-termism is exacerbated, and the concession contracts may become milch cows, with the profits ring-fenced by the concessionaire.

11.5.3 This absence of players committed to the long-term has important implications for the future development of private sector participation, and the form of modality best suited to the market. A combination of government not yet skilled in applying the private sector participation process, and a short-term focus by the private sector is unlikely to deliver 'good' BOT projects, as measured by the yardstick of either party.

11.5.4 It may be preferable for alternative modalities to be developed in such situations. For example, procurement may be split, with infrastructure design/construction let as one or more turnkey contracts, and equipment supply and operations/maintenance let as a separate concession for a 25-30 year period. This is the basis of the approach being followed for the Bangkok Blue Line, and also for Sao Paulo Line 4.

11.5.5 This approach better aligns the project phases to the interests of the contracting parties: construction profits and operations/maintenance. The reasons for tying the equipment supply to operations and maintenance in one concession are that :

- Equipment is then likely to specified on the basis of whole life costs
- Potential problems with technical interfaces are minimised
- The major equipment suppliers are changing their approach and recognise that they need to be in the business of long-term operations and maintenance. This is being spurred by changing procurement practices in Europe and North America and railway privatisation. They do this by forming alliances with operators, usually over the initial years when an operation is being set up.

11.5.6 In different circumstances, it may be preferable for government to implement the whole project, and to set up the operations, followed by letting an operating/ maintenance concession contract. This substantially reduces the risk associated with the operating costs and the traffic/revenues. Other approaches may be adopted, for example if there is a substantial cash surplus from an existing operation, this may be combined with a BOT approach to extend the system.

12 Public Transport Integration

12.1 ***Integration***

12.1.1 Transport integration can be considered at various levels. At the strategic level, it is the aim of any city to integrate land use and transport to reduce the growth in length and number of motorised trips, encourage means of travel which have least adverse environmental impact and reduce reliance on private car transport.

12.1.2 At the operational level, a well-integrated system allows travellers to change between services and between modes in an efficient manner and with minimum inconvenience. System-wide transport operational integration is difficult to even when most modes are controlled in some way (through route franchises, service contracts etc) by the transport authority. In developing cities with a high degree of de-facto or intended deregulation, integration of operations is likely to pose even greater difficulties.

12.1.3 ***The Dimensions of Integration*** - The term 'integration' is often used without a clear definition. In its fullest it requires[17]:

- Coherence between transport, land use and other social and economic policies
- Consistent resource allocation criteria between transport modes
- Consistent budgeting across all modes and services
- Rational pricing, including externalities
- A coherent multi-modal system of regulation
- Design of services and facilities to reflect their individual strengths
- Facilities for easy interchange between modes and services
- Common fares and ticketing
- Co-ordinated timetabling where practicable
- Multi-modal passenger information

[17] see Bayliss, 2000

12.1.4 In practice public transport integration is usually taken as including only the lower half of this list, with the last five or six features being regarded as representing an integrated public transport system. However there is one important exception. Most integrated networks will include services (or service elements) that are un-remunerative and are provided for wider social reasons. This implies the inclusion of an element of the first feature in the list.

12.1.5 In the context of MRT systems, other than 'open' busways, any or all of the following are normally required:

- Physical design at stops/stations, to facilitate interchange (always required)
- Restructuring of bus routes to 'feed' stops/stations (always required)
- Integration of rail/bus tariffs, reducing the penalty of interchange, and
- Provision of public transport network information

12.2 *Busways Experience*

12.2.1 We have noted that there are few system-wide busways and thus experience relating to busways is limited. The following points are noted:

- *Fares integration* – trunk and feeder busway operations require interchange. If the trunk buses and feeder buses are to be operated efficiently and the passengers attracted to the service, some form of 'through ticketing' (in which passengers pay once in a journey) is required. In Brazil, the trunk-feeder system of bus operation is common and integrated fares have been used successfully in Curitiba and in Sao Paulo. The system is understood to be in operation in Quito and planned for Bogota and Lima. As the trunk and feeder services may not operated by the same company, integration requires institutional arrangements for revenue distribution. The Brazilian experience shows that this can be achieved with strong political will (the bus operators are not normally willing to enter into such arrangements), and providing government is willing to fund any resulting deficit on the rail operations

- *Integration terminals* - interchange between trunk and feeder or trunk and conventional buses requires some form of terminal. At the out-of-town terminal on a trunk and feeder system, land provision has not usually proved an issue and terminals are often planned as local service or business centres. At intermediate points along a route, land requirements are also relatively small. Passenger demand tends to be lower, large terminals or stops are not needed , and on-line bus stops providing 'walk across' interchange between trunk line and other buses do not require excessive space. However, space requirements for a terminal may pose an issue in the city centre. As with most transport planning, it is difficult to suggest general guidelines – the problems and the ways in which they may be resolved are highly city specific. However, we note that:

- a suburban railway, for example, requires stations in the centre of cities to be effective – a busway system should be regarded in the same way. Even if it necessary to expropriate land for a terminal, the costs of the busway transit system as a whole is likely to be much less costly than any rail system
- busway terminals offer the same opportunities for commercial exploitation as any other mass transit terminal; the development at the bus terminal close to the Star Ferry in Hong Kong is illustrative
- bus routing may play a role; buses may be routed through a city centre rather than terminate. Depending on passenger interchange requirements this may reduce the space requirements for terminals.
- busways cannot be divorced from city transport policy. It is now common part of policy that car access to congested central areas should not be unlimited and pedestrianisation and bus only streets form part of that policy. If road space is reallocated to buses and pedestrians, facilities for bus terminals and interchange can be included

• *Services integration* - an integrated trunk and feeder busway system will require the reorganisation of existing bus services and paratransit services in the relevant corridor. This may be a factor in determining whether busways are beneficial

• *Passenger information* – passenger information greatly assists service integration. Use of IT is increasing in bus systems – real time displays of 'next bus' and 'time of expected arrival' are now common place in developed cities . As the real costs of the technology reduces, they could increasingly form part of a busway system in developing cities.

12.3 Rail Systems Experience

12.3.1 These require integration, since all but the walk-in passengers must access stations by other transport modes, overwhelmingly buses or partaransit. A few very large cities develop large rail networks, but most cities do not, at least for many years.

The rail system (in particular metro system), is usually a small part of the public transport network, geographically a small footprint in the middle of a much larger urban area. Buses/ paratransit increase the catchment area many times, and are essential to attract the 'mass' ridership which is necessary to justify the high cost of rail systems.

12.3.2 It may be thought that integration would remove the competition between the metro and buses/ paratransit, but this is not normally so. The metro is a high-cost mode, creating a premium level of service – and often charging a premium fare. When this is the case, buses will continue to be necessary to carry those who cannot afford to use the metro, and for short-distance travel in the corridor. Although these roles are in principle complementary, some overlap is inevitable leading to some measure of competition. Secondly, it is in any case usually desirable that there should be competition. In cities where public transport regulation is well developed, service quality may be included in a concession contract and enforced; but this is by no means the usual situation. And in these circumstances without competition, there will be no spur to provide efficient service.

12.3.3 **Table 12.1** summarises the integration measures planned and implemented, established in the 1990 MRT research (Allport et al, 1990).

TABLE 12.1
METRO INTEGRATION MEASURES IMPLEMENTED

Form of Integration	**Number of Cities**	
	Planned	**Implemented**
Removal of competing bus routes	14-15	3
New feeder bus routes	14	6-9
Integrated fares	7	3-4

12.3.4 This demonstrates that effective integration is difficult to achieve, and this is a major reason why ridership forecasts were found to be high. It is clear that planning MRT projects (and this applies to differing degrees to all forms of MRT) on the assumption that integration will happen can be misleading, and undermine confidence in the ridership forecasts. It follows that integration should be central to MRT planning and project development.

12.4 ***The Issues***

12.4.1 ***Context*** - A parallel paper (Bayliss, 2000) addresses the broader issue of the forms of competitive regime and regulatory requirements that exist, their application and their impacts. Integration should be viewed in this context.

12.4.2 The overall issue is that creating a successful MRT project may ‘require ’significant change to the public transport market. Route restructuring may affect all passengers, those who do not use the rail system as well as those who do. Tariff integration may require consolidation of supply, resulting in a small number of operators. A busway may require paratransit operations to be replaced by buses. These changes may in themselves be desirable (in which case the MRT becomes a catalyst for change), or they may not be (they may for example adversely impact upon the poor). Such changes to the overall market require careful examination, as part of the [planning process, in determining what form of integration may be both feasible and desirable.

12.4.3 The starting point in planning is to understand the potential passenger market. The income profile of travellers in the rail corridor is critical. In many developing cities there are large numbers of low or lower-middle income bus passengers, and relatively few who are middle-class. Metros in particular need to attract the middle-class, but they also need to attract a large number of the lower-middle income travellers, if they are to carry a ‘mass ’ridership. This constrains the metro fares policy, because unlike buses the metro cannot discriminate between passengers.

12.4.4 The geographical location of the urban poor may be important. The only way to target the poor in many cities is by targeting services to poor neighbourhoods. When government regulatory capacity is well developed, this may be achieved by letting service contracts, specified by the authority, maybe involving cross-subsidy between routes; but where this is not the case, this is not an option. Sometimes the poor are on the city periphery while employment is distant requiring long journeys (this is typical of many Latin American cities), and flat fares are adopted on social grounds (being cross-subsidised by shorter-distance travellers). This may constrain bus/paratransit fare structures.

12.4.5 The structure of the public transport industry determines what is possible. This varies between cities. In many cities, informal (and sometimes illicit) paratransit operations play a major role, in others there are multiple bus companies, while in others there may be a small number of large bus operations. When supply is fragmented, it is difficult to control, and some forms of integration cannot in practice be implemented. Whether change to consolidate operators is possible depends upon circumstances, often this has been resisted and has not been implementable

12.4.6 ***Bus Route Restructuring –*** The importance of restructuring depends upon circumstances. Once the target market for the rail system is determined in income terms, its target geographical catchment can be defined. Bus route restructuring may be necessary: to ensure that

- Existing services feeding the corridor stop at stations
- New 'feeder' services provide access between the catchment and its stations. These may be 'premium' quality (like a metro) to attract the target market
- There are related changes to frequencies and the routes of remaining services
- And sometimes to eliminate 'wasteful' competition

12.4.7 In principle these changes should not be difficult to bring about, but as shown above, in practice they are often not made.

12.4.8 ***Tariff Integration -*** The simplest form of tariff integration occurs when tariffs are graduated (increasing with distance travelled) on both the line-haul and feeder mode. This minimises the deterrence of interchange. Tariffs on metros should normally be graduated, allowing sophisticated marketing and pricing strategies to be developed, but this is not a uniform practice.

12.4.9 In the absence of this simple form of integration, and in the absence of 'through ticketing (next paragraph), the possibilities and their outcomes are as follows. (**Table 12.2**). However even with both systems graduated, the graduation is often tapered, so that there is a disincentive to transfer unless the tariff covers the whole journey.

TABLE 12.2 TARIFF INTEGRATION STRATEGIES

Trunk Service Tariff (rail or busway)	**Feeder Service Tariff** (usually bus/paratransit)	**Outcome**
Flat	Flat	Little interchange, low ridership
Flat	Graduated	Modest ridership
Graduated	Graduated	Higher ridership

12.4.10 Full tariff integration is the ideal, creating lower combined (bus and rail) fares which will attract passengers e.g. with 'through tickets' or zonal fares. This requires agreement between the bus and rail operators on revenue-sharing and an autonomous revenue-sharing agency to be established. Experience demonstrates that this ideal is only unusually achieved in developing cities. It requires the following:

1) A small number of formal bus operators. It is impossible to revenue share with many. The requirement to integrate tariffs may therefore determine the structure of supply. Conversely the characteristics of supply could determine the feasibility of tariff integration: e.g. if it not possible to replace paratransit by bus services

2) Strong political will. Experience is that bus operators are reluctant to enter into such revenue-sharing arrangements, which remove their ability to compete on price, and will only do so when government imposes the policy

3) Willingness to subsidise the rail operations if necessary. The bus operators may insist on a 'lion's share' of the shared revenue, and implementation may leave the rail service with high patronage (because integration is effective) but limited revenues (the Sao Paulo experience)

12.4.11 Ticketing equipment constrains tariff structure and tariff integration. Simple coin-in-the slot equipment does not allow the introduction of graduated fares, and tariff integration requires compatible ticketing equipment for the different modes. To date magnetic stored-value tickets have usually been used. Increasingly smart cards will facilitate such ticketing, allow the revenue to be allocated automatically to the operators, and substantially reduce revenue fraud. This is likely to assist in tariff integration.

12.5 Implications

12.5.1 MRT systems comprise the MRT options and their feeder services, which need to be integrated one with the other. There are many practical impediments to doing this. Purposeful planning is required to determine what elements of integration are important, what is achievable and the implications for the viability of the MRT options. At one extreme the failure to be able to implement effective integration may undermine the case for such projects. At the other, the MRT may be a catalyst for change, facilitating greater competition in the public transport market, with outcomes which strongly support public policy.

12.5.2 These issues are central to MRT viability, and need to be addressed early and progressively in the project development process. When this is done, confidence will progressively be developed in the ridership, revenue and benefit forecasts.

C MRT IMPACTS

13 Economic Viability

13.1 *Busways and LRT*

13.1.1 There are, as far as is known, few published *ex-post* evaluations of busways - a deficiency which should be corrected and would assist decision making for potential schemes. Many traffic management bus lanes schemes have been shown to have high rates of economic return since costs are typically low and benefits high (provided person travel time savings are included). Intuitively, well-designed busway schemes should produce positive results. Even where road space reallocation from private vehicles to buses is extensive, evaluations are still likely to be positive due to the relative efficiency of heavily-trafficked busways in using roadspace.

13.1.2 The rigour for busway evaluations needs to be substantial if the results are to portray a balanced picture and assist in scheme design, and it is doubtful that this is always done. Instead the benefits often seem obvious and the costs few. Yet as we have shown this is a simplistic view, and there is then a danger that some of the adverse impacts are not quantified, resulting in a misleading picture.

13.1.3 The economic evaluation should encompass the benefits to users of the system (higher speeds, maybe to some extent offset by the need to interchange) and the impacts of the busway on other travellers (including changes in traffic congestion in the corridor and changes arising from restructuring the public transport system); and it should incorporate all the relevant implementation costs.

13.1.4 A similar picture emerges in respect to (at-grade) LRT projects, but more so: there is a record of 'optimism' regarding many of the critical factors.

13.2 *1990 Metro Research*

13.2.1 The 1990 research (Allport et al, 1990) was tasked with establishing the economic viability of metros in developing cities, and specifically developing guidelines and a method for identifying such projects at a pre-feasibility level. Accordingly case study material was collected, a strategic land use/transportation model developed and validated, and the model applied to operating metros in the case study cities.

13.2.2 The results were influential in changing perceptions about metros, in particular towards the view that the right projects could be justified economically, in the right circumstances. The results depended upon:

- The overall method and assumptions adopted
- The database
- The specification of the model, and
- The input assumptions to the model – planning data, assumptions about fares etc.

13.2.3 We are not aware of fundamental questioning of this work in the last 10 years, albeit that the difficulties involved have been much discussed. Nevertheless with the benefit of time, it is right to question it.

13.2.4 The underlying method and assumptions tackle the problem of quantifying impacts which are necessarily complex and require evaluating long-lived assets in an uncertain environment. This review does not revisit these issues, as significant new insights which would practically affect the re-evaluation have not been developed. This is not to duck what are recognised as critical issues, but to recognise the limitations of our state of knowledge.

13.2.5 The database used in 1989-90 to validate the model was considered to be as good as was possible to collate. It resulted from visits to all cities, many meetings and the collection of extensive reports and data. It is as good as data normally is in developing cities.

13.2.6 We first briefly summarise the main results of the 1990 research, and then update the main conclusions in the light of the last 10 years experience.

13.3 ***1990 Research Conclusions***

13.3.1 We start by repeating the overall conclusions from that research (Allport et al, 1990):

Economic Evaluation

We have developed a method for evaluating metros and metro projects quickly and cheaply, and we have applied it to 13 operating systems. We do not claim great reliability for the method, which is not intend to supersede the detailed evaluation of a full feasibility study, but we consider it to be a practical tool for strategic planning purposes. The method includes a probability analysis to take account of uncertainties – of both data and forecasts – inherent in such an evaluation. Ten metros were evaluated by the full method, which includes a small traffic model; three received only a simplified evaluation without the traffic model.

According to our evaluations:

- 3 metros produced rates of return of less than 10%
- 3 produced returns between 10.0% and 12%
- 2 produced returns between 12.0% and 15%
- 4 produced returns above 15.0 %

In most cases the results depend on continuing growth to patronage and income (which determines the value of time). These results suggest that, given the right conditions, metros in developing countries can be worthwhile. It seems impossible however, without a radical reorganisation of taxes, tariffs and controls in relation to cars and buses in urban areas, for metros to be financially viable. The financial position of some metros could be improved by raising fares but this would usually reduce the economic net benefit by impelling some passengers back to the buses.

The results should be seen in perspective. The two best results were for Singapore and Hong Kong, neither of which is classed today as a developing city; it is their relatively high values of time that enables these cities to produce such respectable rates of return. The other satisfactory results come mainly from some of the most heavily used lines in the world. In very large, middle-income developing cities, namely Seoul, Mexico City, Sao Paulo and Santiago. Pusan is a linear city of middle income, ideally structured for a single metro line; Medellin, which we did not evaluate, is similar. Some cities, like Karachi and Bogota (another linear city until recently), have one predominant corridor, which one day might justify a metro line without implying a case for any others. But these were exceptional corridors. In Mexico City our evaluation was confined to the first three lines; the later ones were far less successful and would certainly not produce a satisfactory return. Nor would Line 2 in Santiago or Line 3 in Seoul, if evaluated properly. The Calcutta results must cast doubt on the prospects of any metros in the Indian subcontinent until income levels are considerably higher.

'The results do not imply, therefore, that similar results could be obtained in many other developing cities. Two results are of interest are those in Manila and Tunis. These cites are not in the 'giant' class, nor are they near the top of the income range. Both concentrated on cheapness at the expense of performance and capacity, especially Tunis. By keeping capital and operating costs relatively low, they appear to have achieved a respectable rate of return.'

The Costs and Benefits

'A feature of metros is that the capital costs predominate. Annual operating costs average less than 6% of capital costs (in real terms) even after 20 years of operation when passenger volumes have built up. In our evaluations, which cover periods of 40-50 years of operation, capital costs constitute 34% of total costs but, because they occur first, they constitute 77% of the costs after discounting at 10%. Their impact on the economic evaluation is therefore very great.

'Benefits consist largely of time savings - even at the low values of time adopted in developing countries, they amount to 63% of gross benefits. About 90% of time savings accrue to bus passengers, and are divided approximately equally between passengers who use the metro and passengers who stay on the bus. About 8% of the gross benefit is accounted for by the 'comfort-and-convenience' allowance to metro passengers and another 8% by generated traffic, which represents development benefit. Even the development benefit really consists in savings in time and convenience – from being situated in the city centre rather than a suburb. And nearly all the time saving is in non-working time, although a great deal of it is time travelling to and from work. The only 'concrete' benefits i.e. savings in material and paid labour, come from reduced operating costs, which comprise 21% of gross benefits (15% from buses and 6% from private transport), and 60% of these savings are offset by the operating cost of the metro.

Alternative Solutions

'Our evaluations were made against a do-minimum alternative. There may be other strategic solutions which may provide better value for money than a metro, and (elsewhere) we comment on their potential. In the very largest cities, however, it is difficult to envisage another transport solution that could carry as many passengers. Bus solutions would require three or four new roads to equal the capacity of a single metro. The only plausible alternative would seem to be a land use solution, i.e.. a decentralised or polynucleated urban form. This needs to be carefully studied and costed in large cities where a metro is under consideration.

'In smaller cities, or smaller corridors of large cities, there may be alternative solutions, possibly coupled with land use policies. The choice between bus lanes, busways, light (cheap, low performance) rail transit and metro then merits study.

Rates of Return

'Our evaluations are summarised as rates of return, which give an objective measure of the value of a project, subject to some assumptions, omissions and simplifications. It is necessary to understand the meaning and relevance of the rate of return. It is an important indicator, because it is the only comprehensive and objective indicator available. Nevertheless it is only an indicator and can be misleading.

'In particular no-one can lay down what the minimum rate of return should be. It may vary from time to time, depending on the demand and supply with respect to funds for public investment. It may vary from sector to sector, reflecting social or political considerations. It is a desirable yardstick, however, which should be provided for planners of each public sector because they need to be able to make investment decisions without considering all the alternative ways in which the money could be invested. It is neither possible nor desirable for transport planners to compare the merits of investing in metros with those in housing, water supply etc. It is unfortunate that it is unusual in developing countries for governments to produce such meaningful yardsticks for use by technocrats.

'A metro is an unusually costly investment beyond the normal means of the transport budget in a developing city. It will necessarily require large sacrifices for many years in other sectors, and as we have shown its impacts will extend to other sectors. For this reason metros invariably end up with the Cabinet or President, whose task it is broadly to allocate public funds. The rate of return should help them make their decision; one cannot say more than that.

'We may therefore describe a rate of 10-12%, say, as respectable, reasonable or satisfactory. This does not mean that the project should be , or should have been, approved or that it can be funded. It might still be a mistake, but it is not likely to be a bad mistake.'

13.4 ***Review of 1990 Research Conclusions***

13.4.1 This section seeks answers to two specific questions, which concern the model and the input assumptions:

- Does the model on which the conclusions about metro viability appear to provide plausible forecasts? We have highlighted the poor record of metro traffic forecasts, and this is in part because models have produced misleading forecasts. Given observed metro traffic, what can we conclude?

- Is there any reason to expect the results to be consistently biased as a result of the model or the input assumptions? For example, if all the economic rates of return were to be reduced - or increased, this would be a most important conclusion. What is the evidence?

Method

13.4.2 Information has been sought from the 1990 case study cities, in respect to planning data (population and GDP growth since 1990), changes to fares on the metro and bus systems, and ridership on the metro. Ridership has been compared with the 1990 forecasts. Logic tests have then been applied to establish the plausibility of the forecasts.

13.4.3 There are a number of complicating factors that have been built into this review:

- The 1990 forecasts were for the metro network operational in the late 1980's. Sometimes this has increased as lines have been extended or new lines added. The choice of forecast year for this review has been made to minimise this effect (e.g. in Hong Kong the year before the Airport Railway was opened was adopted). Initially the forecasts have been pro rata'd to take account of increased route length. Providing good core lines have since been developed, 'network effects' would tend to increase ridership on the first line over and above the pro rata'ing assumption. However, where subsequent lines were not good core lines, the results need to be interpreted accordingly. Mexico City illustrates this problem: its first 3 lines were most successful, but its subsequent lines, developed on the basis of creating a grid network, carried a fraction of the initial traffic. The problem was network structure.

- Some cities have implemented integrated land use/transport planning, and/or effective integration of the metro into its wider network. This increases metro ridership.

- In one or two cases, traffic has exceeded line capacity, and (unconstrained) forecasts should be expected to exceed actual ridership

- In the case of Seoul, the large suburban rail operations create modelling problems, and this case study has been excluded for this reason

- In the case of Rio de Janeiro, traffic actually declined as a result of institutional and management failure, something transport models do not take account of

Inputs

13.4.4 **Table 13.1** lists the main inputs for the cities for which information has been obtainable. The source of the data is as follows:

- Base and Forecast years – the 1990 research. The 'forecast' population data was that made by the city authorities, or as a default by the land use/transportation model

- Actual figures – from recent material. In the case of income data, World Bank published GDP/capita growth figures have been applied to the base year figures, adjusting to city figures using the same methodology as in 1990

- The fares information in the case of 'bus' is a weighted average of the public transport modes

These inputs are now briefly reviewed.

Table 13.1 INPUTS TO RE-EVALUATION OF CASE STUDY METROS

City	Year			Population			Income/person pa			Fares in US cents					
	Base	F'cast	Actual	Millions			US$			Bus			Metro		
	B	F	A	B	F	A	B	F	A	B	F	A	B	F	A
Cairo	1988	2008	1998	10.0	13.0	15.0	1075	2002	1386	4.5	4.5	3.1	7.8	8.8	10.5
Hong Kong	1981	2007	1998	5.3	6.9	6.3	5498	12710	17804	20.6	17.9	41.0	31.4	43.1	60.8
Manila	1986	2005	1997	8.9	14.9	10.0	1020	1486	1724	11.0	11.9	8.75	17.4	16.5	21.9
Mexico City	1970	2000	1996	7.0	14.1	8.5	1800	4360	3452	4.4	4.4	9.0	4.8	4.8	9.7
Pusan	1988	2007	1998	3.8	5.4	3.9	2242	5709	8692	15.3	15.5	24.7	21.8	21.8	26.7
Rio de Janeiro	1979	2010	1995			5.5	1980	3150	3916	11.0	20.0		9.7	15.0	25.8
Santiago	1976	2000	1996			4.3			4751	23.0	12.0	29.5	17.0	17.0	27.8
Sao Paulo	1976	2008	1997	9.9	22.0	16.7	1980	3150	3916	15.0	15.0	49.2	15.0	15.7	68.3
Seoul	1975	2005	1995	8.1	11.4	10.6	2274	4442	9561	14.0	14.0		20.0	20.0	26.8
Singapore	1988	2007	1996	2.6	3.1	2.9	7162	14506	23863	24.0	21.4	26.8	37.1	37.1	49.0
Tunis	1986	2009	1995	2.0	4.0	2.0	1887	2976	2256	13.8	12.5		18.3	19.0	15.1

13.4.5 ***Population -*** out of 11 cities, it was not possible to compare recent observed data with forecasts for 2. Of the remaining 9, four have been correctly forecast (or assumed by the transportation model MRTAP), four were over-forecast (i.e. it was assumed that there would be a larger population in the city by now than has actually occurred), and one was under-forecast. Examples of correctly and incorrectly forecast cities are spread over all regions.

13.4.6 ***GDP/capita –*** actual data could be compared to the 1990 forecasts for 10 of the 11 cities. Two were correctly forecast, one was over-forecast, and seven were under-forecast (i.e. actual GDP/capita is higher than was assumed/forecast). Actual GDP/capita is significantly higher in Asia and South America than was originally forecast, especially for Singapore.

13.4.7 ***Bus and Metro Fares -*** only limited data were available on fare levels. Almost invariably, the model input assumptions were found to be too low for both bus and MRT; only bus fares in Manila are cheaper than originally envisaged, but the situation there is complicated by the need to estimate an average fare including jeepneys. The reason for this is a combination of:

- Changing levels of public transport subsidies, which have generally reduced substantially, resulting in increased fares
- The impact of increasing traffic congestion on real bus operating costs, hence fares, and
- The few opportunities for bus operators to increase productivity (for example, most buses still have two-person operation, basically for revenue-protection purposes) to offset increasing costs
- Currency conversion problems: in the case of Mexico and Brazil, where there has been the greatest increase in fares on both MRT and bus, the currency has been effectively re-monetarised, complicating the estimation of current fares in 1986 US$ terms.

13.4.8 ***MRT Patronage*** data have been obtained for all 11 cities., as shown subsequently in Table 13.2. Six were correctly forecast, two were over-forecast, and three were under-forecast. In five of the cities, the MRT line length has changed from the original assumption. Adjusting the observed patronage back to the original line length on a proportionate basis means that one city that had been previously under-forecast is now probably correctly forecast, but that another city that was correctly forecast is now over-forecast. Mexico and Seoul are difficult to interpret given the wholesale changes to the network.

City Specific Factors

13.4.9 The comparison of model forecasts from 1990 and actual ridership is influenced by a range of city-specific factors, that are now briefly reviewed.

13.4.10 ***Cairo –*** The original system, which converted two suburban rail lines into a metro, has been steadily expanded since 1996. Trips on the original line ("1") have been separately identified in Table 16.2 to derive a figure comparable with the MRTAP forecast, although there will be some network effect, line 2 acting as a feeder from the north-west as well as a city centre distributor.

13.4.11 While fares on most buses and paratransit are extremely low, service quality is also low, and several bus trips may be needed to complete a journey. There is also severe traffic congestion, and the metro, despite a relatively low frequency of 10-12 trains per hour on line 1, now carries nearly 25% of all public transport demand in Cairo.

13.4.12 ***Hong Kong –*** The initial 3-line system has effectively been at capacity in the peak periods since the late 1980s. The addition of a second harbour crossing in the east in 1989 had little effect on demand (around 80,000 people per hour in the peak direction) on the original cross-harbour line. With stored-value electronic ticketing throughout the system, the MTRC were able to offer a peak-period refund to people using the eastern route to the Island (as well as imposing a peak period surcharge on the western route) to induce travellers to divert.

13.4.13 In addition to a lack of metro capacity, there has been:

- improving bus services (air conditioning is now offered on most routes);
- declining population in the areas served by the metro (as people re-locate to the new towns); and
- a stagnating economy in the run-up to Hand-over, followed by the South East Asian currency crisis (real per-capita GDP fell, in $ terms, in the mid 90s)

These factors have contributed to static or declining patronage throughout the 1990s.

13.4.14 ***Manila –*** ridership on the initial light rail line in Manila has also been capacity constrained by a succession of maintenance problems (viaduct in 1991/2, vehicles in 1995/6) due to which the service level has seldom reached the planned 24 trains per hour. Despite this, ridership has remained stable throughout the 1990s, with passengers prepared to accept extreme crowding (in excess of 130% of crush capacity at the height of the vehicle maintenance problem).

13.4.15 In part this is because road travel conditions are even worse, with traffic congestion rivalling Lagos or Bangkok in parts of the city. Bus and paratransit fares are regulated at a level too low to fund vehicle replacement. This results in a low quality of service – paratransit achieves a higher yield per passenger with routes shorter than the length covered by the minimum fare (requiring passengers to make several trips in order to complete a journey), but ordinary bus routes are in rapid decline. Less-regulated air conditioned bus and paratransit services have become widespread in the 1990s, but have no significant presence in the corridor served by the (non-air conditioned) metro.

13.4.16 Additional vehicles have been acquired, and air conditioning is being retro-fitted to the original fleet. The flat fare system (which resulted in trains leaving the terminus overcrowded, with few trips able to join at other stations) is also to be replaced by distance-related fares. Unconstrained demand for line 1 is probably in excess of 600,000 trips per day and is reflected by the MRTAP forecast (which obviously does not take into account operating and maintenance problems).

13.4.17 ***Mexico City –*** As noted, the Mexico City metro system has expanded rapidly since the 1980s, making comparison with the 1990 forecasts difficult. Many of the new lines either parallel existing routes (e.g. lines 4, 9) or do not enter the centre of the conurbation (e.g. 6, 7) and add little to the catchment of the system.

13.4.18 The flat fare, historically very low, was dramatically increased during the mid 90s, trebling in real terms between 1994 and 1997, but has declined again in real terms since, and is still the cheapest in the World.

13.4.19 ***Pusan –*** While the first section of line 1 opened in 1985, financial performance fell short of expectations, leading to funding agency reservations regarding extensions of the system. The southern section of the line was not completed until 1995, and the first section of line 2 only opened in 1999. Ridership rose rapidly as more sections of line 1 opened, to around 750,000 per day, but then fell back during the recession sparked by the South-east Asian currency crisis.

13.4.20 While the economy is now recovering, a 50% fare increase aimed at eliminating operating subsidy has restrained recent ridership growth, despite the opening of the first phase of line 2.

13.4.21 ***Rio de Janeiro –*** like Manila, the Rio metro has experienced extreme maintenance difficulties associated with a lack of funding. In Rio these have been even more severe, and by 1995 the metro was operating infrequent trains on a shorter network (with fewer stations) than it was in the 1980s.

13.4.22 The situation continued to deteriorate in 1996, with only 260,000 passengers per day. There has since been an institutional overhaul and concessioning to the private sector, and the system is expected to recover, with restoration of services and extensions to both lines in 1998 and plans for further extensions. There are current problems expanding service, caused by the non-standard 1.6 metre track gauge, which makes rolling stock purchase problematic. As with Manila, it is not surprising that MRTAP over-forecasts patronage under these circumstances.

13.4.23 ***Santiago –*** A 5-line system was planned in the late 1960s, but only lines 1 and 2 were actually built, as traffic was restricted due to unrestrained competition from buses. Increased regulation of buses since 1992 has halved the number of buses on the road and led to increasing metro ridership (595,000 in 1995, 636,000 in 1996).

13.4.24 Bus fares have also been stabilised and controlled, allowing metro fares to rise in real terms, improving Metro de Santiago's finances. A third metro line (line 5) has now been built (1997/8), and plans for a fourth (line 3 in the 1968 plan) have been resuscitated.

13.4.25 ***Sao Paulo –*** For such a large metropolitan area, Sao Paulo has a relatively small metro system. It is, however, well integrated with the bus and extensive suburban rail systems and has very high ridership per route km. While the current system is more extensive than that evaluated in 1990, the additions have added little to patronage as construction of line 2 was suspended in 1992 due to funding difficulties.

13.4.26 Extensive overhaul of the funding and institutional structure of Brazilian urban transport systems in the early 1990s has led to an overhaul of integrated ticketing, with new revenue sharing arrangements, and a radical improvement in finances. Investment has re-commenced, with line 2 completed, extensions to lines 1 and 3, and line 4 planned. Together with additional trains, these projects are expected to increase capacity by 60% and ridership by 33%.

13.4.27 ***Seoul*** **–** like Mexico City, the metro system in Seoul has expanded rapidly since the 1980s. The Seoul Metropolitan Subway Corporation (SMSC) system evaluated in 1990 expanded until 1994, to 135km. A further 4 lines (151km) are being added by the Seoul Metropolitan Rapid Transit Corporation (SMRTC), and Korean National Railways services also run through the city centre on SMSC tracks (lines 1 and 4).

13.4.28 It is thus very difficult to make comparisons between the current system and that evaluated in 1990. Effectively, MRTAP cannot differentiate between MRT/LRT and suburban rail systems. SMSC ridership can be identified - in 1995 traffic of 4.05 million trips per day was reported – but this will include overlap with the KNR suburban system and there will have been network effects with the first sections of the SMRTC system.

13.4.29 By 1998 SMSC ridership had fallen to 3.6 million trips per day. This decline may be due to loss of traffic to the expanding SMRTC system, but SMRTC's incomplete lines only carried 800,000 trips per day in 1998 and the severe economic recession in Korea in 1997/8 is a more probable cause.

13.4.30 ***Singapore*** **–** the authorities have pursued vigorous pro-public transport policies, with restrictions on car use in the city centre, feeder bus services and high transport demand land uses clustered round the network. The economy has also expanded rapidly, benefiting from growth in Malaysia and uncertainty over the future role of Hong Kong as a regional trade centre.

13.4.31 Ridership has exceeded forecast, but capacity is not yet an issue. The system was extended in late 1996, with a light rail feeder service. The North-East Sector Line is now under construction, with plans for more lines and an extensive light rail feeder system to replace some buses.

13.4.32 The experience of Singapore, where the metro is a key element of urban planning, can be contrasted with Manila and Santiago. In Manila, competing paratransit routes were not removed (although commercial considerations have spawned many feeder routes) while in Santiago, unrestrained bus competition was allowed for the first 10 years of metro operation and investment plans were shelved. In these circumstances, the low forecast produced by MRTAP is understandable.

13.4.33 ***Tunis –*** the low-technology street running system adopted in Tunis has facilitated several short additions to the originally planned network, only one of which was operational in 1995, the year used in this re-evaluation. Society du Metro Leger de Tunis has also taken over management of the Tunis-Goulette-Marsa suburban railway, leading to confusion in some sources regarding system size and ridership, with combined data for all 5 lines being quoted. Data in Table 13.2 is understood to relate to the light rail lines only.

13.4.34 Despite complementary revisions to the bus network, the success of the system has not led to the expected decongestion in central Tunis as trams are now so frequent at some intersections that vehicular traffic experiences delays. With more extensions planned, some grade separation may be required.

Comparison of Forecasts with Outturn

13.4.35 The land use/ transportation model should be judged on the basis of its inputs and outputs. That is, if the inputs are high, then the outputs should also tend to be high and vice versa. Out of 11 cities we have complete data (populations, GDP/capita, fares, and MRT patronage) on nine:

- In none out of these nine cities were all inputs and the output correctly forecast. This is largely because MRT fares and income/person were nearly always assumed to be lower than actual levels.

- Despite this, the outputs were reasonably forecast, probably because population and network assumptions were good and these represent the main demand considerations within MRTAP.

13.4.36 **Table 13.2** summarises the observed total and the model forecasts for the observed year. The forecasts are presented as a range in columns 4 and 5 respectively on the basis of alternative assumptions about growth (linear or constant percentage) and for line lengths (adjusted and unadjusted) respectively.

13.4.37 Of the 11 cities considered, patronage was reasonably forecast (after correcting for line extensions) in six, under-forecast in two, and over-forecast in three. Two of the three cities over-forecast (Manila and Rio de Janeiro) had actual patronage constrained by operating problems. The two under-forecast cities (Seoul and Singapore) either had a suburban rail system or extensive demand management policies affecting the outcome.

TABLE 13.2 RIDERSHIP FORECASTS AND OBSERVED PATRONAGE FOR CASE STUDY METROS

City	MRTAP Line and Length[18]	Observed Patronage 000 s/day (year)	MRTAP range for Patronage 000 s/day	MRTAP Patronage adjusted for Line Length	Factors affecting Forecasts	Comments on Forecasts
Cairo	2, 57km (1, 42km)	1,200 (98) line 1 only	909 – 1,251	*		Good forecast
Hong Kong	3, 43km (3, 38.6km)	2,326 (98)	1,721 – 2,647	*	• Good integration – land use, bus • Pro PT policies	Good forecast
Manila	1, 15km (1, 15km)	**440 (97)**	580 – 663	*	• Line 1 capacity constrained • Integration good (jeepneys), end-loading	Over-forecast but capacity constrained
Mexico	10, 178km (3, 65.8km)	4,750 (96)	4,358 – 5,275	Difficult	• Little bus competition within DF, good bus integration/ end loading at boundary • Poor network structure, new lines low pax. And huge fares increase	Difficult to interpret this given wholesale changes to MRT system – good?
Pusan	1, 32,5km (1, 21km)	677 (98)	402 – 469	608 – 709	• Good bus integration	Possibly good forecast if line increase is taken into account
Rio	2, 23km (2, 26km)	360 (95)	763 – 1,035	*	• Poorly managed, poor service quality	Over-forecast but badly run system
Santiago	2, 27.5km (2, 26km)	595 (96)	526 – 756	556 – 800		Good forecast

[18] Key Top figures show this update, and figures in ( ) are 1990 figures. E.g Cairo had 1 line 42kms long assumed in the 1990 forecasts, and 2 57kms long in this update

City	MRTAP Line and Length[18]	Observed Patronage 000 s/day (year)	MRTAP range for Patronage 000 s/day	MRTAP Patronage adjusted for Line Length	Factors affecting Forecasts	Comments on Forecasts
Sao Paulo	3, 43.6 km (2, 28.5km)	2,123 (97) less Green line	1,914 – 2,588	2,898 – 3,532	• Excellent bus integration (and operating subsidy)	Good or possibly over-forecast once line increase is taken into account
Seoul	4, 135km (4, 116.5km)	4,050 (95)	1,102 – 1,854	Na		Under forecast but major urban rail services exist
Singapore	2 67km (2, 67km)	927 (96)	410 – 635	Na	• Good integration – land use, bus • Pro PT policies	Under forecast but GDP/capita input badly low and pro-MRT policies in place
Tunis	4, 32km (4, 30km)	294 (95)	150 – 308	Na	• Competing buses removed	Good forecast

13.4.38 The model (MRTAP) therefore produced logical results in ten out of eleven cases. In the remaining city (Sao Paulo), the forecast was adjusted to reflect increased line length. Without this adjustment, the MRTAP forecast was in line with actual observed levels. Even with the adjustment, the forecast was not too bad - around 50% too high.

13.4.39 It may be asked why the MRTAP forecasts appear better than the norm, reported earlier. This does appear to be the case, and the answer is probably for a combination of reasons. First, the MRTAP forecasts were prepared without any external influences, by experienced practitioners. Secondly the MRTAP model was specified precisely for this task, and validated against an extensive database of developing city experience: although strategic in nature, it represents behaviourally the functioning of complex developing cities better than many so-called detailed models. Thirdly, the local planning forecasts were sometimes quite different from the MRTAP forecasts.

Conclusion

13.4.40 The model on the whole produces plausible forecasts. This is not to say they are by any means perfect, but they were intended for strategic purposes, and when contrasted with the record of forecasting, often from detailed models in this sector, the results are reassuring.

13.4.41 Overall, and making the same methodological assumptions as in 1990, the estimated economic rates of return for case study metros are broadly supported by the evidence of the last decade. This is an important conclusion.

14 Poverty Alleviation

14.1 *Introduction*

14.1.1 Poverty alleviation is at the centre of the policy agenda. We have noted in Section 4 of this report that pro-poor actions are sometimes in conflict with other policy goals. For example, to be economically viable, metro systems are likely to need both a high ridership, and to decongest the roads to some extent. High ridership implies low tariffs, while road decongestion depends in part on attracting car users, for whom service quality rather than low tariffs are important. MRT systems which perform well economically therefore need to strike a balance between these objectives, and there is an inevitable tension between them in developing pro-poor MRT policy.

14.1.2 The overall impact of MRT policy on the urban poor arises from arises from the combination of any/all of the following impacts. Each is considered in turn:

- MRT-generated economic growth, through so-called trickle-down ‘effects
- Specific pro-poor MRT policies
- The impacts on air pollution and safety created by MRT policy
- The impacts on low-income households of implementing/ operating MRT projects, and
- Any possible distortion of public sector funding, arising from MRT megaprojects

14.2 *Benefits from Economic Growth*

14.2.1 Governments require any MRT project to be justified in economic terms, and few argue that to some extent the poor are likely to benefit through the trickle-down effect; there is little doubt for example that the Hong Kong MTR has contributed to economic growth and that all its people have benefited materially from it. The discussion rather focuses on the scale of impact and whether alone it does much for poor. The nature of the political and economic system is clearly relevant and the nature of the project which give rise to it and its financing characteristics. Would there be the same trickle-down from a foreign BOT project in a corrupt regime and a weak laissez-faire economy, as in a well-managed economy, with strong domestic financial markets and a transparent BOT system in a democracy for example.

14.2.2 While there may be argument about the extent to which the poor will benefit (and this should be informed by substantive analysis, which can remove many of the uncertainties), there is a broad consensus that alone this is not enough: additionally, specific pro-poor policies are likely to be required.

14.3 ***Pro-poor MRT Policies***

14.3.1 There are 4 broad approaches to targeting the urban poor, and to set the context for MRT policy, these are briefly reviewed. They are, in declining specificity: targeting individuals, or identifiable groups, geographical targeting or targeting public transport passengers as a class, through subsidised fares.

14.3.2 *Targeting Individuals.* - This is generally preferred for efficiency reasons, because those requiring the support should usually receive it. The problem is that the poor are often not readily identifiable. One case in which an attempt has been made to directly target the poor is the 'vale transporte' scheme which has been in operation since 1978 in Brazil. Such a system is not known of elsewhere and may not work equally well in all societies.

14.3.3 *Targeting Identifiable Groups* - In many FSU countries, a practice that still exists is granting free or discounted travel to a wide range of citizens, many of whom are poor (the elderly, disabled, war veterans etc). This is a direct benefit to them (and to some who are not poor). This method of targeting poor groups in society is however disappearing because governments have no budget (and insufficient administrative capacity) to reimburse the private operators for accepting the concessions.

14.3.4 A similar approach is common for students (who carry student passes), and overall this is probably a progressive policy. Where such systems apply, it is important to the sustainability of public transport that operators are not required to carry the burden of social policy, and that they are by contract (and where possible) reimbursed for concessionary fares schemes. This is possible in Central/Eastern Europe, with well- developed institutions, but is impractical where there is fragmented supply.

14.3.5 *Targeting Poor Neighbourhoods* - *T*he poor are often identifiable by where they live. When they live in large, concentrated communities these can *in principle* be targeted for public transport provision. There is a range of possibilities:

- Government can improve their accessibility, by building/paving roads into these areas, allowing buses and paratransit to serve them

- Where bus services are prescribed by the authority, the level of service to poor areas can be enhanced through authority planning and procurement or setting specific service requirements. It may be that these require a measure of cross-subsidisation within a franchise or licensing arrangement, thus providing support for the poor without direct cost to the public budget. This however requires effective government institutions, and is not possible where these do not exist. Where services are determined by market forces the outcome is less certain and the poor who live in areas that are difficult and/or costly to serve are likely to lose out: this points particularly to the peripheral poor.

- A much less effective form of targeting involves fares which are the same irrespective of distance ('flat' fares). This can assist the problems of the poor who live in peripheral areas. In Brazil, where the poor often live in favelas at the edges of cities, the norm is for fares to be flat, or almost flat. This provides low-cost transport for long-distance travellers; but the downside is that short-distance trips are costly, often leading to paratransit creaming off short-distance traffic and reducing the effectiveness of the intended cross-subsidy.

14.3.6 To summarise, geographical targeting is possible if large poor areas can be identified and there is the administrative capacity to procure services targeted to these areas. Student concessions may be a possibility too. Otherwise efficient targeting is unlikely to be possible.

14.3.7 *Public Transport Passengers* – some argue that low tariffs should 'obviously' be deployed to benefit the poor, and moreover that it cannot be acceptable to use taxpayers money to (for example) fund metros which the poor may not be able to afford to use.

14.3.8 What is acceptable depends in part upon the economic impact of the subsidy, on the efficiency of this approach as a targeting mechanism, and on the state of the public finances. The economic rationale for subsidy rest on second-best grounds (where car prices are below marginal social costs and cannot be raised), and in the case of fixed-track systems, where rail costs are the least cost mode of transport.

14.3.9 System-wide subsidies may or may not subsidise many who are not low income, and may or may not therefore be an efficient form of targeting. But low fares may do little to attract potential car users, and reduce the impact of a metro system on congestion, pollution and future city structure. Moreover, to the extent that metros do decongest the road system, then the poor may benefit through lower fares, less overcrowding and improved service quality, even though they may not use the system.

14.3.10 Ten years ago, many rail systems (in Latin America in particular) were heavily subsidised. Today this is much less the case, as public expenditure constraints have forced tariffs to increase, so that today they at least cover operating costs. Thus a low-tariff policy is a possible policy, but not usually a practical one.

14.3.11 Detailed analysis is required in each situation to consider the impacts of the alternative options open, taking account of public expenditure constraints, in deciding how best to target the poor.

14.4 ***Impacts of MRT Policy on Pollution and Accidents***

14.4.1 We have seen that MRT systems can in some circumstances fundamentally affect urban structure, traffic congestion and its related pollution and accidents. Interventions that successfully improve air quality will benefit the health of all city residents, but there is reason to expect them to benefit the poor in particular, because they often live and work in the polluted street environment, and travel for long periods in non-air-conditioned vehicles. However this impact may be offset by higher fares (e.g. if vehicle specifications are increased, or paratransit services are controlled), which may cause hardship for the poor.

14.4.2 The equity arguments for introducing measures to improve safety are similar. The urban poor suffer proportionately more road accidents than others. They spend considerable amounts of time on roads – living, working or travelling. Often walking, or as cyclists, they are particularly exposed to traffic threats. However, some measures to reduce accidents will, like measures to reduce emissions, likely result in higher fares for paratransit and buses used by the poor. Again the overall impact is not unambiguous.

14.5 *The Direct Effects of MRT Projects*

14.5.1 The impacts of the MRT options can differ markedly. We consider them in turn.

14.5.2 ***Busways*** – although there are no quantified data, busway transit is used by bus passengers who are likely to include many or most of the urban poor. They may benefit substantially from the improved accessibility which busways bring, and it is clear that busways should be strongly pro-poor[19].

14.5.3 ***Metros -*** The 1990 research sought to understand the objectives behind metro projects and establish their performance against expectations. While 'improving the speed/quality of public transport' and relieving traffic congestion' were the two most important quoted reasons, and both would benefit the poor (in common with other public transport users) there was no specific mention of assisting the poor. At first glance this is not surprising, for metros are costly, and tend to be a premium mode offering high quality, at a (relatively high) premium fare. This was not always the case, for example Mexico City metro Lines 1-3 were specifically targeted to lower income neighbourhoods, and adopted low fares; but in common with most other cities, pressures on the public finances have since forced fares up.

14.5.4 The documented evidence of the impact of metros on the poor we are aware of is confined to 2 studies, in Cairo for DFID reported in White et al (1999), and for Medellin. The Cairo study concluded that the poor do use the metro in substantial numbers, in spite of a substantial fares premium over the bus, because of the large time savings. The Medellin study was conducted *before* the metro opening and this concluded that the poor were unlikely to use it, because the route was distant from their travel needs.

14.5.5 However, staff in the World Bank report that in Latin America some of the metros (e.g. in Buenos Aires and Sao Paulo) and suburban rail concessions (in which tariffs are defined by government to be affordable to the poor) benefit the poor substantially and directly.

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[19] However, it would be a mistake to regard busway transit as a low income mode. Busway transit should be regarded as legitimate mass transit mode within the transport strategy of a city and thus should contribute to overall objectives such as promoting mode shift by providing an acceptable alternative to private vehicles.

14.5.6 There is thus little recorded evidence about the direct impact of these projects on the poor, but it is possible to put forward hypotheses, and to test these against experience. We have done this for the 4 new-build metro concession projects, analysed in some detail in section 10. These all have market tariffs (Table 14.1).

TABLE 14.1 PROBABLE IMPACT OF METRO CONCESSIONS ON THE POOR

Proposition	Comment
Metros require land, notably at depot sites.	Need for large area of land imperative, relocation of squatters often on the critical path e.g. Manila for all 3 MRT projects
Metros tend to be built through poor areas displacing the homes and jobs of the poor	Not so (usually in inner city/CBD), other than at depots
The metro route, usually to the city centre, is not mainly where the poor need to travel	Often this is so (metros are always CBD orientated)
Metros provide jobs, most of which are skilled and semi-skilled, and therefore exclude the poor	Construction does provide jobs for the poor (e.g. Manila), but few jobs thereafter
Poor people cannot afford to use the metro	Always true for BOT concessions, fares are too high
The poor do not benefit from fares concessions which are often given	Not an issue, as few fares concessions are given
Metros increase land prices near stations, leading to displacement of poor people	Probable medium-term impact (no evidence yet)
Metros reduce traffic congestion, and air pollution, which helps the poor	These projects attract little ridership, and even busy metros do not reduce traffic congestion markedly. Likely to be a marginal impact upon air pollution. Poor design can cause localised pollution problems (e.g. Bangkok)
Metros facilitate population growth, which is fuelled by in-migration from the provinces	Some evidence that the construction phase does attract migrants, who then remain living on government lands

14.5.7 The available evidence supports the above propositions. Almost all are likely to be adverse for the urban poor. It seems clear that at least these concession projects do not specifically benefit them. This should not be surprising, since in no case was poverty alleviation a factor in their development.

14.6 *Possible Distortion of Public Sector Funding*

14.6.1 We have noted that metro costs are high, and that government requires to fund them to a considerable extent; typically most of their capital cost needs to be funded by government: 0.6-2.0bn for elevated and underground projects respectively. The scale of this additional funding is large relative to the size of government’s budget. Additionally, metros and ‘lumpy’ investments. This may lead to a distortion of government’s investment portfolio.

14.6.2 We have also seen that forecasts for metro projects are often poor, and that governments often require to supplement expected expenditure with large unbudgeted additional expenditure. Experience demonstrates that, *as currently conceived* these projects inadvertently and sometimes profoundly distort the allocation of government resources. This may impact to a major extent, adversely on other social programs with a higher potential to benefit the poor. This is considered a likely outcome in many cases.

14.7 *Summary*

14.7.1 It is apparent that the identification of policy to target poverty alleviation is complex and not always obvious. The need is to approach policy development with clarity and holistically, and to systematically establish, by analysis, the likely consequences of policy for the poor, mitigating the adverse impacts so far as possible. Within this approach, it is concluded that:

- Busways are clearly beneficial to the poor. Many suburban rail systems are too, in that they have traditionally carried many of the poor, who benefit when they are upgraded

- Metro projects may, by contributing to city efficiency and its trickle-down effects, benefit the poor. To the extent that they contribute to a transport strategy which reduces congestion, with pollution and accidents, the poor benefit also

- The poor may benefit from jobs during construction of metro systems, and their buses may be slightly better once they are open - more efficient through somewhat reduced congestion, and less overcrowded if there is metro competition

- When MRT policy can target the poor effectively, it will benefit them; but this is often difficult to do. Instead, public transport tariffs are sometimes held down to benefit the poor as a class. This benefits the poor (and other too), and is a policy applied particularly in parts of Latin America, and applied *inter alia*, on metros and suburban rail systems. But pressures on the public finances have led to increases in tariffs, albeit they are still relatively low

- Metros can have adverse consequences during implementation and operations. They often require the relocation of the homes and jobs of the poor[20], and enhanced land values near stations and depots may force them to move elsewhere[21]. However, metros then often provide a facility that the poor cannot afford to use in a CBD radial corridor they often have no need to frequent.

14.7.2 The poor may lose out substantially through distortions in the allocation of public funding, to the detriment of pro-poor programmes, due to the large, lumpy nature of metro investment. If the metro costs overrun, and/or traffic fails to materialise – which are common occurrences – then this prospect increases.

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[20] These are acquired and relocated, using increasingly standard procedures that provide for consultation, fair compensation and rehousing

[21] This may suggest action to provide them with security of tenure (so that at least thay gain from increased land values) or to provide public housing

15 The Travel-Disadvantaged

15.1 Definition

15.1.1 Social policy is usually concerned with those in society, who we have terms 'travel-disadvantaged'. Some are fully physically and mentally fit, but are encumbered and find travel difficult, or are inhibited from travelling by the perceived threatening environment, others are frail, and others still are disabled in one way of another. Together they are large in number, and providing for their accessibility is a matter of public policy. This section considers how MRT policy can make provision for them.

15.1.2 We have defined the travel-disadvantaged in this review to include the following:

- Those who are encumbered (those with children, with shopping, or market produce)
- The frail, infirm and elderly - who are unable to use stairs/escalators, and
- The physically and mentally disabled who may be similarly disadvantaged. They may also be economically disadvantaged, either because their physical/mental state impairs their ability to earn, or because of cultural characteristics (notably towards women in some chauvinist societies)
- Women when they are in a threatening environment.

15.1.3 Numerically in total these groups are probably large. In the UK the experts argue that at any one time more than 5% of the population is physically disabled. In many poor countries it is likely that this proportion is larger. In total they are obviously a minority, but nonetheless a sizeable minority. It is natural that authorities should wish to provide for their accessibility.

15.1.4 They therefore include those who can walk and those who cannot. Some may be expected to be poor, others not so. Women often predominate. Much of their travel is probably off-peak, partly to avoid over-crowding.

15.2 ***MRT Issues***

15.2.1 Ideally these groups could be targeted individually. Conditions differ, and as noted before, for example in Central/ Eastern Europe and the Former Soviet Union the elderly and war veterans often do receive concessionary travel passes (these are reducing in the FSU with privatisation, as private bus operators refuse to accept them). For them the issue is their ability to use public transport. But for some groups and most developing countries such targeting is not possible, because the individuals are not identifiable.

15.2.2 When over-crowding becomes very severe, as in Mexico City and Bombay, special provision may be made for women. In India suburban trains are often provided with women-only coaches, and in Bombay there are 2 women-only peak trains. In Mexico City on the packed metro 2 end carriages are reserved for women.

15.2.3 The travel-disadvantaged often have difficulty, or cannot in practice use the buses. The conditions at stops (if they exist) are often chaotic with no queuing, the vehicles are truck chases, difficult to climb on and off, overcrowding on board is common. It is difficult to see many using busways were they could be introduced, unless approached on a system-wide 'quality' basis as in Curitiba.

15.2.4 But metros are often pressured to 'provide for the disabled'. Are the authorities and pressure groups right to do so? In answering this question, it should be noted that metros suffer from a basic accessibility problem, in that metro lines are usually few, and usually elevated or underground. They require longer access distances to stations, usually access by bus and interchange, and to access the trains at a different level and maybe a considerable distance within stations.

15.2.5 In answering this question, we note the following:

- The disabled *per se* will benefit from a metro only if they can assess/ egress from it, and interchange when necessary. Underground metros are challenging to the physically disabled, with sometimes long, tortuous passages between lifts and platforms In most developing cities it is unlikely they will be able to use a metro. We have noted that many are unlikely to be able to use the buses.

- Security is often a major issue for the disabled, and for women at 'quiet' times. Underground metros are inherently more threatening than at-grade or elevated routes.

- There may be concern with the automation that often comes with a metro. However, this is a matter of design. A well designed and staffed modern system is less threatening than older systems like New York's Subway and London's Underground. Examples are the Washington metro which is safer - and perceived to be, than the streets above. Another example is the Paris Meteor, which combines good design with visible staff and security measures.

- To the extent that some of this group are poor, the extra interchange and premium metro fares militates against their using the metro

15.2.6 Yet, when lifts are installed on metros, and 'step-free' access is designed in, they are well used by most of the above categories of the travel-disadvantaged, and probably least by the physically disabled. The Tyne and Wear Metro in the UK provided early insights into use. There the lifts justified for the disabled, and in practice are heavily used by all the above travel groups. The result is that the metro has had a large social impact, being accessible by most of the people. This provides the main rationale for the inclusion of lifts, which in many cases will justify their cost on commercial, let alone social grounds.

15.2.7 The cost of provision is affected by three issues, when access for *the disabled* is planned for:

- The need for special emergency evacuation facilities in the case of emergency, notably for an underground train crash or fire. Thorough risk assessment and thoughtful strategies for incident management often mean that the traditional case for very expensive facilities for evacuating severely disabled passengers have been shown to be a poor use of money. Thus, after much careful analysis, wheelchairs were allowed on the London Underground, despite warnings of catastrophes.

- The cost of lifts when designed in *from the beginning* is small in the case of elevated metros, larger for underground systems, where they have to be fire-hardened to be usable in evacuations from fire-related incidents. Operating costs are incurred too, and the need to provide a high standard of maintenance to ensure availability.

- The feasibility and cost when *added in afterwards, without prior planning* can sometimes not always be achieved, or only with considerable difficulty. For elevated stations it is less a problem, although the lifts have to access both ticketing and station platforms. Underground however this can be difficult and costly.

15.3 Conclusion

15.3.1 The travel-disadvantaged are numerically large. Many will find bus systems impossible to use, in the typical street environment and operating conditions of developing cities. Some may find use of the metro impossible, because they cannot get to and from it, because of problems with the buses, acceptable sidewalks or pedestrian phases at street signals. Many may be poor, and the metro fare combined with need for extra interchange may militate against their using the metro, unless they are in receipt of a concessionary travel pass.

15.3.2 Others however will be able to use the metro if lifts are provided. It is probable that if provided, they will be well used – not so much by the physically disabled as by the other travel-disadvantaged groups. They may then be justified on commercial, or a combination of commercial and social grounds.

15.3.3 It will usually make sense to provide for lifts from the outset, but where this is not done the stations should be planned for their subsequent installation. A high standard of availability is essential once installed.

16 Land Use and City Structure

16.1 *Introduction*

16.1.1 The literature is full of references to the symbiotic relationship between metro development, land use and city structure[22]. Metros are sometimes promoted as ‘essential ’to creating the urban structure and land use determined by government to be desirable; this was the case in Singapore. We have seen that in Curitiba the busway system performed this role, provide the structural axes for its development.

16.1.2 If the authorities have a soundly researched Development Plan for the city, and if they control development, then they can create demand conditions which may help justify a metro on economic grounds. Then, when an MRT system is built, land prices are expected to increase in its catchment area, in particular near stops/ stations, and this may result in property development/redevelopment. In turn this may lead to densification in the MRT corridor and property profits, which may then contribute to the funding of the MRT system.

16.1.3 This is sometimes the expectation, creating a virtuous circle. We examine the evidence for these effects, and seek to draw conclusions, to establish how and the conditions under which MRT policy may contribute to achieving these objectives. Most of the evidence concerns rail systems, but we first summarise experience with busways

16.1.4 ***Busways Experience -*** The impacts of busways on land use and city structure have been little researched. There are diametrically opposed examples. Some busways have resulted in environmental degradation of corridors arising from heavy bus flows, poor quality vehicles, vehicle emissions, noise and severance. We have seen that these issues can be addressed at the operational level by improving bus types and by improved standards of physical design of the busways.

16.1.5 On the opposite side, it has been possible to integrate busway transit and land use, in Curitiba. It has successfully integrated land use controls to densify land use along busway transit corridors, ensured that those uses are appropriate to a transit

[22] Urban structure is defined as the pattern of activities, which is one principal detreminant of the pattern of movements in the city. The other principal determinants are personal incomes and the management of the transport system

corridor and promoted social development around the main terminals of the trunk-and-feeder system. Clearly, other cities would not be expected to replicate Curitiba directly, particularly as the Curitiba system took many years to realise; however, the experience serves to demonstrate that it is possible to integrate land use and busway transit over time.

16.2 Rail Research Evidence

16.2.1 ***1990 HF/TRRL Research -*** This research was based upon case studies. It was noted that sometimes the metro was justified partly on the basis that it would link large concentrations of high-density housing to the city centre, and there was some evidence of this type of development in 8 of the 21 cities studied. In Hong Kong and Singapore government itself was the developer, and the metro was partly justified to provide efficient links to the centre. In Istanbul the *proposed* land use was probably the main reason for the LRT, while Porto Alegre rested on similar, forecasts which had not been realised. The misfortune in Porto Alegre illustrated the difficulty of land use planning in developing cities.

16.2.2 The research examined the role of the city centre and concluded that where there was the dynamism for growth, then without the metro the city centre could not have grown as it clearly had. This growth was not visibly connected to the metro, yet it had taken place only because the metro had permitted it.

16.2.3 This argument concerned the larger cities, and results from the capacity constraints of bus-based systems. We have reviewed this issue and broadly reinforced the conclusions reached: when bus passenger flows along the major radial corridors reach 15-20,000 passengers per hour/direction, then rational people begin to say 'the buses cannot cope'. This is not in itself a justification for the metro, but it is a sign that urban development may have reached an important threshold. And if the metro is not then built, further growth of the city centre can only be accommodated by a change of structure, with central functions forced to non-central locations. A metro has a capacity at 3-4 times that of a major radial road, and a single metro through the city centre clearly provides a massive addition to capacity.

16.2.4 The metro concentrates capacity along a few routes, and development would be expected to be drawn towards the metro lines. But in the case studies the evidence of this type of development was not striking, and the largest examples were provided by *public sector* developments (in Hong Kong and Singapore, described above and to a lesser extent in Sao Paulo).

16.2.5 The overall conclusion based upon the case studies in developing cities, was that:

- Where government has embarked upon major development, the metros have been an important stimulus to changing urban structure

- Elsewhere the development impact has appeared small, and where there has been an identified impact this has been difficult to forecast in advance

- In large cities, the city centre has been allowed to continue to grow, something that would otherwise not have been possible.

16.2.6 ***TRL Research*** - The UK Transport Research Laboratory subsequently reviewed the evidence in both developing and developed cities (TRL, 1992), focusing on impacts in the 5-10 year timeframe, specifically with the MRT funding potential in sight. Case studies were undertaken in a wide range of developed cities in Europe and the United States. It is interesting that the conclusions were consistent with the earlier developing city research, as follows:

- The systems with the greatest effect on urban development occurred where there has been a long process of urban planning in conjunction with the rail system

- Where rail systems have been introduced without this planning framework, there has been very little effect on urban development

- Wherever a system has been successful, there is always a variety of other factors which have contributed. Usually these amount to a great deal of public will and money to harness the benefits of the rapid transit system.

- A consistent finding from nearly all cities was that the rapid transit system encouraged urban development in the *city centre*, while the intuitive expectation that there would be identifiable development impacts outside the city were not usually borne out.

- Rapid transit tends to accentuate existing trends. Development can only be successfully channelled if there is a demand for property.

- Developers have usually been *encouraged* to locate in the areas around stations by means of incentives and *discouraged* from locating elsewhere

- Many developments turn out to be *public sector* ones which can be viewed as part of the public commitment to support the rapid transit system

16.2.7 ***Recent Evidence -*** Recent experience reinforces earlier conclusions. There have been interesting cases of purposeful government action in China: Shanghai metro Line 2 is integral with the development of its new CBD in Pudong, while Guangzhou metro Line 1 ran into problems when the anticipated development gain for metro Line 1 failed to materialise as expected.

16.2.8 The private sector BOT projects, whose promoters often include property developers, have tended to reinforce activity along the inner city radials. In the case of Manila's MRT3, development is likely to take place over stations, but elsewhere expected development gain has not been realised.

16.3 ***Analysis***

16.3.1 The 1990 research provided an explanation of what happens or does not happen in this area, and why. We here supplement it, and draw conclusions in relation to overall city structure and strategy, drawing on recent evidence.

16.3.2 ***Desirable City Structure -*** The conclusion from the 1990 research that, in large cities the metro allows the city centre to continue to grow, something that would otherwise not have been possible was described as 'the major development impact of metros, whose implications are enormous, complex and controversial'.

16.3.3 One reason for this description is that there is not unanimity amongst city planners as to the desirable city form, and specifically to the benefits of a strong-centre in a developing city, whose future size cannot be known. Some argue strongly that a strong centre is mega-productive, and that economies of scale are maximised with this city form. Others argue for a poly-nucleated form.

16.3.4 Suffice to say that the authorities should prepare a well-researched Development Plan for the city, with clear guidance on future structure, based upon the implementation tools and administrative / professional capacity available. This is done exhaustively in the more successful cities (Singapore and Hong Kong are examples). It is however notable that many *developing cities* do not have such plans that are both well-researched, and form the basis for government action.

16.3.5 ***City and Network Size –*** The size of the MRT network relative to that of the city must determine its structural impact. If the city is large, and the network is small, the 'small metro' becomes 'isolated' within the much larger city. The reason for the permissive impact of the metro on the city centre is that buses cannot cater for the travel for its employment and other requirements. If the buses 'feeding' the ends of the small metro network cannot carry the scale of demand for the city centre, the city centre impact of the metro will not be realised (in effect there are capacity bottlenecks beyond the ends of the metro). Then, it may be better to construct fewer long lines into the city, rather than a comprehensive network in the inner city. This over time would be expected to change materially the structure of the city, as traffic is concentrated into these few corridors.

16.3.6 In practice, with high costs usually higher than expected, and traffic/ revenues and development profits lower than expected, developing cities *can often only* afford to build a 'little metro' (whether procurement is by the public sector or by BOT concessions). And by the time they can afford to substantially increase the network, the city will have become hugely larger in geographical extent.

16.3.7 The implication of this is that the city-centre 'justification' for a metro should be used in circumstances when the city is large (otherwise the buses can cope), and when a substantial metro network can be built, extending into the city. This does not have to be a large number of lines, since even one metro through the city centre will have a major impact. But its long-term impact upon city structure needs to be recognised.

16.3.8 ***Integrating Land Use with Metro Stations and Depot*** – This is often sought, either because it is desirable in principle (on the grounds that, other things being equal, urban densities should be high where accessibility is high), and/or because development gain is required to 'create' profitable projects which otherwise would not be profitable.

16.3.9 A central problem, particularly if the objective is to help fund the metro, is that the property market is typically subject to bust-and-boom characteristics. This is the case just about everywhere – in London and Singapore, Guangzhou and Bangkok. A typical metro, with stations every kilometre can itself exacerbate the problem, if large developments all come on stream at about the same time – this was a problem in Guangzhou with metro line 1.

16.3.10 Developers try to time new developments to avoid the worst of these cycles, but by definition many do not succeed. When developments are planned to link with the timetable for metro developments, timing flexibility reduces, and if the metro funding depends upon development gain, problems are often encountered. This was the case with the Hong Kong MTR – the Initial System realised very large development property development at stations and depot, and the development gain funded 15% of its huge initial cost, but the subsequent Island Line timing was wrong, with much disappointment. In Guangzhou, problems occurred and the recent Asian economic crisis has affected all the BOT projects adversely.

16.3.11 Partly for this reason, many banks will not accept development gain as a component of project revenues, because they cannot be relied upon. In effect it is not considered to exist, and does not therefore contribute to creating profitable metros.

16.3.12 Several approaches have been adopted in pursuing integrated metro/ property development, as follows.

16.3.13 *Redevelopment of land in the vicinity of metro stations.* To have a real impact on either objective, the land area must be large. Sometimes the land will be in government ownership. But more often it will be in private ownership and ownership will be by multiple owners. In some Asian societies – Taiwan is an example - there is a tradition of dividing land between the children, and over the generations this results in huge numbers of land owners, each owning very small areas. Private developers make profits by focusing on sites which are developable – they have the choice of sites in the city or country. They have no interest in such sites which are in multiple ownership. This is the major reason why metros often do not 'generate' development at stations – even when there is a demand for development. The firm conclusion is that such desired redevelopment in the vicinity of stations/depots almost always require advance action by government to acquire the land and assemble viable land parcels for development/ redevelopment. This in turn requires substantial capacity by the authorities. In practice in developing cities it is rarely done.

16.3.14 *Development over the metro right-of- way.* The Hong Kong MTR provided an early example of what is possible, by planning development over its *depot* site. This is part of the rationale for the Manila MRT3 private sector project, and the Bangkok BTS (where the depot is integrated with an out-of-town bus interchange and development). This approach requires the depot to be in the inner city where land prices justify such multi-level developments; whereas normally the depot is desirably elsewhere. In other words, such depot developments are likely when land is scarce and /or the metro is a small system, not extending into the main city

16.3.15 Manila MRT3 is aligned along and in the centre of the major corridor in the city, and the private sector concept is that developments will progressively be built above the central stations and over the adjacent very wide highway. It is early days and little signs of development yet exist. Potentially the volume of mainly shopping development is large, reinforcing the primacy of what is already one of the world's largest corridors.

16.3.16 *Developing links to existing developments from stations* – this was a core strategy of the private sector Bangkok BTS project, with the objective of extracting development gain and assisting with providing access to street level, given the narrow available side-walks. Experience here and more widely demonstrates that this is difficult to achieve. The 'free-rider' problem exists - people wait for others to contribute, and benefit without paying; or links may not fit well with the design of existing developments, or insufficient time may exist to tie down arrangements before decisions about station location and design need to be made. Achieving this requires advance action, usually by government.

16.4 Conclusion

16.4.1 The impacts of metros on land use, city structure and metro funding are not obvious, neither are they fully understood. However, empirical evidence allows a number of conclusions to be drawn. The main conclusion is that metros can be used as to help structure the city, and to achieve desired land uses, and that by securing the benefits of the symbiotic link between land use and metro traffic, development profits can contribute to the metro funding. But this happens only when government capacity is well developed, and the public finances can afford to develop a substantial network relative to the size of city.

16.4.2 The major structuring effect is in large cities, when the metro allows the CBD to grow, when the dynamic for its growth exists; without it, an alternative land use would be forced. This requires the metro network to extend into the city, overcoming the bus capacity bottleneck, which is the constraint on growth of the CBD. In cities which are not large, and when affordability constrains the scale of network, this is unlikely to provide justification for the metro.

16.4.3 The development of few lines deeper into the city may overcome the capacity problem, and over time lead to significant restructuring of the city towards these sectors of the city. The alternative of a 'small metro' network extending along many corridors, but which does not extend far, may have little impact on development.

16.4.4 Development in the vicinity of stations and depots, and links into existing developments in their vicinity can be made to happen. But they require advance and purposeful action, usually by government. This comes back to the comment about institutional capacity.

16.4.5 Property gain as a basis for metro funding is unsafe, because it cannot be relied upon. Banks will usually not accept it. It is a plus if it happens, but cannot underpin the project finances.

16.4.6 Finally, metros are sometimes proposed as central to the sustainability agenda. The argument is that they are a necessary component of a package which also allows private car restraints, which can control traffic congestion, with its pollution and other adverse impacts. Together with their impacts upon city structure and land use, they contribute to a balanced, environmentally sustainable strategy, in which acceptable accessibility for all can be ensured. This ideal is indeed approached in a few cities, but it is not the experience of developing cities, many of which have large or very large population increases, creating a continuing geographical explosion and constraining rises in income and affordability.

16.4.7 Here the role of the metro is likely to be more limited, albeit still strategically important. This is focused upon 'keeping the city functioning' in the face of severe congestion (which it will mitigate) and – in the larger cities - allowing its CBD to continue to grow; permitting a strong-centre structural form where this is desired. The metro may, when developed only along some radial corridors, over time also have substantial impacts upon the balance of development between city sectors with and without metro lines.

17 The Environment

17.1 Introduction

17.1.1 We consider in turn the overall impact of MRT systems on air pollution, through changing congestion levels, the vehicle mix and urban structure; and then the direct impacts of MRT infrastructure and operations – in terms of visual impact, severance, localised pollution and so on.

17.2 Air Pollution

17.2.1 The air pollution argument for MRT systems rests on two main propositions. These are that it changes the traffic composition towards cleaner vehicles and reduces vehicle-kilometres as more efficient MRT replaces existing buses/paratransit; and that MRT can have a strategic impact upon city form, resulting in less travel and its attendant pollution.

17.2.2 The arguments focus on rail systems and metros in particular. Busways are likely to have a more marginal impact, except where they are a catalyst to replacing paratransit with bus MRT. Some argue that metros can play a strategic role in controlling congestion, thereby air pollution, and together with other benefits (denser urban form, more liveable city…) can set a city along a different and more sustainable development path. 'Imagine the 2.5 million passengers transported each day by Sao Paulo's metro moving back to buses, how much congestion and consequent pollution would they cause' is the argument.

17.2.3 In considering the veracity of this, the starting pint is a recognition that:

- such impacts of MRT systems (of any type) will be much greater when traffic restraint policies are introduced on private cars, and
- any such evaluation is against a 'do nothing' situation, which itself may be quite different from the situation today.

17.2.4 There is now a widespread recognition that air pollution is often a critical problem in developing cities, and it is becoming the practice to develop comprehensive air pollution strategies, linked to land use/transportation strategies. This is particularly so in large cities, which are rapidly increasing in wealth, resulting in rapid increases in the demand for travel. The major increases in pollution are from vehicles and not from industries, and this is likely to continue to be the case in most cities.

17.2.5 The major policy response is to tackle mobile sources of pollution by introducing a combination of cleaner fuels and cleaner vehicles. This focuses on eliminating lead in gasoline, reducing aromatics and benzine in gasoline and reducing sulphur in gasoline. For diesel the strategy is to reduce the sulphur content. With cleaner fuels come cleaner vehicles, since the cleaner fuel is needed to use some of the technologies. Catalytic converters are increasingly more efficient; vehicles today emit less than 5% of the pollution of those sold 25 years ago.

17.2.6 In developing countries these trends are slowly taking place, as oil companies are moving towards global cleaner products. Vehicle manufactures are doing the same and developed country technologies are gradually being introduced in developing countries. In developing countries two particular issues are diesel, because of the large proportion of diesel vehicles in the fleet, and 2-stroke motorcycles, which produce high levels of pollution given the small amount of fuel they consume. This is the background which is taking place in the 'do nothing' situation.

17.2.7 Turning to the mechanism by which metros can impact upon pollution, this commences with reduced congestion. This is reduced, not by a major amount (witness Seoul, Tokyo or Taipei, all with substantial metro networks and severe congestion), but significantly. The result is that the minimum speed is less low than it would be without the metro. The composition of the traffic flow changes, from (often major polluting) bus/paratransit vehicles towards potentially cleaner cars, as available roadspace is mostly taken up by suppressed car demand. Before too long however, the metro corridor again fills with buses/paratransit, as overall demand is much higher than was previously possible. So the evaluation is against a different 'without metro' scenario, probably a more dispersed city, involving extra bus and paratransit vehicle kilometres. The point remains that a metro is likely to significantly reduce bus/paratransit traffic and to some extent other traffic too.

17.2.8 The extent to which this is a benefit depends upon the pollution characteristics of the alternatives. Rail systems require power to operate, and this will cause some pollution. However, if it is from power stations distant from cities, the adverse impacts on people's health may be small (but the long-term global warming impacts will exist).

17.2.9 The other strategic impact of a metro network rests on the argument that at the margin it leads to less car ownership and less car use, and that over the long-term this may create a different and more concentrated urban form, with less vehicle-kilometres, congestion and pollution. There is little empiric evidence to assess the scale and circumstances for these impacts, although there is an increasing view that they are plausible and do take place to some extent.

17.2.10 Overall. there is little doubt that MRT systems may impact on air pollution substantially. Much more research is required to inform future policy, given the importance of the subject. We may conclude that:

- The scale of the impact will depend on the polluting characteristics of the existing vehicle fleet, and steps which are taken (in the 'do nothing' situation) to improve this

- The scale of impact will depend upon the size of the MRT network. A substantial network will likely be necessary to deliver strategic improvements

- The issue is relevant for all MRT systems. 'Clean' busways can be developed, where this is a critical issue (e.g. the trolleybus system in Quito); electrified suburban rail can have a significantly beneficial impact; then there is LRT, and metros, with the latter holding promise for major impacts in the right circumstances.

- The strategic impacts will be critically reinforced by complementary measures to control private vehicles, as part of a balanced transport strategy

17.3 Direct Impacts: Bus-Based Systems

17.3.1 We have noted that the environmental impact of some busways has to date been poor, and this has been a major reason for proposals to replace them with rail MRT. Where busways have been operated by large numbers of relatively low capacity diesel buses, this has degraded the environment through unacceptable levels of vehicle emissions, noise and severance, and the busway corridor has generally deteriorated.

17.3.2 However, there is no reason why busways should not be designed, as LRT systems often are, to enhance the environment of the corridor in which they are situated. The provision of high capacity 'clean' buses, high quality passenger facilities, high standards of 'track' (road pavement) and routine maintenance of all facilities should be regarded as the norm. While these actions may increase busway system cost, that cost would still be small in relation to those of most rail options. Finally, as with any transit corridor, land use controls should be exercised to ensure, that over the long terms, development of busway corridors are compatible with their functions as a major transit corridor.

17.4 Direct Impacts: Rail Systems

17.4.1 Section 7 of this report addressed the broad issue of environmental attitudes and their consequences, and Section 9 considered the cost implications of providing for elevated metros, which are aesthetically pleasing. The conclusions were that:

- The combination of developing aspirations, cultural attitudes and institutional regime shape environment attitudes. Understanding these is essential to project identification and understanding environmental impacts – what matters, and what does not.

- In some societies, elevated structures may be acceptable on visual grounds, maybe even in confined corridors. But this depends in part on the quantum mass of other elevated transport infrastructure planned and in place.

- Good rather than basic design from the outset is likely to be a sound investment, as environmental perceptions are likely to rise with incomes, and it is not possible to retrofit an ugly structure to make it attractive.

17.4.2 The critical issues concern elevated metros Where a 'canyon' effect would occur for a prolonged length of route, the result may be the degradation of the corridor, the opposite of the expected and wanted developmental impact. This was the case along the Rizal Avenue corridor in Manila for example. The impact of such construction upon the future urban character of the corridor should be assessed. Control of air pollution which may otherwise become trapped beneath stations in narrow 'canyon' streets should be planned for.

17.4.3 More generally, aesthetics may become an issue, if it is not yet, particularly where there is an accumulation of elevated infrastructure planned. The cost of good design is small and there is no reason why this cannot be implemented in a developing city – there are many examples where this has been done. The conclusion is that effort should go into the design and construction process to deliver this result, which will create an aesthetically pleasing design.

17.4.4 The overall conclusion is that Government needs to determine the MRT project specification, in the context of overall urban design requirements This needs to extend to the following, as well as conforming to the normal requirements of Environmental Impact Assessment (EIA) legislation:

- The vertical alignment, station locations, interchange arrangements with other lines and depot location
- Design and construction standards
- Mitigating requirements during the construction period
- Aesthetics and air pollution, as described above
- Severance, in particular provision of pedestrian facilities crossing the metro route

D APPROACH

18 MRT Planning

18.1 ***Approach***

18.1.1 There is no standard process for developing MRT projects, but much has been learned and the following provides pointers to good practice. There are two broad stages, identifying the right projects and securing government commitment (based on an appreciation of all the key factors), followed by implementation and operations. Planning and economics drive the first stages, but these need to tempered by realism in financing and implementability. Institutional planning, financing, procurement and the development of complementary measures to enhance MRT impacts should drive the second stage. Risk analysis should be built into the process throughout.

18.1.2 The 'planning' function encompasses all activities involved in identifying the project, to the level of detail which allows government to commit to it, in the knowledge of its consequences. This should define its physical (including land) and operational requirements, tariffs and integration requirements with the remaining public transport system, institutional and legal arrangements, funding and the procurement strategy.

18.1.3 This requires a close interface between the 'planners' and the political decision-makers. This is the only way of avoiding conclusions that are unacceptable to decision-makers. The planners normally bring a technical expertise and knowledge of what is technically possible, and this has to be combined with local political imperatives, in order to develop a strategy that will be acted upon.

18.1.4 The planning process needs to be holistic. MRT systems can be catalysts in cities, in securing wide-ranging benefits. System identification requires a broad perspective, starting with the city development (or structure) plan, to identify the appropriate role for MRT. This requires a multi-disciplinary, open-minded and realistic approach from the start.

18.1.5 The requirement of the planning process is that it *generates a broad consensus behind a doable, affordable, 'good' and robust strategy*. These requirements seem obvious, yet they are by no means always followed. This places demanding requirements on the approach:

- The requirement for consensus among the broad body of stakeholders requires an open process involving participation/ consultation. This requires the process to be designed with the time for participation/consultation to be effective, and the technical outputs to be timely and comprehensible.

- The process needs to identify 'doable, affordable' projects, which requires a practical, and implementation and finance-led focus

- The strategy needs to be 'robust'. This places a requirement that uncertainty should be formally built into the process from the beginning, and throughout.

18.1.6 Finally, we note that Governments often take advantage of international development assistance to progress the series of technical studies that are necessary. In some cases these may extend to so-called 'free studies' promoted by vested interests. These usually promote a technology, national interest or interest group seeking secure downstream contracts and avoid competition. They often appear attractive, but may not provide the necessary basis for sound decision-making, and may prejudice the overall project development process.

18.2 Institutional Requirements

18.2.1 Institutional coordination is critical to urban transport planning, and to successful MRT project development. Issues that have caused problems include the following:

- Coordination between national and city governments. National government will almost always be involved in the case of rail projects, because of the scale and requirement for funding support, and because they are often in the national capital. Which tier of government should own and manage the process: city or national government? How should the two be coordinated? And if the national government takes the lead, how can 'ownership' of the project be created within the city?. Answers to these questions can prove difficult to resolve satisfactorily

- Leadership and coordination between the wide range of government institutions which require to be involved – transportation, economics, finance, environment and so on

- The national railways as promoter. Sometimes rail projects have been developed by the national railways. Its rail culture combined with acceptance of its constrained tariffs and the absence of management autonomy have undermined their effectiveness

- Public transport integration: sometimes the opportunity to integrate the buses/ paratransit has not been taken; or there are institutional jealousies between the a 'new' metro and the 'old' suburban railway; or different agencies and tiers of government are involved, and agreement is difficult

- Existing agencies often try to implement a new project, without the recent proven ability so to do, and major problems have arisen: they are simply not equipped for the challenge. It may be that the existing agencies will not have the expertise to tackle the complexities involved.

- The role of the private sector. Recently 'the private sector' has sometimes been regarded as *the* answer, including the planning answer, with government by implication taking a hands-off attitude.

18.2.2 There is a requirement that the process develops consensus among the broad body of stakeholders, including both technocrats/ decision-makers and those likely to be affected, suited to the particular environment. This requires a process involving some level of participation/ consultation, and when this does not take place either the project specification has been ill-suited to need, or implementation has been problematic. The process needs to be designed with time for participation/ consultation to be effective. It also places a considerable responsibility on technical experts to present the results of analysis in a form that is both balanced and comprehensible, so that interaction is effective.

18.3 ***Strategy Development***

18.3.1 The transport strategy should define the management, investment and institutional components, which will best give effect to government's objectives and fit within the defined constraints. MRT should be a core component of this strategy. MRT benefits are likely to be much enhanced when complementary transport sector actions take place; indeed in their absence MRT system implementation and justification is often problematic. A soundly based transport strategy, which defines the role of MRT in the context of management strategies for the road system, and its development is a necessary prerequisite to major MRT investment.

18.3.2 The MRT strategy is developed by evaluating the options, on the basis of three main inputs, which are briefly reviewed:

- Government's objectives, set out in the city development plan
- The main constraints, particularly public sector funding, and
- The feasible MRT projects which are identified and could practically be implemented

18.3.3 ***City Development Plan*** **–** this should define government's objectives, the core funding and other constraints, and the broad sectoral priorities for action, given existing conditions and problems. Ideally, a city will have a meaningful Plan, one that sets out its future physical strategy, and its economic and social strategy (reflected in land uses), in the context of available resources (finance, land, institutions). Such a Plan will ideally have been developed as a result of an exhaustive evaluation of the options, involved widespread consultation and be constantly monitored and updated.

18.3.4 The reality in many developing cities is very different. Some cities have no meaningful Plan at all (that is, one that influences government's actions). Because transport has such an impact on the future structure and land use of a city, undertaking transport planning in the absence of any Plan is problematic. For MRT – and particularly metros – this is particularly important, due to their impact on the city structure and city centre (is a concentrated monocentric city form desired, or not for example).

18.3.5 ***Available Public Funding*** – The funding of the project should be addressed from the earliest strategy development stage, and progressively refined through the development process. It will be necessary to broadly assess the ability of the city government and central government to fund the project. The development of such agreed assumptions between central and local governments early in the planning process will avoid wasting time planning for unaffordable strategies. Progressive studies will enable more confidence to be placed in the government support required. Government may investigate new earmarked revenue sources to assist in the funding. Progressive 'decisions' are required as the studies become more detailed, allowing the financial consequences to be assessed with greater certainty (for example in the Hong Kong MTR, there were 4 successive funding decisions to proceed, each in the light of more detailed investigations, and only the last irrevocable).

18.3.6 The project costs (capital, asset replacement and operating) and farebox revenues define the essential financial structure of the project. Ancillary revenues increase the revenues, but not usually by much (typically by 10% for rail projects). This defines the inputs to the funding analyses. Initially the issue is the whether/to what the recurrent revenues exceed the operating costs – hence the need for government to fund the initial costs, and its ability so to do. For rail systems, this is almost always be a major problem, which requires to be addressed in terms of the opportunity costs of the required funding.

18.3.7 The forecasts of available funding will depend upon the future performance of the economy, and on government decisions about its macroeconomic management and priorities (the proportion of GDP allocated to public investment, regional allocations, and within cities sectoral priorities) – all factors that cannot be known with confidence. To meet these requirements, it has proved effective to develop a range of forecasts, and to use these to develop a responsive strategy. Thus:

- A lower estimate of funding can be defined, on the basis of which a Core Investment Strategy can be developed – something that can (almost) *definitely* be implemented, and

- An upper estimate of funding can then be developed, on the basis of which the extra projects can be identified that will then be affordable, creating a Core-Plus Investment Strategy

18.4 ***Identifying Potential MRT Projects***

18.4.1 Based upon the available research and experience, it is possible to define broad requirements for identifying MRT projects. These should be based on a sound basis of fact and assessment of existing problems, by means of a rigorous audit of the existing situation. The following pointers can then be used to narrow down the dauntingly large number of options.

18.4.2 ***Busways*** – busways are shown to be demanding to design/ implement and operate well, but once operational robust. Assuming that existing public transport demand levels are substantial, the circumstances that favour busways are likely to be:

- Cities and city corridors which are wide enough to accommodate them (though they do not have to be continuous). They may, depending on policy and design, be planned by reallocating existing roadspace without increasing congestion for other traffic, or they may result in increased congestion for other traffic. Most successful busways are in the centre of the road, and are 1-lane in each direction, but where demand is high extra capacity may be required

- Cities where public transport is provided by larger vehicles, which can use the busways efficiently. In particular many, small paratransit vehicles cannot do this, and if paratransit is important, then there will need to be a major restructuring of the existing system. This may or may not be desirable, and it may or may not be possible to implement

- Cities where public transport is provided by a small number of operators. This helps plan and implement effective integration measures

- Cities where the relevant institutions are reasonably well coordinated, and where traffic management skills are developed. The former are particularly important where busway systems are planned, since these require a relatively sophisticated level of planning. The skills required to design the system and implement it can however be bought in

18.4.3 There are no known examples of BOT busways. Sao Paulo attempted to use BOT but the proposals failed and there have been proposals elsewhere (for example C5 in Manila which appears to have failed not leas because the city pursued construction of flyovers which prevented the construction of a segregated busway). However there are no fundamental reasons why concessioning of busways should not take place, and recently much activity to try and do just this.

18.4.4 There are several issues that should be addressed I considering this approach, for example:

- (unguided) busways are suitable for use by any bus or paratransit vehicle and control mechanisms must be in place such that only buses intended by the concessionaire may use the infrastructure (in one city in UK, this was the rationale for the proposed implementation of guided bus – the restricted geometry meant that no other operator could use the busway)

- while cities are willing to give up part of the right of way of roads to LRT, they appear reluctant to do the same for busways
- as in Sao Paulo, the lack of familiarity of financing agencies with busway concepts and their perception of the financial risk and uncertainty meant that finance was not viable
- the problems of dealing with powerful, entrenched, existing bus and paratransit operators has proved difficult to overcome (reference the failure of the Bogota busway network in the mid 1990's)
- the elements of busway transit - buses, infrastructure (busways), bus operations and traffic control (busways cross junctions and need traffic signals) - are not the responsibility of a single agency or company;

18.4.5 ***LRT*** – many of the factors relevant to busways and metros are applicable to LRT. LR may be particularly applicable when MRT strategy is environmentally driven, when broader urban objectives are planned, of which LRT may be a centre-piece, and when demand levels are not very high.

18.4.6 ***Metros*** – the 1990 research was required to identify, based on the analytical work undertaken, the conditions where metros may be justified economically. Most of the following conditions were found to be necessary. In our judgement these conditions apply today, and they provide a 'screening' context for MRT identification:

- Corridor size - high existing public transport flows down the main corridor, of the order of 10-15,000 passengers per hour per direction are required
- City income which are not low (typically at least 1,800 US dollars per person)
- Growth prospects - prospects for sustained growth, notably economic growth
- City centre growth - an expanding centre, preferably of a national/provincial capital city
- A Low-cost metro alignment
- Fares policy - a fares policy on metro and bus systems to encourage ridership yet limit the need for financial support
- City management - government institutions which were stable and have demonstrated competence, and

- Metro management - strong, largely autonomous management, with clear objectives.

18.4.7 The important issues which underlie these guidelines are the following:

- Metro viability is concerned with the size/characteristics of major city corridors, not just with city size. Thus in a linear city (such as Pusan or Caracas) a metro may be viable, even though the city is not large. Similarly in Singapore the city has a very few major corridors, and the metro is not only economically viable, but essential to the city form that has been determined. Metro viability is linked to the nucleated city structure.

- The need to keep costs low, and passenger traffic -and revenues high. Low costs require an alignment which is elevated rather than underground, and at-grade rather than elevated; and an effective metro operator. High ridership/revenues requires station locations in the right place (penetrating the heart of the city centre, and major residential areas); integration between buses and metro (requiring physical measures, bus route changes, and fares to be set correctly).

- The great majority of metro passengers will need to switch from buses/ paratransit. Large existing bus passenger flows (the potential metro market) should therefore exist in any potentially viable metro corridor.

- Most of the benefits depend upon future conditions. It is thus important that there is a scenario of future growth in incomes (particularly) and an underlying growth in the City Centre.

- Metro costs do not vary substantially with city income (a large part are foreign costs, similar throughout the world), but benefits do (most are time savings, which increase proportionately with income). Thus metro viability is strongly correlated with income. The question concerning metro viability should often be: When will be the conditions be right to implement such a project?'

18.4.8 ***Suburban rail –*** the requirements for successful suburban rail systems have been set out in section 11.1.

18.5 ***The Alignment Decision***

18.5.1 The main MRT parameters concern its horizontal and vertical alignment and station/stop locations (these decision are inter-related), and the form of its integration with the existing public transport system (section 13 of the report addresses the integration issues).

Route

18.5.2 We start by noting that the following conclusion of the 1990 research has been reinforced by recent experience:

'The transport planner should beware of alignments that are chosen because they are easy. In particular any metro proposal that does not run into and through the city centre must be suspect. The main radial roads to the city centre are where one invariably finds the greatest passenger flows, the greatest congestion and the least need for modal interchange. Our study has not discovered anywhere in the world a non-radial line that is well patronised, apart from distributor lines in the city centre itself[23]. Moreover the location of metro stations (or rather their entrances) is much more critical than is often appreciated – locations only 600 or 800 metres from desired destinations very substantially reduce patronage'.

18.5.3 The 1990 research also concluded that technology was not an important issue in the case of metros. There is a well-developed industry that creates equipment that delivers performance levels that do not differ markedly, at costs that are not materially different in the context of overall system costs[24]. The 1990 research confirmed that (with one exception in Rio, where there were institutional/ management problems) all metros worked and were operated well, and were perceived well by their users. To them the critical issue is station numbers and locations, the former determining the speed and the latter the convenience of access. It can be risky to trial new technology e.g. BART and the London Jubilee Line Extension (signalling)

18.5.4 It is important that operational advice is included from the earliest stages of the planning process. There is a range of issues which should fundamentally influence project development, which require this expertise.

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[23] Possible exceptions are in Tokyo and Moscow Line 5

[24] The one exception is automated systems which have a much higher initial cost, with potentially significant benefits, but at the risk of being tied to the system supplier.It is unlikely such systems will be appropriate in developing cities

Vertical Alignment

18.5.5 This is probably the most important decision after route and station location, which are often inter-related. It affects some things substantially, yet some little at all. Thus it has a large impact on initial cost and the physical environment, some impact on choice of technology and recurrent costs; while the impact upon patronage and revenues depends upon circumstance.

18.5.6 The need for interchange should significantly affect the choice of vertical alignment in respect to rail systems. In particular interchange between underground and elevated systems is always difficult, while underground interchange within the same stratum may be effective.

18.5.7 There are some things that one might expect vertical alignment to affect, which in practice it often does not – in particular the choice of route. Thus the apparent routing freedom which an underground alignment could provide in practice is surprisingly seldom realised, other than where it crosses barriers such as rivers of hills. Otherwise, mass transit systems usually follow the same corridors (usually roads) that elevated systems would follow.

18.5.8 An underground environment brings with it special needs for evacuation, drainage, staffing levels and fire resistance, which affect both technology and cost to some extent.

18.5.9 Because budgets are constrained, and undergrounding massively impacts upon budgets, the alignment decision may be much more than a simple technical issue. Instead the real options may be whether to build an at-grade or elevated alignment (now), or maybe build an underground alignment, later.

18.5.10 Once built, mass transit systems are there for all time. Thus decision-makers often face a difficult choice: whether to provide an elevated but affordable system now - and live with the environmental consequences (recognising that environmental perceptions may well strengthen in the future as incomes increase); or deferring construction until an underground alignment becomes affordable.

18.5.11 In practice the undergrounding issue should be rather different: given the characteristics of the corridor (in terms of urban design, the existing right-of-way and the geology/ ground conditions) and given the circumstances (particularly affordability and environmental perceptions), what is the balance of advantage between at-grade, elevated and underground construction for each section of the route? It follows that a route may be underground in sensitive areas, and elevated (or at-grade) elsewhere.

18.5.12 The alignment issue is therefore usually of central importance to mass transit, and hence to transport strategy. This reinforces the need for sound, objective and rigorous assessment of the alignment option.

The Impacts of Vertical Alignment Choice

18.5.13 The impacts may be classified as follows (**Table 18.1**), and each is considered briefly:

TABLE 18.1
THE IMPACTS OF METRO VERTICAL ALIGNMENT CHOICE

Major Impacts	Minor Impacts
• Capital Cost and Risk	• Operating cost
• Visual/ Aesthetic	• Air Pollution
• Patronage	• Noise
• Image and Severance	
• Development potential	
• Construction impacts	
• Political, in obtaining the right-of-way	
• Vibration	

18.5.14 ***Capital Cost*** – we have reviewed the cost of metros. The figures show that typically underground construction at least doubles all-in cost (while at-grade construction, when feasible, is one fifth that of underground construction). Increasingly important is the impact of alignment on project risk. Metros have a justified reputation for exceeding their cost estimates by large margins, particularly where underground construction is required. Cash-strapped governments, and BOT concessionaires requiring to make a quick return, are naturally wary of underground construction in particular – because of its well recorded inherent risks, and the time taken for construction**.**

18.5.15 ***Visual/ Aesthetic*** – self-evidently, there must be major benefits from underground construction (or they would not be built). The visual/ aesthetic impact is often the major quoted reason for underground construction. However, underground construction also brings archaeological risks e.g. the ATTICA metro.

18.5.16 ***Patronage*** – In older urban areas, and city centres with complex street structures, it is generally not acceptable to create a new elevated alignment, and here an underground alignment often becomes 'essential' where a metro is required to penetrate the heart of the city centre. But these circumstances are often the conditions which make underground construction costly, risky and difficult (with potential problems of subsidence etc.). Where an underground alignment is feasible, and allows a metro to serve traffic demands better than an elevated alignment constrained by the existing road network, its impact on patronage may be significant (because journeys are more direct and require less interchange). Experience however suggests this occurs less often than might be expected. By contrast in cities, particularly grid cities which have developed on the basis of wide arterial roads with sufficient median, the underground alignment offers little traffic advantage over its elevated alternative. In the author's experience, this major <u>potential</u> benefit of underground alignments is surprisingly infrequently realised in practice. This is in part because of real obstacles to underground construction - when an underground line is built after the CBD is developed with deep-piled foundation buildings, finding a (not very deep) alignment can be difficult. When there are time pressures, and particularly when BOT projects are being developed, such potential problems are avoided from the outset and the pressures are for elevated construction.

18.5.17 There are three further patronage issues:

- Underground stations typically reduce accessibility, and if the station is at a substantial distance underground, this may cause passengers to switch to surface modes.

- In some cities (studies in Birmingham, UK was one such example) some segments of the market, and particularly many women, stated that they would resist travelling underground for security reasons; having said this we know that good design and operational practices can largely overcome this problem

- Where underground and elevated alignments co-exist, then interchange can be very difficult (the Bangkok system is an example: it is difficult to see how this can operate as an integrated network, when the so-called interchanges are so difficult)

18.5.18 ***Image and Severance*** – it would seem self-evident that elevation could impact hugely on the image of a corridor, something that underground construction does not. Whether this impact is good or not would then depend very much upon the quality of design and the characteristics of the corridor. A major factor in metro planning involves determining how and whether the transit system will enhance - or detracts from, urban quality, for it can do both. There are examples of both good and bad impacts. Bad impacts result from the combination of a constrained corridor, endemic traffic congestion and land ownership patterns which constrain property redevelopment. The result can be a degradation of the physical environment, with 'tunnels' created at stations, and a move 'down-market', with the mass transit system a barrier to movement between communities either side. Elevation in the wrong corridor/ location can thereby create severance, and blight frontage properties, the opposite of what is widely expected. This can over time significantly change the character and structure of the city. The Hopewell project in Bangkok would have built an integrated development/ structure right through the city on both its major axes, following the rail lines. This has now been abandoned, but clearly would have created massive severance (it was three levels high, and it was not possible for other infrastructure to cross it).

18.5.19 ***Development Potential*** - Well-planned underground alignments allow more effective integration of the metro with property developments adjacent and over stations. This maximises the prospects of intensification of land use where accessibility is at its highest, and it offers the prospect of development gain, which may assist fund the metro. These <u>potential</u> benefits depend upon effective planning to be realised in practice: where this exists, then such benefits may be substantial, and the resultant benefits can be very important. Experience suggests this is likely to happen where government and the planning system are effective.

18.5.20 ***Construction Impacts*** – the most disruptive of all construction methods is cut-and cover construction, which is usually required for underground stations. Bored construction primarily poses problems at the portals/ entrances where there is a concentration of materials, people and equipment, and requires quite large construction sites for a considerable time. The resulting traffic disruption can be an important issue. At one extreme, in Hong Kong, experience of the disruption caused during cut-and-cover construction along Nathan Road (for the MTR Initial System), led to the decision to exclude cut-and-cover methods from future consideration. But this is not a simple black-and-white issue. Recent experience suggests that elevated construction, when reasonably well-managed, does not cause undue congestion. Underground construction can be very disruptive, unless stations are tunnelled (rather than constructed as cut-and-cover) – which increases costs.

18.5.21 ***Political: Obtaining Rights-of-Way*** – The potential metro alignment often faces two problems in acquiring right-of-way, one physical (relocating buildings and activities in its path, negotiating other infrastructure etc.) and the other political. This concerns opposition to any reduction in roadspace which an elevated metro requires. The evidence is that this roadspace requirement created by the structure columns may be quite small, or along divided carriageways none at all[25]. Politically right-of-way acquisition can be unpalatable, and the route followed by a road may provide the most attractive alignment for an elevated metro, and is certainly the lowest cost for the government.

18.5.22 ***Vibration*** – this can be a significant issue in the case of underground alignments, particularly where the alignment is under a historic centre with important, old buildings.

18.5.23 ***Operating Costs*** – this is a factor primarily in tropical environments, due to the costs of air-conditioning stations. Platform-screen doors mitigate the problem, but the cost penalty remains large. There are additional costs of maintaining an underground system, which do not occur with elevated alignments.

18.5.24 ***Air Pollution*** – This is an occasional problem, at its worst when elevated stations create a 'tunnel effect' in heavily-trafficked constrained corridors. For underground alignments the main issue is the location/ design of ventilation shafts to avoid undue localised pollution.

18.5.25 ***Noise*** – good design does not cause problems, but this is not always achieved. Where it is not, then noise associated with elevated structures can be problematic[26].

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[25] Of course this may be refuted on the grounds that the metro removes large bus/ paratransit flows, creating <u>extra</u> roadspace for other vehicles

[26] The effect is the combined result of noise transmitted through the air and vibration transmitted through the structure

This is less likely to be a problem in developing cities given their normal ambient noise level.

Key Issues Determining the Importance of the Impacts

18.5.26 The key issues which 'drive' alignment decisions are the following:

- The state of the public finances
- The effectiveness of government institutions
- The procurement system, specifically the trend to private sector participation
- Environmental regulations, and
- Other miscellaneous factors

18.5.27 ***The State of the Public Finances*** - we have noted that underground metros are costly. We have reviewed the expectations that BOT projects will remove this burden against the evidence and concluded that there is no objective evidence to revise this conclusion. Most metro projects will require most of their initial cost to be funded by government - whether or not the private sector implements/ operates them under a concession. Faced with resistance to increasing taxation, governments are having to target expenditure to core priorities. It is difficult to see a scenario that will reverse this trend. It is likely that a country's economy will need to perform well over a sustained period for metros to be rational investments.

18.5.28 ***The Effectiveness of Government Institutions*** - underground construction requires effective institutions and effective procurement. Government's role is to:

1. Identify the project, which it must then strongly support through implementation and operations. *Inter alia*, it must obtain the necessary permissions (from local authorities etc.).
2. Manage the process of public consultation according to local practices, particularly where relocation and environmental issues arise, and manage public information through the construction process
3. Acquire land for the depot, stations, working sites etc.
4. Ensure that regulatory bodies control construction impacts, and that the police manage traffic diversions through the construction process
5. Provide funding for the project

18.5.29 This role is more demanding for underground than elevated construction. Where government capacity is not yet well developed, then underground construction may be particularly risky – meaning that the programme and cost may well increase in an uncontrolled way.

18.5.30 ***The Procurement System*** - the general experience of private sector involvement is that the companies involved in the concession company have a clear focus on implementability, fundability and risk control. This translates to elevated forms of construction, on all counts:

- Where government capacity is not yet well developed, this is seen as the 'obvious' (though by no means risk-free) alternative
- Contractors are often more experienced in elevated alignments, than tunnelling, which requires more specialised skills (they may have experience of constructing viaducts for expressways in the same city for example)
- We have seen that elevated construction more than halves the initial cost, and reduces operating costs too, increasing the project's fundability
- And the inherent risks (geotechnical etc.) associated with underground construction are greater than those for elevated structures

18.5.31 ***Environmental Regulations*** - the environmental regulations of the country and the requirements of funding agencies are important factors. Most countries – developed and developing, now have Environmental Assessment and Environmental Management Plan requirements in law, and the laws are being increasingly applied in practice. Compliance then has to be demonstrated as part of the process of project development, design, construction and operations. Thus it is often necessary to produce an Environmental Statement, an Environmental Mitigation Plan, an Environmental Monitoring Plan, and an Environmental Management Plan for the construction period.

18.5.32 Environmental perceptions are not readily transferable. Thus MRT planners need to be wary of imposing their values on other societies. There are often cultural factors that influence identification and design. More difficult to judge are the changing perceptions of environmental impacts over time. The general experience and wisdom is that people put increasing value on their environment as their incomes rise; and as incomes are expected to rise in most cities contemplating mass transit systems, there may be expected to be a trend towards good-design, and a trend towards less-intrusive, underground construction.

18.5.33 ***Other Miscellaneous Factors*** - it is not uncommon to find other factors which may have a large influence on the alignment decision. Those encountered include:

- Security – underground stations can be designed as nuclear shelters in time of emergency (to mitigate the impacts of bombs, rather than to withstand a direct hit). In some cases this has been the decisive factor in alignment choice

- There is a deeply ingrained belief in some quarters that so-called 'subways' must be underground.

- There sometimes seems a desire to make a simple decision : 'elevated or underground?'- rather than to recognise that there is a balance of advantage, which may change between the city centre and the suburban radial corridors.

- With electric traction, underground construction can be relatively easy. Long road tunnels are a different proposition, and raise a major safety issue. Busways could be accommodated underground in short tunnels, while long tunnels would probably require electric propulsion.

18.6 Demand Forecasting

18.6.1 Section 8 of this report addresses the problems associated with demand forecasting and sets out the basis of a recommended an approach, incorporating benchmarking against existing operational systems.

18.7 Evaluation

18.7.1 Evaluation is required to inform decision-making, throughout the project development process. To be effective the method needs close interface with decision-makers (or in decentralised systems, a method which is clear and institutionalised). In most situations the former is the case, and only by close interaction will the real trade-offs between objectives, and the political constraints become understood. It has to be said that the continuous trend to shorter studies and concentrated activity often makes this problematic in practice.

18.7.2 In the past, planning focused upon project optimisation and the 'planning' decision of what to implement. This optimisation was based upon a confidence in the ability to forecast which was at variance with the prevailing conditions of uncertainty in developing cities. And the focus on the planning decision reflected the implicit assumption that 'how' to implement the project and the implementation process itself were neutral in terms of their impacts upon project costs and benefits. Hence, once the 'decision' had been taken to implement a project, evaluation was no longer considered to be necessary.

18.7.3 Experience has demonstrated the weaknesses of this approach. Optimisation in this sense is the last objective which is relevant: rather the focus should be on developing a robust strategy, which will deliver 'good' results under the reasonable range of future scenarios; this provides a new definition of 'optimisation'. And it is widely recognised that what happens during the implementation and operational phases often has a dominant impact upon costs and benefits, hence project viability. It is clear that evaluation needs to be a continuing activity.

18.7.4 Given this understanding, how can the technical activity of evaluation be undertaken? In simple terms the evaluation process involves 'objective' assessment under individual evaluation criteria (economic, social etc), and 'subjective' weighting of the importance of the different criteria, so that decisions about overall worth can be made. The problem (of course) is that no-one agrees what the weightings should be, which is one example of uncertainty which the evaluation must address. More generally there is usually considerable uncertainty due to exogenous (political/ economic/ social) factors, and sometimes about government policy (investment, transport policy, public transport, integration).

18.7.5 It is therefore necessary that the evaluation formally incorporates uncertainty, in developing a 'robust' strategy. These requirements for consensus-generation and the incorporation of uncertainty lead to the requirement that the planning process is comprehensible. This is often not the case, as the transport modelling and evaluation processes are often opaque. Unfortunately, as we have seen, this density and complexity have little correlation with the quality of the forecasts produced. A comprehensible method imposes a requirement on planners to justify forecasts in common-sense terms, and is likely to improve quality.

18.7.6 The *economic evaluation* is government's core criterion for establishing the 'worth' of public sector investments, when taken together with the social, environmental and development, and financial evaluations. This evaluation is dominantly important at the planning stage. As implementation approaches it becomes less important, but it is necessary to monitor the costs and benefits throughout to implementation (some benefits are not captured in the financial evaluation, for example road congestion impacts arising from poor design of viaduct structures, or ill-planned construction management)

18.7.7 ***Economic Evaluation*** - Estimating the economic worth of a long-lived asset such as a metro is a particularly difficult task however, and raises many issues. These were addressed in the chapter 9 of the 1990 research (Allport et al, 1990) and included:

- Definition of the metro alternative
- The transport policies that should be assumed
- The Rate of return that should be required – it was concluded that government's test discount rate should in practice not be considered a 'justification', but rather a minimum threshold for further project consideration
- The value to be placed upon time savings
- The evaluation of comfort and convenience which the metro provides
- The evaluation of alternative urban structures
- The evaluation of generated trips

18.7.8 The research made pragmatic assumptions about each issue. Some were particularly intractable, and have since been the subject of debate (notably in Mitric, 1997). Significant new insights which can be operationalised have however yet to be developed.

18.7.9 ***Financial Evaluation*** - The *financial evaluation* is quite different and concerns only the money costs and revenues of the project. They define the financial structure of the project (the net cash flow taking account of the capital, asset replacement and operating costs, and the farebox and ancillary revenues), and allows alternative funding structures to be investigated (with different debt:equity ratios, terms of debt and returns to shareholders). This is important from the beginning in terms of defining the impact upon the public finances, and whether this is in the right 'ballpark'. It then becomes increasingly important as progress is made towards the final implementation decision. Thereafter it remains critical, as the integration arrangements are put in place, and throughout the operational phase.

18.7.10 There are two separate financial considerations which need to be addressed. The first concerns the project *funding*. Assuming that there is a shortfall of project revenues when set against costs, this should determine broadly where will the extra funding come from. This can be established dealing in the main magnitudes (what are the costs and revenues, what is a typical financial structure and the terms of debt… .). It may be that the answer is ancillary revenues, or earmarked taxes (e.g. road user charges), or property development gain, it may be central or local government allocations (from taxation or borrowings), or it may be any combination of these.

18.7.11 The second issue concerns the *financing* of the financial shortfall. This concerns the financial engineering of the project, and the mechanism for making the project bankable. It may involve borrowing against future revenue streams, which is committing future generations to pay for today's infrastructure. This is considered in detail in preparing the Business Case for the project, the next stage in project development, and requires detailed consideration of the ability of the city government and national government to service debt.

18.7.12 ***Comprehensive Evaluation*** – a considerable responsibility rests with the transport planner in presenting the results of evaluations in a form that is both balanced and comprehensible. Many decision-makers cannot be expected to be familiar with transport models and the intricacies of evaluation. Yet it is very easy for results to be 'massaged' to produce answers which decision-makers may wish to hear. There is no single best way of doing this, but the focus of attention must be adopting a procedure which is familiar and ensuring that :

- Government's policy thrusts are translated into clear criteria
- Insofar as possible the impacts under each criterion are quantified and valued; and otherwise treated qualitatively
- Explicitly and formally incorporating uncertainty in the evaluation
- If converting impacts into 'scores' or alternative proxies, using an explicit method
- If weighting criteria to produce overall scores, defining the weights explicitly

18.7.13 The evaluation process must be an interactive process with the decision-makers. This requires time to implement and iteration to ensure that the analysis responds to the concerns of the decision-makers. Given this, and a sound evaluation method, then the confidence will be developed to proceed to the next stage in the project development process.

19 Implementation and Operations

19.1 *Institutional Planning*

19.1.1 Once government has decided in principle to implement a defined project, the requirement is firstly to put in place the necessary institutional arrangements. We review experience in this area.

Bus Systems

19.1.2 As there are few busway transit *systems*, experience of system-wide institutional arrangements is limited. In most cases, where busways are in use, the franchising and regulation arrangements for conventional bus services currently in force in the city still apply. In the 'model' case of Curitiba, bus operations are privatised but closely regulated with the following essential institutional features:

- The planning and regulation of the system, including routing, fares, service levels, terminals and other infrastructure etc, is carried out by URBS – a para-statal company;
- Bus services (including non busway based bus services such as express and inter-district services) are operated by private sector companies;
- Bus operators are paid on a per km basis for the services provided using a formula which allows for operating costs, administrative costs and profit and depreciation; company income is thus not related to passenger demand and URBS retains all passenger revenue;
- URBS monitors performance (passengers carried) and checks the bus service delivered (kilometres travelled).

19.1.3 A similar system applies in the Quito busway and is proposed for the Bogota busway system. While Curitiba may not be the only model for operating a bus transit system, it has been shown to be effective and financially viable.

Rail Systems

19.1.4 ***LRT and Metros*** - these are radically different from existing bus, tram or national rail systems, in terms of technology and traffic density. Without high standards of operations, maintenance and administration the system will, particularly in the case of metros, rapidly deteriorate and may become dangerous. The culture, managerial standards and attitudes often found in the bus companies and railway corporations of developing countries are unsuitable for a metro.

19.1.5 Accordingly, most cities set up new institutions with new people and fresh ideas, unhampered by the conventions and attitudes of existing institutions, and with its own purpose-built premises.

19.1.6 Ownership and ultimate responsibility will usually remain with government at some level, but one general aim has been to separate the metro from other transport authorities and to provide its management with some freedom of action. In some cities the metro is owned and therefore ultimately controlled by central government, in others by local government, and sometimes ownership is shared.

19.1.7 Most governments have separated ownership from management by setting up a public corporation as the operating agency. These have often been established as provisional authorities for the implementation phase, when they have rapidly increased in staff numbers from a small core staff to a large undertaking, at which stage they have become full authorities, responsible for all operations.

19.1.8 The evidence is that, as with all businesses, the greater the management focus and autonomy provided, the more effective the metro operation is likely to be. Factors which are important are the following:

- The appointment of the best key staff. The people at the top of the organisation set the culture and drive. Experience is that the best metro operations have senior executives who would compare favourably with any major company board. Conversely, poor appointments fundamentally undermine the operation

- Clear financial targets, and the control over costs and revenues to achieve them. For example, the Singapore MRTC was set the financial objective of covering its operating (operations, maintenance and administration) costs and asset replacement costs from farebox and ancillary revenues. In other words, government fully funded the initial costs, and did not expect to be further involved in funding the operation. The MRTC had the responsibility for controlling its operating costs, which it was responsible for, and for setting service levels and integration arrangements to secure the necessary revenues, on the basis of fares which were to serve the whole population. This was demanding to achieve, and provided clear management focus.

- Arrangements for financial support from government which are contractually secure. Where this has been lacking (Rio was the obvious example in 1990), then the operation cannot be sustained

19.1.9 Occasionally, the metro has become part of the national railways (in Calcutta and Cairo for example). This has not worked well, as the metro has been unable to escape the working practices, wage scales and bureaucratic procedures of the parent organisations, nor to obtain separate treatment of its financial needs.

19.1.10 ***Suburban Railways*** – the World Bank's extensive experience suggests that there are essential prerequisites to maximising the potential of suburban railway systems. Suburban rail operations that contribute to urban transport requirements are unlikely to be possible when provided as part of the national railway system. Rather, it is necessary to have an institution specifically responsible for managing such suburban rail operations whose geographical coverage is coterminous with the main commuter catchment area, and which has some financial independence and therefore power.

19.1.11 Railways are often reluctant in practice to give up their suburban operations, even though they are often a financial burden. However, the implications of *not* being able to secure such acceptable institutional arrangements, is that apparently 'obvious' physical opportunities which should be attractive for rail operations cannot be effectively utilised.

19.2 ***Business Case***

19.2.1 Traditionally governments have procured MRT systems through a range of modalities. Sometimes government itself has undertaken most of the design (through a separate institution), and let a number of equipment supply, construction and coordination contracts. Sometimes contracts have been let to private sector concessionaires for substantial or complete supply packages. Increasingly attention has focused on concession contracts to private sector consortia.

19.2.2 It is necessary to prepare the Business Case for the project, to confirm the decision to let the project, and identify the method of procurement and the terms of the bidding in the knowledge of the likely market response; hence contact with potential bidders is necessary.

19.2.3 This in-depth analysis should:

- Establish the project financial structure
- Identify the nature and scale of all the project risks
- Confirm the procurement modality
- Define the balance between the package of government support and provisions (such as defined tariffs) designed to secure specific government objectives
- Allocate risks between government and the concession company.

19.2.4 ***Private Sector Role*** - The role of the private sector should be defined following analysis of the project financial structure and risks, the effectiveness of government's private sector participation process, sentiment towards the country and the project, and the interests of the private sector parties likely to be interested in bidding. The private sector has an increasing role to play, and the frontiers of potential application are currently being tested.

19.2.5 We are optimistic as to the prospect for *busway* concessioning. This should lead to the improved operational management of existing busways and create promoters to extend busway development. The concept may be a management contract with incentives for operational performance, it may include collecting revenues from operators who use the busway (say a payment per month), or it could be a BOT for a new busway system. A core issue is how to provide incentives to the private sector, while avoiding monopolistic behaviour.

19.2.6 The Latin American experience of *suburban rail* concessioning has comprised a three-prong approach, which appears to be successful: decentralisation of responsibility, concessioning to the private sector, and negative concessions in which tariffs are defined by government to be affordable to the poor. In effect this creates 'surface metros' at low cost, which can benefit the poor. When it is possible to separate responsibility for suburban services, and to manage them separately, then this approach is likely to be applicable.

19.2.7 To date the *metro* experience has focused on the BOT model, and this has been problematic. In part this is because of the project financial and risk characteristics, which have not always been appreciated. Large public funding support is always likely to be necessary, and in the light of recent experience few entrepreneurs are likely to take all the commercial risk. In part it is because of the interests of the private sector players, which are dominantly concerned with securing profits from construction, equipment supply and property development. There has often been little interest in the operational phase. While the projects may have generated construction and supply profits, they have left systems with poor commercial prospects, and property-related profits have often been found to be illusory.

19.2.8 There is likely to be far more caution as to future projects. This is timely, as there is a need to better align the interests of the public and private sectors, given the characteristics of the project and the project environment. Thus the rules of engagement for the private sector, laid down by government, will determine what the private sector brings to the table in terms of role, commercial expertise and funding. There is a range of concessioning possibilities, for example:

- Public sector implementation and initial operations, followed by concessioning the commercial operations
- Public sector implementation of the infrastructure, and a concession for equipment supply and operations
- Design-build-operate-maintain (DBOM), and
- Full BOT

19.3 ***Allocation and Management of Risk***

19.3.1 Central to the business case is an in-depth understanding of the nature and scale of risk. This is an intrinsic feature of any MRT project, and risk needs to be allocated and managed efficiently. This has become a focus of attention with private sector concessions, but should be addressed rigorously what ever the procurement approach.

19.3.2 In public transport there are four main types of risk:

- Production risk
- Commercial risk
- Policy risk
- Other legislative risks

19.3.3 These risks should be defined, understood by all parties concerned, clearly allocated to, and accepted by, the most appropriate party for the purposes of the venture in question and managed prudently throughout the project.

19.3.4 ***Production Risk –*** this includes all those features that relate to the production of transport services such as (Bayliss, 2000):

- The cost of capital
- Labour efficiency
- Labour relations
- Management efficiency
- Technical performance of plant, equipment and other assets, including
- 'Natural' changes in the operating environment (e.g. road and traffic conditions)
- Passenger, employee and public safety
- Compliance with legal requirements

Ideally these should lie with the transport operator, however this may not always be possible when government action is necessary, for example in respect to acquiring land, relocating occupants, obtaining permissions.

19.3.5 ***Commercial Risk –*** this requires the operator to take responsibility for earnings as well as costs. This has the advantage that it opens up the possibility for optimising operating costs and revenues jointly. Amongst other things this means that any savings from providing a poorer service will be offset, to some extent, by reduced revenues. For long-lived assets such as rail systems, where traffic is heavily dependent upon the performance of the economy (total travel increases, the willingness-to-pay for quality increases, and buses find it more difficult to operate in congested conditions) then the commercial risk can be large. This is compounded by uncertainty as to whether tariffs will be adjusted as defined. In such situations the simple allocation of risk may be better dealt with by a sharing of risk, in which the authority provides a minimum traffic guarantee, but shares in higher-than-expected traffic revenue. Operating cost risks should normally be borne by the operator.

19.3.6 ***Public Policy Risk*** - public policy can have important implications for the performance of service contracts, franchises or concessions. This could affect costs (e.g. changes in taxes and traffic restrictions) and also revenues (e.g. authorising competitive services and projects). Because these are better understood by, and under the control of, the public sector these risks will generally reside better with the public authorities. If contractors have to bear them then there will be a tendency to overestimate these; therefore the cost of carrying the risk will be higher than if it were in the public sector. If the contractor under-provided for them then there is a good chance that he would get into financial difficulties and the authority would be in the position of either compensating him, or embarking on the costly and disruptive process of his replacement. Even then the new contractor would include the effects of the policy change in his price.

19.3.7 ***Legislative Risk*** **-** all businesses have to face the risks from changes in legislation. Such changes may lead to more demanding environmental or safety requirements, better conditions for the workforce and changes in general taxation. Public transport operators are no different from other businesses in this respect and there is no reason why public transport service contracts should differ from those in other sectors in this respect. However public transport contracting should follow good commercial practice and recognise these possibilities and make provision for re-negotiation in the same way as in contracting generally. The exception to this may be discriminatory legislation that particularly and substantially affects public transport services. In these instances it will probably make commercial sense to recognise that the authority will carry these kinds of risks, at least in part. This will have to be done by example as it is not possible list all possible contingencies of this kind. The principle underlying such compensation should be that of compensation for 'demonstrable loss'. Although this might seem unduly onerous for operators it does not prevent the authority compensating fully and promptly, but puts it in a strong negotiating position.

19.3.8 While it is difficult to generalise, the experience of BOT metro projects suggests that the following allocation of risks may be appropriate (**Table 19.1**):

TABLE 19.1 BOT METROS - RISK ALLOCATION

Risk	Responsibility of Government	Responsibility of Concession Company
Production		
• Land Acquisition/ permissions	√	
• Design		√
• Construction time/ cost		√
• Financing	(gov't support)	Agreed with the banks √
Commercial – operations, maintenance and administrations cost		√
Commercial – Traffic Revenue	Joint, government sharing in 'super-profits', and providing downside guarantees	
Public Policy - Competing projects etc - Devaluation and Inflation	√	
Legislative	√ discriminatory legislation	
Default and Force Majeure		
• By Concession Company		√
• By Government	√	

19.4 ***Securing Competitive Bids and Operations***

19.4.1 The basis for bidding follows directly from the business case. International marketing to potential investors may be necessary to maximise market interest. Success in attracting serious bidders requires the existence of an acceptable private sector participation process, realism in the balance of risks and rewards offered, confidence in the government resulting from its past performance, and good timing given the external macro-economic environment.

19.4.2 It is necessary to establish a clear and transparent bidding and negotiating process, to minimise the possibility of corruption and to maximise the prospects for successful project implementation and operations:

- The project requirements need to be specified closely, to ensure evaluation of bids can be equitable
- Government support should be defined, where necessary as a maximum - rather then held back for negotiation. This allows the private sector to prepare realistic bids, and helps avoid failed bids
- Government should have access to expert advice during the entire process, from preparation of bid documentation through to contract signature. The private sector will have such advice and Governments need to be equally well prepared
- There is merit in having simple evaluation criteria - for example, bidding at defined tariffs to minimise the level of government investment required since it gives transparent decisions
- Conforming and non-conforming bids should be allowed, to foster private sector innovation. This raises problems in evaluating non-compliant bids, but is on balance desirable in many environments

19.4.3 Government should establish whether and to what extent the private sector project achieves value-for-money, by comparing costs with the best public sector alternative. Government should also seek to establish, through before-and-after audits, how expectations are matched by reality - as a basis for continuous improvements to the process.

19.4.4 Government should be proactive during this period, with the objective of maximising the success of the project. Government will administer the concession contract, and regulate on an agreed basis in the public interest. When unforeseen circumstances occur, government must follow the procedures set out in the concession agreement.

ANNEXES

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